IMPACT OF VISION ON FALLS AND FEAR OF FALLING IN OLDER ADULTS

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy

by

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August 2020

Acknowledgements

First and foremost, a huge thanks to the Dunhill Medical Trust for giving me the opportunity to conduct this research and supporting me throughout the fellowship. Thank you to all my supervisors: Professor Harding, Professor Robinson, Dr Newsham and Dr Czanner for their expertise, guidance and encouragement throughout my PhD journey.

Many thanks to the PPIER (Patient Public Involvement in Eye Research) group and especially all the participants who volunteered to take part in the study and shared their experiences with me.

There are too many to name individually but I have been extremely lucky to have the most amazing family, friends and colleagues. I wish to extend my warm thanks to them all for their advice, love, kindness, support and encouragement. A special thanks to my lovely friend, Ginni Manning, who has spent hours proofreading this thesis and supporting me.

Last but by no means least, thank you to my wonderful husband, Dave and remarkable children: Rohan, Millan and Iyla who have given me their unwavering support, love and encouragement through this endeavour. They have kept me grounded and reminded me to take time out and laugh during some of the tough times. Thank you for believing in me and I'm looking forward to being back in the family fold!

"If I have the belief that I can do it, I shall surely acquire the capacity to do it even if I may not have it at the beginning."

Mahatma Gandhi

Declaration

All work in this thesis, including the clinical assessments and interviews, has been undertaken by myself. I have composed this thesis with the guidance of my supervisors: Professor Harding, Professor Robinson, Dr Newsham and Dr Czanner. Jo Porter was responsible for transcribing the interviews and Dr Gabriela Czanner provided statistical support. Professor Harding acted as the chief investigator on all ethics and sponsorship applications.

This thesis or any portion of it has not been submitted in any previous application for any degree.

For my Dad and Masaji

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List of abbreviations

ABC	Activities-specific Balance Confidence
ActiFE-Ulm	Activity and Function of the Elderly in Ulm
AMD	Age-Related Macular Degeneration
BO	Base Out
BI	Base In
BSV	Binocular Single Vision
CERC	Clinical Eye Research Centre
COPD	Chronic Obstructive Pulmonary Disease
6CIT	6-item Cognitive Impairment Test
CPD	Cycles Per Degree
CRF	Case Record Form
CRN	Clinical Research Network
CS	Contrast Sensitivity
DAG	Directed Acyclic Graph
DVLA	Driving and Vehicle Licensing Agency
ECLO	Eye Clinic Liaison Officer
ELSA	English Longitudinal Study of Ageing
ETDRS	Early Treatment Diabetic Retinopathy Study
EQ-5D	EuroQoL-five dimensional (questionnaire)
FES	Falls Efficacy Scale
FES-I	Falls Efficacy Scale-International
FOF	Fear of Falling
FRIDs	Fall Risk Increasing Drugs
FrPC	Falls related Psychological Concerns
HR	Hazards Ratio
HRQoL	Health Related Quality of Life
HRA	Health Research Authority
IADL	Instrument for Activities of Daily Living

ICD	International Classification of Disease
IDAOPI	Income deprivation affecting older people index
IMD	Index of Multiple Deprivation
IRAS	Integrated Research Application System
rFES	Revised Falls Efficacy Scale
mFES	Modified Falls Efficacy Scale
SFES-I	Short Falls Efficacy Sclate-International
MET	Melbourne Edge Test
MMSE	Mini Mental State Examination
NICE	National Institute of Clinical Excellence
OR	Odds Ratio
PA	Physical Activity
ProFaNE	Prevention of Falls Network Europe
POAG	Primary Open Angle Glaucoma
PROFET	Prevention of Falls in the Elderly Trial
QoL	Quality of Life
RAPA	Rapid Assessment of Physical Activity
RCT	Randomised Controlled Trial
RLUH	Royal Liverpool University Hospital
RR	Relative Risk
SAFFE	Survey of Activities and Fear of Falling in the Elderly
SOC	Sense of Coherence
TUTG	Timed Up To Go
VI	Visual Impairment
VA	Visual Acuity
VF	Visual Field
WHO	World Health Organization

Abstract

Background: Falls are the second leading cause of accidental deaths worldwide mainly in older people. A fall does not only lead to physical health issues but also has psychosocial consequences such as the fear of falling and social isolation. Older people have poor vision. There is published evidence to suggest that poor vision is a risk factor for falls and fear of falling, though it is variable and studies exploring this vary in methodological quality and rigour. Despite, the National Institute of Clinical Excellence (NICE) recommendations, less than half of falls clinics assess vision as part of the multi-factorial assessment of older adults at risk of falls. Published evidence suggests that there is an association of fear of falling with specific ophthalmic conditions. However, no qualitative studies have explored the fear of falling in older adults with age-related ophthalmological conditions.

Aim: To investigate the relationship between visual function and falls and to explore the fear of falling in older adults with age-related ophthalmic conditions.

Method: A mixed-methods approach was used for the study in this thesis. I employed a prospective observational age-matched case-control design to compare measures of visual function between age-matched falls (n=83) and non-falls participants (n=83). Socio-demographic factors, general health, number of medications, health quality, fear of falling and physical activity data were also collected for each participant. The qualitative phase of the study was informed by a phenomenological approach. I conducted semi-structured interviews with two groups of participants with age-related ophthalmic conditions to explore the fear of falling: 1) falls participants (n=15) and 2) participants who had not experienced a fall since their ophthalmic diagnosis (n=15).

Results: Falls participants had significantly poorer visual acuity, contrast sensitivity and depth perception than non-falls participants on univariate analysis (all $p<0.05$). Multivariable logistic regression demonstrated that the combination of social (people from areas of lower-income deprivation), behavioural (older adults reluctant to socialise out of the home) and biological (reduced contrast sensitivity and depth perception) determinants were significant predictors of a fall ($p<0.05$). Participants with age-related sight conditions privilege difficulties with depth perception and lighting when describing the lived experience of their sight. However, many of the participants did not consider their sight condition to be a contributing factor in their fall. The consequences of a fall were transformative from an emotional, social and physical perspective. There was a preponderance of fallers who were fearful of falling compared to the non-fallers who appeared to continue with their daily routines with caution. Although the fall appeared to be transformative for some at the time of the interview, there was a temporal sense of managing the risk or fear and ‘getting on with it’ to minimise the impact on their daily living. Personal, social and environmental resources influenced participants’ responses to managing their risk/fear of falls. Similarly, being diagnosed with a sight condition did not appear to encumber individuals as they used similar resources to cope with their condition and maintain their routines.

Conclusions: Impaired stereoacuity and contrast sensitivity were key visual risk factors for further falls in this study and should be included in the falls assessment. Individuals did not attribute fear of falling to having an age-related ophthalmic condition but were conscious of difficulties with depth perception and lighting. Personal, social and environmental resources influenced participants’ responses to fear of falling and therefore their resilience.

Chapter 1 Introduction

1.1 Rationale for the thesis

One in three people over the age of 65 years will experience at least one fall/year and this rises to 50% of people older than 80 years (NICE 2013). In 2015, 17.8% of the population was 65 years and over and this is expected to increase to nearly a quarter of the population by 2045 (Office of National Statistics 2017). With the ageing population set to increase and evidence to show that the risk of falls increases with age, (Klein et al. 2003) the economic and social care implications for NHS resources is a matter of public health concern. In 2017/18, Liverpool had the highest recorded number of emergency admissions due to falls in people aged ≥65 years in the North West and one of the worst records in England (Public Health England 2019a). Therefore, every effort is required to improve the health and wellbeing of older adults by minimising the risk of falls and consequently the number of hospital admissions.

NICE (2004), in an effort to reduce the risk of falls, recommended a multifactorial assessment which includes an assessment of vision. Despite this recommendation, a national survey of services for the prevention and management of falls in the UK found that the assessment varied substantially, with only 58% of the clinics offering vision assessments (Lamb et al. 2008). The authors went on to report that only 35% of the falls clinics intervened for visual deficits predominantly by onward referral. A briefing paper published by the RNIB in 2011, estimated that the cost of falls associated with sight loss to the NHS is £25.1 million per year (Boyce 2011). Yet, a survey of falls services confirmed that only 54% of respondents checked vision as part of their falls service, and 85% of these simply questioned the patients when they last had an eye test (The College of Optometrists 2014). The survey did not report data on the number of falls services which clinically assessed visual function as part of the multi-factorial assessment of falls.

A number of published studies varying in methodological quality have reported an association of visual function and falls in older adults (de Boer et al. 2004; Freeman et al. 2007; Klein et al. 2003; Lord, Clark & Webster 1991; Lord & Dayhew 2001; Nevitt et al. 1989; Tinetti, Speechley & Ginter 1988). Therefore, the motivation behind this study was to carry out a case-control study comparing all clinical measures of visual function: visual acuity, contrast sensitivity, depth perception, binocular vision and visual fields while adjusting for confounders to robustly establish the risk of impaired visual function and falls.

Furthermore, whilst a fall may have obvious physical consequences such as injuries and fractures, the older adult is also at risk of experiencing a sequelae of outcomes: fear of falling, functional decline, loss of independence, social isolation and a further fall (Scheffer et al. 2008) that has devastating consequences. Fear of falling has been defined as a "*lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing*"(Tinetti & Powell 1993). Fear of falling is not exclusively experienced by individuals who have experienced a fall and is problem in older adults irrespective of their falls history (Kumar et al. 2014; Liu 2015). Studies have identified that individuals with impaired vision have a greater fear of falling (FOF) (Klein et al. 2003; Nguyen et al. 2015) with visual field loss and a decline in contrast sensitivity as significant predictors of fear of falling in patients with age-related macular degeneration (AMD) and glaucoma respectively (Ramulu et al. 2012; van Landingham et al. 2014). Although sight impairment has been identified as one of the predisposing factors for FOF, it is not known how FOF relates to sight affected by age-related ophthalmic conditions such as cataracts, AMD or glaucoma. Each of these age-related ophthalmic conditions can affect different aspects of visual function namely visual acuity, contrast sensitivity, binocular vision, depth perception and visual fields. Hence, the nature of the deficit may affect the patient's perspective on their visual contribution to their independence, mobility and consequently falls. Fear of falling will be further explored in more depth in Chapter 3.

The multi-disciplinary team (MDT) in falls clinics normally includes nurses, occupational therapists, physiotherapists and pharmacists. Eye health professionals rarely form part of this team and instead may offer training to the MDT to assess vision. The assessment of visual function is often overlooked in individuals at risk of falls, maybe due to the lack of clear guidance on which visual function tests should be included. There is also a gap in the depth of knowledge regarding the fear of falling in older adults with age-related sight conditions. Hence, I have designed an innovative mixed-methods study with an aim to establish evidence on specific visual risk factors for falls along with the perspectives of older adults with age-related ophthalmic conditions on the role of vision in falls and fear of falling. The findings of this study may inform clinical practice when assessing older adults at risk of falls particularly in designing the visual assessment element.

1.2 Study objectives

The overall aim of this mixed methods study is to explore the relationship between vision and falls and fear of falling in older adults. In the quantitative phase of the study my aim is to identify whether there is an association between impaired measures of visual function and falls. In the qualitative phase, I explore the perspectives of individuals with age-related sight conditions and their experience of having a sight condition in relation to falls and fear of falling. There are three main objectives of the study:

Quantitative objective:

1. Compare the following measures of visual function in falls and non-falls participants to determine an association between impaired visual function and falls:

- Visual acuity
- Contrast Sensitivity
- Depth perception (i.e. stereoacuity)
- Binocular functions
- Visual Fields

Qualitative objectives:

2. To explore the experiences of older people with age-related sight conditions (cataracts, AMD or glaucoma) who have suffered a fall and gain an insight into their view on the role of sight in the fall and potentially their fear of future falls.

3. To explore the experiences of individuals recently diagnosed with an age-related sight condition (cataracts, AMD or glaucoma) and their perspective on the role of sight in having a fear of falling and the impact on their daily life.

1.3 Thesis structure

The overall structure of this thesis takes the form of nine chapters, including this introductory chapter. Chapters 2 and 3 include a review of the relevant literature for this thesis. Literature searches were conducted using the University database 'Discover' for books and journal articles. Web of Science (1898-current), MEDLINE (1946-present) and APA PsycInfo (1887-present) were used to conduct searches of relevant published journal articles and details of the search terms for Chapters 2 and 3 are in Appendix 1. Reference lists from individual journal articles were manually searched for further relevant sources.

In Chapter 2 (Falls and visual function), I give an overview of the literature on falls including the definition, epidemiology and risk factors. In the same chapter, I describe and critically evaluate each measure of visual function that is assessed in this study with a critical appraisal of the literature on the association of impaired visual function and falls.

In Chapter 3 (Fear of falling, risk and resilience), I present a literature review of the fear of falling, including the various measures, risk factors and consequences. Later in the chapter, I examine the concepts of fear, risk and resilience with a theoretical lens that supports the qualitative findings in this study.

In Chapter 4, I give an overview of my philosophical underpinnings which informed the mixed-methods design of the study in this thesis. The overall mixed methods design is then described before giving a full account of the specific methods and statistical analyses used for the quantitative phase of the study. I then follow this with the theoretical framework (phenomenology) that has informed the qualitative phase of the study before describing the specific methods employed for the interviews and data analysis.

In Chapter 5, I present the analysis of the non-visual and visual data collected for the falls and non-falls participants during the quantitative phase of the study. Within this chapter, I present univariate and multivariable analyses to account for confounding factors when determining the association between impaired visual function and falls.

In Chapters 6, 7 and 8, I present the qualitative findings from this study. Chapter 6 begins with a brief introduction to each of the participants in the qualitative phase of the study before presenting the subjective perceptions of sight as seen and described by the participants in this study.

The qualitative findings from the 'fall' and the 'fear of falling' are presented in Chapter 7, where participants have described the causes and consequences of the fall. I also give an account of the participant's description of either feeling fearful or cautious of falling in relation to their sight.

Chapter 8 is the final findings chapter in which I present the life-worlds of individuals that influence the way in which they manage following the fall or being diagnosed with a sight condition, both considered disruptive events. The findings highlight the importance of individual, environmental and social resources in managing disruptive events and making positive adaptations.

I have introduced and summarised each of the chapters. Chapter 5 includes a discussion of the quantitative findings. However, in Chapters 6, 7 and 8 I have woven the discussion through the narratives.

In Chapter 9, I have discussed and assimilated the key findings from both the quantitative and qualitative phases of this study in relation to previously published literature. The final conclusions include recommendations for future research.

Chapter 2 Falls and visual function

2.1 Introduction

In this chapter, I discuss the literature on the association of impaired visual function and falls. I begin with a review and discussion of the literature pertaining to falls including the definition, epidemiology and risk factors (Section 2.2). This is followed by a critical review of the literature on each visual function and a justification for the assessment of each measure in this study (Section 2.3). Finally, I summarise the chapter highlighting the gaps in the evidence base regarding vision and falls and my rationale for the clinical quantitative component of my thesis.

2.2 Overview of falls

A ‘fall’ can be interpreted as one of many potential incidents e.g. slip, trip, collision or syncope which brings an individual from an upright position to lying on the ground. In this section (2.2.1), I discuss the various definitions used for a fall and the one that I will use for this study. Falls are a global public health problem (WHO 2007) and in Section 2.2.2, I present the findings from the published literature on the epidemiology of falls in countries across the world. The risk factors for falls are diverse explaining their multi-factorial nature. The main non-visual risk factors will be evaluated here in this Section (2.2.3) and visual deficits associated with falls will be addressed in Section 2.3.

2.2.1 Definition of a ‘fall’

Zecevic et al. (2006) suggest that people use tacit knowledge to define a ‘fall’ and therefore attempt to define it by the cause, for example, a ‘slip’ or ‘trip’. In their study to determine the definition and the main reasons for a fall, they conducted interviews with community-dwelling older adults (≥55 years, N=477) and health practitioners (N=31). The authors reported that older adults and health care practitioners focused on the events leading to the fall and the consequences of the fall. They argued that definitions used by researchers in the published literature focussed on the event of the fall itself rather than events leading to and after the fall. This was a large telephone interview study and therefore was carried out by multiple volunteers choosing common phrases on a form. This could potentially introduce variability in how each of these phrases were applied. However, their study design suggests that all transcripts were appropriately analysed. The main contribution from their findings is that research studies need to have a working definition of a 'fall' which has clear inclusion and exclusion criteria and is easily understood by participants recruited to the study.

The Prevention of Falls Network Europe (ProFaNE) is a thematic network of 25 partners who work on a collaborative project to reduce the burden of fall injury in older people (Lamb et al. 2005). They developed a consensus on the definition of a fall as 'an unexpected event in which the participant comes to rest on the *ground, floor, or lower-level*'. The simplicity of this definition leaves little room for interpretation as it does not refer to any medical consequences or causes of the fall. The WHO definition of a fall is similar but includes an explicit exclusion of individuals who do not come to the ground but instead are consciously aware of coming to rest from an upright position: "*inadvertently coming to rest on the ground, floor or other lower level, excluding an intentional change in position to rest in furniture, wall or other objects*"(WHO 2007).

There is also the issue of defining injurious falls which, in a systematic review was found to be defined in three main ways: 1) based on symptoms (fractures, bruises, sprains, lacerations) 2) based on a combination of symptoms and healthcare use (hospital attendance, wounds needing stitching, medical help) and 3) based on healthcare use only (Schwenk et al. 2012). However, there is potential for variation when reporting injurious falls using these possible definitions. There is inconsistency in the definition of falls depending on the person, place and nature of injury in the literature, therefore for this study, I have adopted the ProFaNE definition of a fall as it does not include specific medical causes or events and is easily understood by participants.

2.2.2 Epidemiology of falls

The incidence data on falls dates back to the 1980s and 90s when large population studies were carried out. The data estimated that the number of individuals over the age of 65 years suffering at least one fall/year ranged from 28-35% (Blake et al. 1988; Prudham & Evans 1981) which increased to 32-42% in the 75+ age group

(Downton & Andrews 1991; Tinetti, Speechley & Ginter 1988). However, these and many other studies (Table 2.1) relied upon the respondents recalling a fall in the preceding 12 months and therefore are potentially underestimated due to recall bias. The falls rate in people living in long term care institutions is twice the rate of community-dwelling older adults (Rubenstein 2006). However, in this thesis, I will focus on falls in non-institutionalised older adults only.

In epidemiological studies it is essential to clearly define the fall as the findings could relate to 'injurious falls' only or 'all falls' irrespective of the nature of the injury. Also, an 'injurious fall' could be defined as a fall that results in 'fracture(s) only' or falls that have resulted in 'lacerations, bruises and fractures'. The systematic review described earlier by Schwenk et al. (2012) found a number of differences across RCT falls prevention studies in categorising and defining injurious falls. Following their review, the authors recommended that injurious falls should be categorised as serious, moderate and minor by both symptoms and medical care use. They suggest that a consistent and standardised approach to defining falls would allow for a more robust comparison of outcomes. In my opinion, any report on falls incidence should include 'all falls'; injurious and non-injurious as individuals may experience consequences beyond the physical injuries. Therefore, I have included studies reporting 'all falls' in Table 2.1.

Peel (2011) reviewed the literature from sixteen different countries to illustrate the incidence/prevalence of falls in community-dwelling older people. The author highlighted that between 20-33% of older adults fall each year, with the lowest rates in Hong Kong Chinese (Chu, Chi & Chiu 2005). Further studies identified in Table 2.1 illustrate the variation in falls worldwide but there is considerable heterogeneity in how falls are reported in each of the studies. Ganz, Higashi and Rubenstein (2005) highlighted that although recall of any fall in the previous year is relatively specific (91-95%) it is less sensitive when compared to intensive prospective data collection with calendars or diaries. This was further supported by Freiberger and de Vreede (2011) who favoured a prospective design as self-reported recall of falls may be underreported.

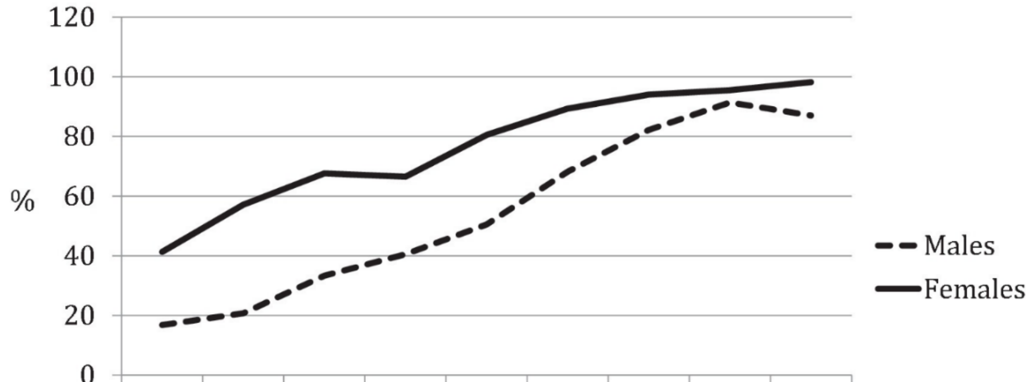
Table 2.1: Proportion of community-dwelling people reporting falls (Studies 2011-19, presented in order of most recent to oldest)

Author (Date) Study design	Country	Falls reporting	Sample and size (N)	Findings
Gamage, Rathnayake and Alwis (2019) **A cross-sectional study of rural communities**	Sri Lanka	Fall reported in the last 12 months on a questionnaire	Community-dwelling patients (age ≥65years) N=300	34.3% of participants reported a fall in the previous year
Almegbel et al. (2018) **Cross-sectional study**	Riyadh, Saudi Arabia	Fall reported in the last 12 months on a questionnaire	Community-dwelling patients (age ≥60years) N=1182	49.9% experienced one or more falls during a 12-month period
Cruz and Leite (2018) **Cross-sectional as part of the Health Survey of the Elderly Population of Juiz de Fora.**	Brazil	Fall reported in the last year on a questionnaire	Community-dwelling older people ≥60 years. N=400	35.3% reported a fall in the last year 44.0% had fallen more than once
Yunchuan et al. (2018) **Cross-sectional study as part of the National Health and Aging Trends Study (NHATS)**	US	Fall reported in the past month	Community-dwelling older people ≥65 years. N=5930	683 (11.5%) reported a fall in the previous month

Franse et al. (2017) **Cross-national Survey of Health, Ageing and Retirement in Europe (SHARE)**	12 European countries (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, The Netherlands, Spain, Sweden, Switzerland)	Fall reported in the past 6 months	Community-dwelling older people ≥65 years. N=18596	Switzerland, Denmark, Sweden and Austria 7.9% - 9.5% Italy, The Netherlands, Germany and Belgium 11.0%- 12.8% Estonia, France, Spain and the Czech Republic 13.9%- 16.2%
Gazibara et al. (2017) **Cross-sectional study**	Serbia	Fall reported in the last 6 months during a survey	Community-dwelling patients (age >65 years) N=354	15.8% reported falling in the past 6 months
Gale, Cooper and Aihie Sayer (2016) **A cross-sectional study from the English Longitudinal Study of Ageing (ELSA)**	England	Falls reported in the last 2 years on a survey	Community-dwelling patients (age ≥60years) N=4301	28.4%, (Women-29.1%, Men-23.5%)
Jiang et al. (2015) **Systematic review and meta-analysis of 40 cross-sectional studies published from 2000.**	China (mainland)	Survey studies were included but no data on whether falls were recorded prospectively or retrospectively	27 articles reviewed and overall sample N=98392	54.95 (fall-related injury) per 1000 persons

Boffin et al. (2014) **Cross-sectional study over 2 years.**	Belgium	Fall recorded by the GP for new injuries caused by a fall	Community-dwelling patients (age 65 years and older) N=1503 reported a fall-related injury	Person based incidence estimated as 2509 per 100000
Rapp et al. (2014) **Cohort study derived from two population-based studies:** **1) German health interview and examination survey for adults (DEGS1)** **2) Activity and Function of the Elderly in Ulm study (ActiFE-Ulm)**	Germany	DEGS1 -Fall reported within the last 12 months on a questionnaire ActiFE-Ulm-Weekly fall calendars posted back every 3 months and retrospective data	Community-dwelling older adults DEGS1 8(age 65-<80 years), N=1986 ActiFE-Ulm (aged 65-<90, N=1388	Retrospectively assessed falls (65-<80 years gp): DEGS1- 25.7% (women), 16.3% (men) ActiFE-Ulm-37.4% (women), 28.9% (men) Prospectively assessed falls (65-<90 years) ActiFE-ULM- 38.7% (women), 29.7% (men)
Muraki et al. (2013) **Cohort study**	Japan	Fall reported in previous 3 years	Community-dwelling people aged 23-95 years. N=2215	18.9% women & 24.6% men reported at least one fall.
Milat et al. (2011) **Cross-sectional study**	New South Wales, Australia	Fall reported in the last 12 months on a questionnaire	Community-dwelling patients (age ≥65years) N=5681	25.6% reported falling in the previous year

The prevalence rate of fractures from falls will also vary depending on whether it has been reported as *any fracture* or *hip fracture only* and whether prevalence differs for men, women and across the age groups. For example, an epidemiological study from Edinburgh Royal Infirmary reported prevalence rates of fall-related fractures (non-spinal) in men and women of different ages. The graph from their paper (Figure 2.1) highlights the increased prevalence of falls-related fractures in the older age groups but also in women compared to men (Court-Brown et al. 2017). The difference in prevalence in females, particularly in the older age groups, can be attributed to older females suffering from osteoporosis and osteopenia. It has been reported that younger women of the equivalent body size and age to males have lower bone mineral content and density to their male counterparts (Nieves et al. 2005). Hence, the evidence from the Edinburgh study would suggest that gender is a key risk factor as highlighted in the study from Edinburgh (Court-Brown et al. 2017).



	16-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90+
Males	16.8	20.7	33.3	40.5	50.5	68.2	82.2	91.4	87
Females	41.3	57.1	67.6	66.5	80.5	89.3	94	95.5	98.2

Figure 2.1: Prevalence of fall-related fractures in males and females in different age groups in 2010/11 (Court-Brown et al., 2017)

The following section will examine key risk factors which may explain the reason for the global variation in falls rates that I have explored in this section. There is wide variation in the proportion of community-dwelling older adults reporting a fall worldwide, from 7.9% in Italy, The Netherlands, Germany and Belgium to 49.9% in Riyadh, Saudi Arabia. There is considerable heterogeneity in the methodology of the studies to determine the prevalence or incidence of falls. However, it is clear there is substantial variation in the falls rate globally. Future studies could explore risk factors such as the socioeconomic status, the built environment and cultural values affecting physical activity which could potentially explain this global variation.

2.2.3 Risk factors

Falls have a multi-factorial aetiology with some review studies reporting on a large number of risk factors (Ambrose, Paul & Hausdorff 2013; Bloch et al. 2013; Deandrea et al. 2010). Based on several identified risk factors, NICE recommends that older adults should have a multi-factorial assessment to prevent further falls (NICE 2004). The risk factors have been described as intrinsic; for example, age, co-morbidities, physical fitness, mobility, cognitive impairment and visual impairment, or extrinsic; for example, environmental hazards in and outside of the home (Bueno-Cavanillas et al. 2000; Todd & Skelton 2004).

It was the seminal prospective one year study by Tinetti, Speechley and Ginter (1988) that identified specific risk factors associated with falls in a sample of 336 older adults aged ≥ 75 years. Participants were excluded if they were non-ambulatory or living in a nursing home. Falls data were recorded monthly by telephone interviews with each participant asked to keep a diary of their falls. At the one-year follow-up, 32% of the cohort had experienced at least one fall. Although many of the variables (risk factors) were significant at the bivariate level, their logistic regression model retained six independent risk factors (at 0.05 significance level): use of sedatives, cognitive impairment, lower-extremity disability, palmomental reflex, foot problems and an increased number of balance and gait problems. Poor vision at near was reported to be significantly associated at the bivariate level but was not included in the final model. The authors defined impairment as a 20% loss of vision but did not identify the level of 'poor vision' at near to make any judgements regarding the association. The authors found that the risk of a fall increased linearly with the number of risk factors, for example, individuals with zero risk factors had an 8% risk of having a fall compared to 78% in those with four risk factors ($p<0.001$).

Since then, there have been many exploratory studies published on specific risk factors associated with falls. Todd and Skelton (2004) summarised some of these studies and reported that intrinsic factors were more likely to be associated with falls among people aged 80 years and over, whereas, for people under 75, extrinsic causes were more likely. Whilst the risk factors are broadly described as extrinsic or intrinsic, a model proposed by the WHO (2007) further categorises each factor into 4 main domains: biological, behavioural, environmental and socio-economic, illustrating their interaction and that exposure to these factors increases the risk of a fall (Figure 2.2). The WHO model is useful to conceptualise the groups of risk factors.

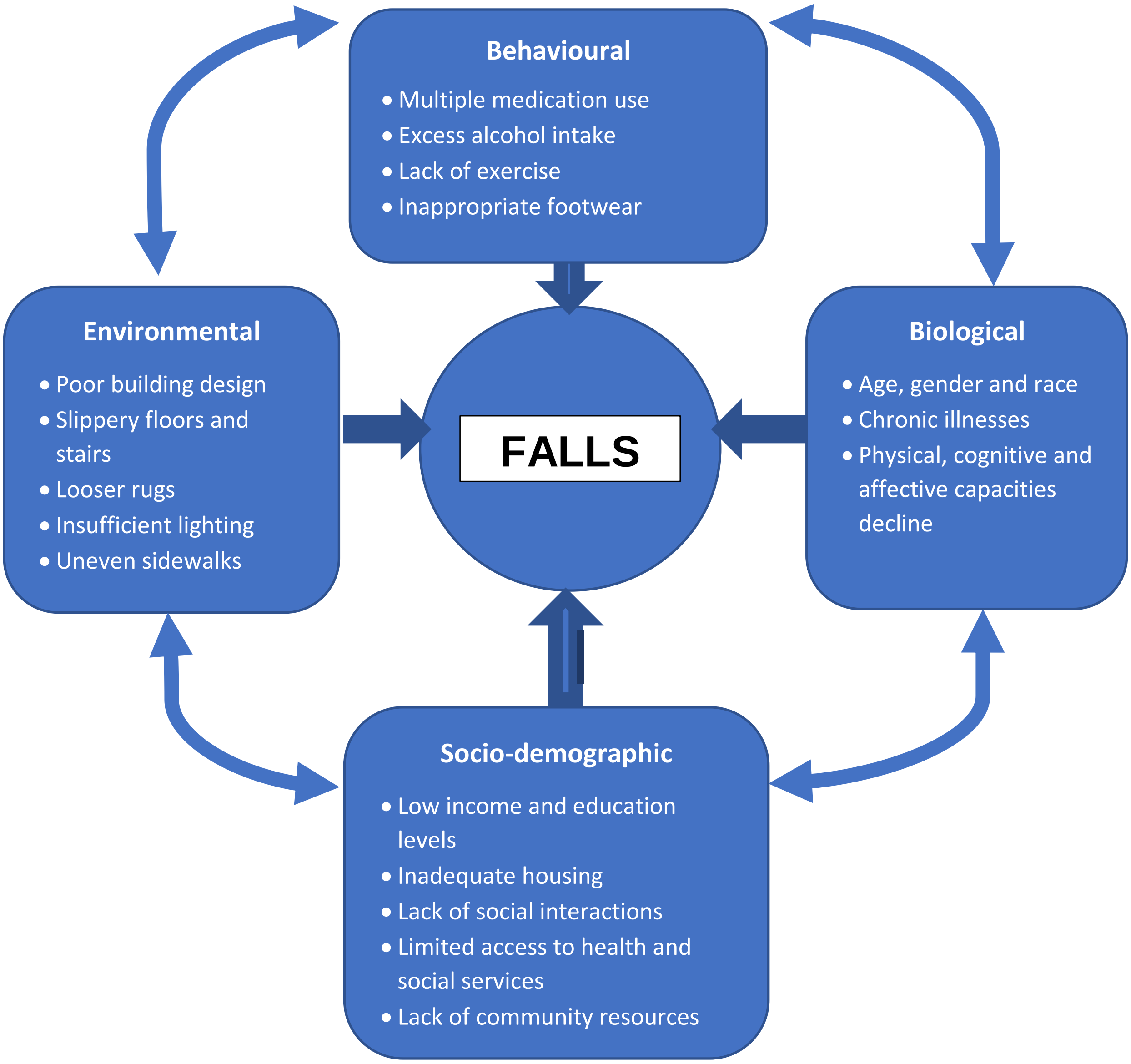


Figure 2.2: Risk model for falls (WHO, 2007)

Two systematic reviews with meta-analyses of the risk factors for falls have been published in the last decade (Bloch et al. 2013; Deandrea et al. 2010). Deandrea et al. (2010) included prospective studies published from 1988-2009 and found 31 risk factors from a total of 74 studies to include in their review and meta-analyses. Bloch et al. (2013) performed 88 meta-analyses from 220 studies (published from 1981-2011) on 156 identified potential risk factors. It is difficult to compare each of these reviews as the methodology varied for each in terms of inclusion of the studies, measuring heterogeneity and the outcome data for each of the risk factors.

Sociodemographic data were missing in the review by Bloch et al. (2013) as it was handled in a separate study which had different study selection and inclusion (Bloch et al. 2010).

In Table 2.2, I have illustrated some of the key findings from the comprehensive systematic review by Deandrea et al. (2010). The data is reported as pooled odds ratios from all the studies reviewed in their systematic review, including those reporting adjusted and unadjusted ORs (odds ratio) and for all fallers (person who had fallen at least once during the follow-up period).

Table 2.2: Association of risk factors with falls in community-dwelling older people (pooled odds ratio for all fallers and from all studies in the systematic review by Deandrea et al. (2010)

Risk factor	Measure of effect -OR [95% CI]	Heterogeneity p-value
History of falls	2.77 [2.37-3.25]	0.0001
Age (5-year increase)	1.12 [1.07-1.17]	<0.0001
Gender	1.30 [1.18-1.42]	0.004
Education (low vs intermediate/high)	1.01 [0.88-1.16]	0.01
Living situation (alone vs non-alone)	1.33 [1.21-1.45]	0.44
Physical activity (limitation vs no limitation)	1.20 [1.04-1.38]	0.01
Walking aid use (yes vs no)	2.18 [1.79-2.65]	0.006
Co-morbidity (Increment of 1 condition)	1.23 [1.16-1.30]	<0.0001
Self-perceived health status (poor vs good)	1.50 [1.15-1.96]	0.004

Fear of falling (yes vs no)	1.55 [1.14-2.09]	<0.0001
No. of medications (for 1 drug increase)	1.06 [1.04-1.08]	0.86
Hearing impairment (yes vs no)	1.21 [1.05-1.39]	0.13
Vision impairment (yes vs no)	1.35 [1.18-1.54]	<0.0001

The strengths of the review by Deandrea et al. (2010) are that only prospective studies were included and they used a minimum of 5 studies to estimate the predictive value of each risk factor. They also calculated statistical heterogeneity for each risk factor and those with a p-value <0.05 meant that the results from individual studies were heterogeneous. Hence, from Table 2.2, studies evaluating 'living situation', 'no. of medications' and 'hearing impairment' were not significantly heterogeneous. Impaired balance was not evaluated in their review due to the variety of methods used to assess balance across the studies.

Similar to the review by Deandrea et al. (2010), taking medication (yes/no), history of fall(s), fear of falling and use of a walking aid were some of the most significant risk factors reported in the review by Bloch et al. (2013). Here, I briefly discuss some of the main risk factors that have been evaluated since the review by Deandrea et al. (2010). Literature published on visual risk factors for falls is evaluated separately in Section 2.3.

History of fall(s)

A history of falling is a strong risk factor for further falls (Deandrea et al. 2010; Gale et al. 2018; Pohl et al. 2014). Pohl et al. (2014) conducted a 5-year prospective long-term study to determine whether a history of falls (injurious and non-injurious) increased the risk of further falls in community-dwelling older adults (75-93 years, N=230). The authors reported those who had sustained at least one injurious fall in the initial 12-month follow up had a three-fold increased risk (95%CI, 1.40-5.50) of experiencing an injurious fall within the next five years compared to those with no falls. More recently Gale et al. (2018) in the English Longitudinal Study of Ageing (ELSA), prospectively examined the risk factors for incident falls over a 4 year period in 3298 people aged 60 years and over. The authors reported a relative risk of 1.67 (95% CI, 1.55 - 1.79) in those who had a history of previous falls. The evidence from both of these prospective longitudinal studies suggests that having a history of a fall in the previous 12 months increases the risk of further falls in the future. These findings imply that a history of falls could potentially impact on the significance of additional modifiable risk factors.

Age and gender

Data from the Centres of Disease Control and Prevention (CDC) in the US demonstrated that death from falls increased with age between 2007-16 and that the largest increase was in people aged ≥ 85 years (Burns & Kakara 2018). The China Health and Retirement Longitudinal Study (CHARLS) studied fall prevalence over two time periods, 2011 (N=6114) and 2013 (N=8683) in people aged 60 years and older (Wu & Ouyang 2017). The authors reported a significant reduction in falls in older adults aged 66-70 years over a 2-year period but a significant increase in falls in individuals over the age of 80. They also reported that chronic disease was a significant factor associated with falls which may explain the difference in prevalence between the two age groups with the older group potentially having an increased number of chronic diseases. Although the consensus remains that there is an increased likelihood of falls with advancing age (Deandrea et al. 2010), it may differ for men and women as age-related risk factors may vary across men and women, for example, the onset of osteoporosis.

In both men and women, the risk of falls has been reported to increase with age, but following multivariable analysis, age was associated with a slight risk in men only (OR=1.02, 95%CI,1.04 - 1.07)(Gale, Cooper & Aihie Sayer 2016). However, a later study examining the risk for incident falls in older men and women found that older age was the only factor associated with increased risk of incident falls in both genders (men-RR 1.15, 95% CI, 1.10 - 1.21, women-RR 1.12, 95%CI, 1.07 - 1.17) (Gale et al. 2018). The differences in associations between the two studies may be due to the methodology. The earlier study by Gale, Cooper and Aihie Sayer (2016) was cross-sectional examining a history of falls in the previous 2 years compared to the longitudinal study (Gale et al. 2018) examining incident falls over a 4 year period.

Chang and Do (2015) conducted a large cross-sectional study (Canadian Community Health Survey-Healthy Aging) of 14,881 Canadian adults aged 65 years and over. They reported that whilst falls prevalence increased with age among both genders, there was a greater influence of age on the risk of falling in women age ≥ 85 years (OR 1.51 95% CI, 1.14-2.00). Ageing brings along physiological and pathological changes that can account for the increased risk of falls. Also, there is evidence to suggest muscle weakness in women 70 years and older and the increased risk of falls in women (Campbell, Borrie & Spears 1989).

To summarise, studies have consistently reported an increased risk of falls with increasing age, but the influence of gender is inconclusive with evidence weighted towards an increased risk of falls in women (Chang & Do 2015; Deandrea et al. 2010). In the quantitative phase, I have age-matched the fall and non-falls participants, thereby formally adjusting for age as a risk factor in this study but I will examine the differences in falls between men and women.

Fear of falling (FOF)

Falls and fear of falling (FOF) have been reported to be predictors of each other and have other shared risk factors such as being female and having a history of stroke (Friedman et al. 2002). A recent longitudinal prospective study of 640 community-dwelling individuals aged ≥ 75 years was conducted in a region of Spain (Lleida) to determine whether FOF was a cause, consequence or both of falls (Lavedán et al. 2018). The authors recorded the FOF with a simple yes/no to the question "are you afraid of falling?" at baseline along with socio-demographic data and previous falls data. The authors reported that women were four times more likely to be afraid of falling than men and that women were four times more likely to fall within a period of two years than men. However, there was no association between FOF and falls in a logistic regression model adjusted for socio-demographic variables. Instead, having a previous history of falls was a strong risk factor for falls along with female gender, comorbidities, symptoms of depression and disability (Lavedán et al. 2018).

Murphy, Dubin and Gill (2003) also reported that those who developed a fear of falling had specific predisposing factors; age 80 years or older, visual impairment, a sedentary lifestyle and no available emotional support which was evident in 85% of the participants who experienced a subsequent fall. Fear of falling, like falls, is multi-factorial (Kumar et al. 2014) and as a result, has common risk factors.

Medication use

There are two issues to do with medication use and the risk of falls: 1) the effects of particular types of medications and 2) the number of medications. A meta-analysis of the impact of nine medication classes (antihypertensives, diuretics, B-blockers, sedatives/ hypnotics, neuroleptics/anti-psychotics, antidepressants, benzodiazepines, narcotics and non-steroidal anti-inflammatory drugs) on falls reported that sedatives/hypnotics, anti-depressants and benzodiazepines demonstrated a significant association with falls in older adults (≥60 years) (Woolcott et al. 2009). This was later supported by a meta-analysis study examining the association between psychotropic medicines and falls (OR 1.78, 95%CI 1.56-2.01) (Bloch et al. 2011).

Psychotropic and cardiovascular medications are considered as the most important class of fall risk-increasing drugs (FRIDs) (Seppala et al. 2019). An RCT conducted in the Netherlands reported no effect of withdrawal of FRIDs on falls in 612 community-dwelling older people aged 65 years and over (Boyé et al. 2017). The trial was affected by a significant non-compliance rate due to the complex nature of multi-morbidities in older people, hence raising the need for a further study to validate these findings. A Cochrane review of interventions for preventing falls in older people in care facilities and hospitals also reported low-quality evidence to suggest that a general medication review may make little or no difference to the rate of falls (Cameron et al. 2018). In light of the evidence from the RCT and Cochrane review, NICE is considering a change in the current recommendation regarding reviewing the use of psychotropic medicines to prevent falls in older people (NICE 2019a). NICE acknowledges that optimising medicines has wider benefits and is good practice when managing multimorbidity. Therefore in their surveillance report (NICE 2019a), they have suggested that reviewing medications is covered within their guidelines on multimorbidity and medicines optimisation.

Nonetheless, multiple medication use (polypharmacy) remains a risk factor in older adults (Deandrea et al. 2010). In a systematic review of definitions of polypharmacy, the most commonly used definition was the consumption of five or more medications daily (Masnoon et al. 2017). The ELSA study assessed the longitudinal association between polypharmacy and falls in a study population of 5213 adults aged ≥60 years (Dhalwani et al. 2017). The authors reported that the rate of falls was 21% higher in people with polypharmacy (≥5 drugs) compared to those without and was also high at 18% when the threshold was lowered to using ≥4 drugs daily. Therefore, although there is little or no evidence for a medication review reducing the risk of falls (Cameron et al. 2018), the NICE surveillance summary (NICE 2019a) suggests that medication review in those individuals who are at risk of falls and are on four or more medications should have a review as good practice for optimising medicines and in the management of comorbidities.

Co-morbidities

The risk of having a fall increases with the number of co-morbidities (Deandrea et al. 2010; Gale, Cooper & Aihie Sayer 2016; Sibley et al. 2014). Gale, Cooper and Aihie Sayer (2016) in the ELSA study surveyed 4301 men and women to establish potential risk factors for falls. The authors reported that the diagnosis of at least one chronic disease which included diagnoses of heart attack, heart failure, stroke, chronic lung disease, diabetes, arthritis, Parkinson's disease, dementia, psychiatric illness, cancer and osteoporosis was associated with an increased likelihood of falls in women and men. A larger cross-sectional survey of 16,357 older adults ≥ 65 years examined fall risk and patterns of particular co-morbidities(Sibley et al. 2014). The study included 8 co-morbidities (arthritis, cancer, chronic obstructive pulmonary disease (COPD), diabetes, depression, heart disease, hypertension, stroke) based on overall prevalence in a representative population (Diederichs, Berger & Bartels 2011) and a further 5 conditions which the authors identify from the literature as being associated with falls (dementia, osteoporosis, Parkinson's disease, urinary incontinence and visual impairment). The authors reported that except cancer each condition was associated with increased prevalence of falls but that hypertension and COPD were the dominant conditions in the clusters significantly associated with falls. Parkinson's disease was, however, removed from the cluster analysis due to the low prevalence in the participants. Neurological conditions like Parkinson's and stroke have been reported in another study to be associated with impaired gait and postural stability and consequently a greater risk of a fall (Samuelsson, Hansson & Persson 2019).

Balance impairment may also be present in older adults with diabetes due to the effect of the disease on the visual, somatosensory and vestibular system which are all essential for postural stability (Hewston & Deshpande 2016). In a systematic review evaluating the risk of falls in older people with diabetes, older adults with diabetes were found to have a 64% increased risk of falls (Yang et al. 2016). Diabetes is a risk factor for kidney disease and the incidence of falls in chronic kidney disease has been reported to be between 1.18-1.60 fall/patient year (López-Soto et al. 2015).

NICE guidance has recognised that the multifactorial assessment for falls should include an assessment of urinary incontinence and a cardiovascular examination (NICE 2013). Urinary incontinence has been reported to be associated with an increased risk of falls (OR 1.45, 95% CI 1.36 to 1.54) (Chiarelli, Mackenzie & Osmotherly 2009), however having mobility issues could confound this risk factor. Managing postural hypotension and common cardiovascular disorders associated with falls have been recommended by the American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons (Summary of the Updated American Geriatrics Society/British Geriatrics Society Clinical Practice Guideline for Prevention of Falls in Older Persons 2011).

Many comorbidities have been identified in the literature to be associated with falls. These can be broadly grouped into neurological (stroke, Parkinson's), circulatory (heart conditions, hypertension and hypotension) metabolic (diabetes, kidney disease), musculoskeletal (osteoarthritis and osteoporosis) and sensory (vision and hearing).

Impaired balance

Maintaining balance is dependent on the appropriate input from the vestibular, visual, somatosensory and musculoskeletal systems with appropriate cognition (Horak 2006). Reduced balance control has been demonstrated in older adults with low vision and blindness (Chen et al. 2012). Deandrea et al. (2010) did not address impaired balance specifically as a risk factor in their systematic review due to the number of studies using non-comparable ways to measure balance, however, they did find that if individuals had gait problems they were twice as likely to be at risk of having a fall (OR=2.06, 95%CI 1.82-2.33). Balance related impairments have been reported to be critical predictors of falls (Delbaere et al. 2010c). Exercises which target balance, gait and muscle strength have been shown to be an effective intervention for preventing falls in community dwelling older people in a Cochrane review of 108 randomised controlled trials (Sherrington et al. 2019). This finding suggests that impaired balance is a modifiable risk factor for falls.

Reduced physical activity

In a review on the effect of physical activity (PA) on postural stability, Skelton (2001) reported that moderate PA can help modify certain risk factors for falls like strength and balance. However, the author also highlights the need for the exercise to be an individually tailored intervention, which is progressive and enjoyable. In a systematic review and meta-analysis of 23 studies, physically active older adults were reported to be at less risk of falls (OR=0.75, 95%CI: 0.64 - 0.88) compared to those who were physically inactive or sedentary (OR=1.41, 95%CI: 1.10-1.82) (Thibaud et al. 2012). Although the authors included a number of studies for review, in some cases the distinction between physical activity and sedentary behaviour was not clear and the quality of some studies was poor. For example, PA was determined through self-report questions or non-validated measures. However, a more recent systematic review to determine the association between PA level and risk of falling (Soares et al. 2019) included only four studies but each of them had measured the level of PA using either PA questionnaires or objective measurements (using motion sensors or accelerometers). The authors reported there was inconclusive evidence regarding the association between any falls and the level of PA but did find that the risk of recurrent falls increased by 39% if older adults had the lowest level of PA. The levels of PA were defined according to the instrument used in each of the cohort studies. The evidence for reduced physical activity as a risk factor for falls is inconsistent, mainly due to the problems with measuring physical activity (subjective vs objective) and categorising the type of PA, for example, walking or strength and balance training (Clarke, McMurdo & Witham 2015). Yet, a recent Cochrane review of 108 RCTs of exercise (as an intervention) for preventing falls in older people concluded with high certainty evidence that exercise (all types) resulted in a 23% reduced rate of falls compared to the control intervention (Sherrington et al. 2019). Further longitudinal evidence is needed to determine objective levels of PA including the type and duration to prevent further falls in individuals with varying levels of baseline strength and balance.

Environmental hazards

Indoor and outdoor environmental hazards have been reported to be risk factors for falls (Gillespie et al. 2012; Lee, Lee & Ory 2019; Li et al. 2006). Letts et al. (2010) completed a systematic review and meta-analyses of cross-sectional and cohort studies to evaluate the physical environment as a risk factor for falls. Home hazards were not a significant risk factor when all studies were included in the meta-analyses (OR=1.15, 95%CI: 0.97 – 1.36) but did reach significance when only the highest-rated studies were analysed (OR=1.38, 95%CI: 1.03 – 1.87). Also, they found that the use of mobility aids increased the risk of falls (OR=2.07, 95%CI: 1.59 -2.71) but the effect may have been due to poor balance or lower limb weakness rather than the mobility aid. It is difficult to ascertain the type and number of home hazards in a study, therefore there was considerable heterogeneity in the studies included in the review (Letts et al. 2010). A Cochrane review of interventions to prevent falls concluded that home safety improvements by an occupational therapist reduced the rate of falls and risk of falling (Gillespie et al. 2012) therefore implying the increased risk of home hazards for indoor falls.

Li et al. (2006) interviewed 2193 participants to determine risk factors for outdoor falls in participants aged ≥ 45 years. The authors reported a significant association between increased leisure-time physical activity and outdoor falls with 73% caused by uneven surfaces, tripping or slipping on objects either on the pavements, curbs and streets. These outcomes are further corroborated by the findings of a mixed-method study exploring the experience of older adults (N=120, ≥ 55 years) in relation to outdoor falls risk (Chippendale & Raveis 2017). Participants described the surface conditions of streets and pavements (e.g. wet or uneven) as risks and causes of falls. The study is subject to response bias as a substantial proportion of the respondents experienced an outdoor fall (71%), nonetheless, the mixed-method approach allowed for a detailed description of the causes of outdoor falls (Chippendale & Raveis 2017). The causes were described as environmental (objects, surface conditions or stairs), activity-related (during physical activities, socialising with friends, opening or closing doors), due to behaviours (inappropriate footwear) or a combination of environmental and behavioural factors. The authors conducted the study using a telephone survey with open-ended questions which were analysed using phenomenological analysis. Phenomenological research is based on the nature of the experience from the individual's point of view or otherwise known as the 'lived experience' and is normally conducted through interviews, stories or observations (Connelly 2010). Hence, although the authors were able to collect data from a large number of older adults using a survey, the in-depth 'lived experience' of an outdoor fall was unlikely to be captured.

To summarise falls in older adults are a worldwide problem and future studies should include any fall as defined by the ProFaNE group (Lamb et al. 2005). This will enable a more robust comparison of incidence rates and outcomes across published studies. I have illustrated in this section that falls have a complex and multifactorial aetiology. Based on the review of the published literature, the main risk factor groups are socio-demographic, environmental, biological and behavioural. Environmental factors such as home hazard and the physical state of the area will not be included in this study. However, the other risk factors will be considered when examining the association between visual function and falls and will be explored in further detail in Chapter 4 (study design). In the following section, I critically appraise the literature on visual risk factors for falls.

2.3 Visual function and falls

Postural stability is achieved by adequate input from the visual, vestibular and somatosensory systems, processing of the information by the cortex and finally an efficient motor response of the muscles, joints and reflexes (Lázaro et al. 2011). A deficit in any of the sensory systems may affect balance and potentially put an individual at risk of falls (Horak 2006). The performance of the visual system is assessed by measuring different visual function. It is not judged on simply resolving the smallest high contrast object at the furthest distance (visual acuity), but additional measures of visual function such as contrast sensitivity, visual field, colour vision, and binocular vision are also involved. Visual function has been reported to decline during later life (Owsley 2011; Zhang et al. 2008) and while this decline may be due to age-related eye diseases, it could also be due to the normal ageing process (Zhang et al. 2008).

It would seem reasonable to propose that each facet of visual function should operate at an optimal level to ensure the visual system is adequately contributing to maintaining postural stability and minimising the risk of a fall. Visual acuity, a measure of vision, is essential for an individual to respond to visual stimuli in their environment. A deficit in both central visual acuity and peripheral vision (assessed with visual fields) has been associated with an increased risk of falls (Patino et al. 2010). The ability to judge depth (depth perception) and perceive spatial relationships (contrast sensitivity) has been suggested to be important for navigating an environment with hazards and obstacles (Lord & Dayhew 2001). In terms of falls risk, there is little role for colour vision compared to the other measures of visual function, therefore I will not be reviewing the literature on colour vision in this thesis. Many cohort studies have investigated the relationship between different aspects of visual function and falls in older adults (Ivers et al.

1998; Klein et al. 1998; Lord, Clark & Webster 1991; Lord & Dayhew 2001; Nevitt et al. 1989; Tinetti, Speechley & Ginter 1988). In this section, I give an overview of each measure of visual function and critically review the literature on the association with falls. This study focusses on including visual functions that can be assessed practically using standard clinical procedures. Hence, I will not be assessing gaze stabilisation in this study but will give a brief overview of the literature on the association of gaze stabilisation and falls at the end of this section.

2.3.1 Visual acuity

Visual acuity (VA) is the ability to resolve fine high contrast detail and the level depends on ocular and neural factors. VA is the most commonly assessed visual function to determine the individual's ability to respond to visual cues. There are several methods available to measure the VA of an individual, however, for a cognitively normal adult population, the ETDRS (Early Treatment Diabetic Retinopathy Study), a logMAR based chart (Figure 2.3) has been described as the method of choice of for clinical and research purposes (Ferris et al. 1982). Therefore, the ETDRS chart and the reduced logMAR will be used for assessing VA for distance and near respectively in this study. It has the same number of optotypes per line, a standard logarithmic progression of 0.1 log unit between each row and proportional spacing within and between rows. The ETDRS method involves testing VA using a retro illuminated chart at 4 metres in a dark room. The individual is asked to read the letters with either eye using their distance correction (if they have any). VA can be recorded as the number of letters correctly read or as a logMAR score. Each letter is given a value of 0.02 logMAR and a full line is equivalent to 0.10 logMAR.

The other commonly used method to measure VA is a Snellen acuity chart (Figure 2.4), and whilst it has been superseded by the ETDRS, many hospital trusts continue to use it in their routine clinical practice. Snellen acuity is recorded as a Snellen fraction, for example, 6/12, where the numerator indicates the viewing distance, normally 6 metres and the denominator is the letter size (the distance at which the letter subtends an angular size in minutes of arc).

Published evidence on normal VA in older adults (≥60 years) has been reported to be better than +0.2logMAR (Elliot, Yang & Whitaker 1995; Owsley et al. 2016; Radner & Benesch 2019). Furthermore, in clinical settings, between +0.20 and 0.00 logMAR (75-100 letters) or 6/9.5-6/6 VA in either eye is considered normal. Table 2.3 illustrates the conversion from the ETDRS letter score to logMAR, the A.S.E (Approximate Snellen Equivalent), and the equivalent US notation for reference.

Figure 2.3: ETDRS chart

Figure 2.4: Snellen chart

Table 2.3: Conversion table for ETDRS, logMAR, Approximate Snellen Equivalent and US notation

ETDRS letters	**logMAR**	Approximate Snellen Equivalent (A.S.E)	US Equivalent notion to the A.S.E
5	1.60	6/240	20/800
10	1.50	6/190	20/630
15	1.40	6/150	20/500
20	1.30	6/120	20/400
25	1.20	6/96	20/320
30	1.10	6/75	20/250
35	1.00	6/60	20/200
40	0.90	6/48	20/160
45	0.80	6/38	20/125
50	0.70	6/30	20/100
55	0.60	6/24	20/80
60	0.50	6/19	20/63
65	0.40	6/15	20/50
70	0.30	6/12	20/40
75	0.20	6/9.5	20/32
80	0.10	6/7.5	20/25
85	0.00	6/6	20/20
90	-0.10	6/4.8	20/16
95	-0.20	6/3.8	20/12.5
100	-0.30	6/3	20/10

Many studies have reported a decline of VA with age (Attebo, Mitchell & Smith 1996; Evans et al. 2002; Klein et al. 2006; van der Pols et al. 2000). An MRC study of the prevalence of visual impairment in Britain reported that 12.5% of the population aged 75 and above presented with binocular VA worse than 6/18 (Evans et al. 2002). This level of binocular VA is classed as a moderate visual impairment (International Statistical Classification of Diseases and Related Health Problems 10th Revision). There is no justification for defining visual impairment at

6/18 in the study methods by Evans et al. (2002) as the acceptable DVLA standard for driving is 6/12 with both eyes open (DVLA 2019). When VA changes were assessed over a 15 year period in a cohort aged 43-86 years (N=4068) in the Beaver dam study in the US, the overall change in VA was a loss of one line in the 43-54 age group and a loss of 3 lines of vision in individuals aged ≥75yrs (Klein et al. 2006). The group also reported that the ≥75yrs group were 12-13 times more likely to develop impaired vision. Therefore, it is evident that visual impairment is prevalent in the ageing population and with an increased risk of falls with age, reduced vision becomes a potential risk factor.

Vision is the most commonly assessed function to evaluate a patient's visual ability as part of a multifactorial assessment for falls (The College of Optometrists 2014) . Close et al. (1999) in a randomised control trial to compare a multi-disciplinary assessment (N=184) and usual care (N=213), reported 59% of the patients who experienced a fall had visual acuity of 6/12 or worse in either eye. A review by Legood, Scuffham and Cryer (2002) of the published evidence on the risks and types of injuries associated with visual impairment determined that individuals with reduced VA were 1.7 times more likely to suffer a fall, 1.9 times more likely to suffer multiple falls and 1.3-1.9 times likely to suffer a hip fracture. However, the threshold used to define 'reduced visual acuity' is variable and occasionally unclear. If normal VA is assumed to be 0.0 logMAR, then it would be more appropriate to use +0.3 logMAR (6/12) as a threshold as this is based on the recommendation that a 15 letter reduction (+0.3 logMAR) change is clinically meaningful (Joussen et al. 2007).

Reduced VA and visual impairment have been reported as increasing the risk of hip fractures (Grisso et al. 1991; Luukinen et al. 1997) and major injurious falls (Koski et al. 1998) which include fractures, lacerations, joint dislocations and intracranial injuries. However, these early studies which evaluated a number of risk factors lacked methodological detail (Koski et al. 1998; Luukinen et al. 1997) or objective VA measurements. For example, in one study participants were asked if they could recognise a friend across the room if they self-reported an age-related eye disease (Grisso et al. 1991). As well as using standardised clinical protocols for measuring acuity, a consistent threshold for the level of VA would allow a more robust comparison between studies.

In Table 2.4, I present some key studies that have investigated the association of VA and falls. There is considerable heterogeneity in the methodology and results of the studies owing to differences in VA measurements, thresholds set for defining impaired vision and outcomes. Some studies have chosen hip fracture as an outcome (Dargent-Molina et al. 1996; Ivers et al. 2003b; Ivers et al. 2000) or multiple falls (Coleman et al. 2004; Klein et al. 2003; Nevitt et al. 1989). Studies that have set out to identify the risk factors for any falls have reported the association of reduced VA and multiple falls (Ivers et al. 1998; Lord & Dayhew 2001) or single and recurrent falls (Campbell, Borrie & Spears 1989; Yip et al. 2014). The study conducted by Campbell, Borrie and Spears (1989) did find in their cohort study of 761 individuals that there was significant difference in visual acuity between the falls and non-falls group at the bivariate level but was not a significant risk factor in the logistic regression model. All but one study in Table 2.4 included a quantitative measurement of VA. French et al. (2016) asked participants to self-report their visual impairment as none, moderate or severe. Although this method allows for the participant to describe their visual impairment, it does not help to identify a clinically measured threshold at which VA becomes a risk factor.

A large age and sex-matched case-control study (cases=911, controls=910) of visual impairment and hip fractures reported a binocular VA worse than 6/18 in 20.4% of the cases (hip fractures) compared to 12.7% in the control group (Ivers et al. 2000). In an adjusted regression model, binocular visual acuity worse than 6/18 was significantly associated with increased risk of hip fractures (OR=1.5, 95%CI: 1.1 - 2.0, p=0.007). This was a well-powered study with a clear standard for impaired acuity but specific to hip fracture falls.

An epidemiological study of 8317 participants investigated the association between measured VA and self-reported vision in relation to falls (Yip et al. 2014). The authors reported greater odds of falling in individuals with VA < 6/12 (N=46, OR=1.52, 95%CI: 1.17-1.97) and similarly in those reporting poor self-reported vision (N=177, OR=1.52, 95%CI: 1.26-1.84). It could be argued that the lack of a quantitative measure in a self-reported VA does not allow us to identify the exact clinical threshold at which visual impairment becomes a risk factor for falls. However, the association between self-reported vision and falls remained significant after adjusting for VA. This suggests that participants consider other aspects of visual function when reporting on their vision. Furthermore, self-reported moderate rather than severe visual impairment has been reported to be associated with injurious falls (OR 1.58, 95%CI: 1.15-2.17) in a survey-based study of 33,104 adults >18years of age (French et al. 2016). There were fewer individuals with severe visual impairment who suffered an injurious fall possibly due to them adopting a more cautious approach to ambulation.

Table 2.4: Published studies investigating the relationship between VA and falls (RR-Risk Ratio, OR-Odd Ratio, PR-Prevalence Ratio, HR-Hazards Ratio).

Author (Date) Study design	Sample and size	Outcome	Visual impairment definition	Result of association
Tinetti, Speechley and Ginter (1988) **Cohort**	Community-dwelling older adults ≥75 yrs. N=336	1+ fall (Monthly telephone call)	≥20% near vision loss (Jaeger chart) ≥20% distance vision loss (Snellen chart)	RR=1.7 (95% CI: 1.2-2.3) for near vision RR=1.4 (95% CI: 0.9-2.0)
Nevitt et al. (1989) **Cohort**	Community-dwelling adults aged ≥60 yrs. N=325	2+ falls Recorded by weekly postcards	Equal to or worse than 6/15 (logMAR 0.4) measured with Bailey Lovie chart	RR=1.5 (95% CI: 1.1-2.1)
Campbell, Borrie and Spears (1989) **Cohort**	Community-dwelling older adults ≥70 yrs. N=761	1+ fall Monthly form over 1 year	Equal to or worse than 6/12 Snellen acuity	Women RR: 1.3 (95% CI: 0.8-2.2) Men RR: 1.3 (95%CI: 0.8-2.8)
Dargent-Molina et al. (1996) **EPIDOS study** **Cohort**	Community-dwelling women aged ≥75 yrs. N=7575	Hip fracture Recorded every 4 months	3-4/10 (6/15 equivalent) ≤2/10 (6/30 equivalent) Snellen acuity assessed at 5m and reported as decimal notation	RR=1.9 (95%CI:1.1-3.1) RR=2.0 (95%CI: 1.1-3.7)

Ivers et al. (1998) **Blue Mountains study** **Cross-sectional**	Community-dwelling Australians ≥49 yrs. N=3299	2+ falls in the last 12 months recalled by the participant	Worse than 6/9 logMAR VA	PR=1.9 (95% CI: 1.2-3.0)
Ivers et al. (2000) **Auckland Hip Fracture Study** **Case-control**	Community-dwelling older adults ≥60 yrs Cases: 911 Controls: 910	Visual impairments in hip fractures vs no hip fractures	VA worse than 6/19 Snellen VA	OR=1.5 (95%CI: 1.1-2.0)
Lord and Dayhew (2001) **Prospective Cohort**	Community-dwelling older adults age 63-90 yrs N=156	2+falls Monthly questionnaire over 1 year	Equal to or worse than 6/10 (binocular) logMAR VA	RR=1.59 (95%CI: 0.85-2.98) (adjusted)
Ivers et al. (2003b **Blue Mountains study** **Cohort study**	Community-dwelling Australians ≥49 yrs N=3654	Hip fracture over a 5 yr follow up period by self-report or review of medical records	Corrected VA worse than 6/19 (20/60) at 2 year follow up	HR=8.4% (95%CI: 1.5-48.5)
Klein et al. (2003 **Beaver Dam Study** **Cross-sectional**	Institutionalised and non-institutionalised adults 43-84 yrs N=3722	2+ falls in the last 12 months recalled by the participant	Equal to or worse than 6/12 (binocular VA) Distance VA- ETDRS Equal to or worse than 6/12 (binocular visual acuity) Near VA- MN Read	OR=2.02 (95% CI: 1.13-3.63), OR=1.68 (95% CI: 0.65-4.33),

Coleman et al. (2004 **Cohort**	Community-dwelling women ≥65 yrs N=2002	2+ falls Recorded by postcard or telephone every 4 months	Loss of ≥ 10 letters Bailey-Lovie Chart	OR=1.43 (95% CI: 1.17-1.75)
Lamoureux et al. (2008) **Singapore-Malay study** **Cross-sectional**	Community-dwelling adults aged 40-80 yrs N=3280	Fall reported in the last 12 months by the participant	VA equal to or worse than 1.0 logMAR in the worse eye VA equal to or worse than 1.0 logMAR in one eye and VA >0.3 & <1.0 in the other eye	OR=1.6 (95% CI: 1.1-2.3) OR=2.1 (95%CI: 1.4-3.1)
Yip et al. (2014) **EPIC-Norfolk Eye study** **Cross-sectional**	Community-dwelling adults aged 48-92 yrs N=8317	Single and recurrent (≥2) falls in the last 12 months recalled by the participant	Worse than 6/12 Worse than 6/18 Worse than 6/60	OR=1.52 (95% CI: 1.17-1.97) OR=1.78 (95% CI: 1.04-3.06) OR=2.29 (95% CI: 0.70-7.51)
Loriaut et al. (2014) **Case-control study**	96 cases aged 60-99 yrs 103 controls aged 62-98	Visual impairments in hip fractures vs no hip fractures	Worse than 20/40 (6/12) Snellen acuity	OR=6.4 (95%CI: 3.8-10.8)
French et al. (2016) **National Health Interview Survey (NHIS) study**	Community-dwelling adults ≥18 yrs N=33014	Injurious fall reported in the previous year	Self-reported moderate visual impairment	OR=1.58 (95%CI: 1.15-2.17)

When the effect of VA was assessed in relation to postural stability it was reported not to be associated with falls or body sway on a firm surface but when subjects were placed on a foam surface, those with poor acuity demonstrated increased sway (Lord, Clark & Webster 1991). The authors suggest that patients with poor acuity may still be vulnerable in environments with less supportive surfaces, for example, thick carpets, soft lawn and ground. Although a foam surface in their study does not reflect an individual's natural flooring, the study does highlight the importance of vision in maintaining postural stability.

The association of impaired VA with falls is inconsistent with either a lack of significance in the final multivariate model (Campbell, Borrie & Spears 1989; Tinetti, Speechley & Ginter 1988) or VA being reported as a significant risk factor for multiple falls only as opposed to a single fall (Ivers et al. 1998; Klein et al. 2003; Lord & Dayhew 2001; Nevitt et al. 1989). The heterogeneity in the published literature makes it a challenge to conclusively affirm the association between reduced VA and falls, due to the lack of consensus in defining a visual impairment that is considered a risk for falls. However, the available evidence does suggest that there is a risk of fall(s) in individuals with VA less than what is regarded as normal acuity (6/6 or 0.0 logMAR).

2.3.2 Contrast sensitivity

Spatial contrast has been defined as "a physical dimension referring to the light-dark transition of a border or an edge in an image that demarcates the existence of a pattern or an object" and the measure of how much contrast is needed to see an object is contrast sensitivity (CS) (Owsley 2003). The CS function is a measure of contrast thresholds across a range of spatial frequencies (in cycles per degree-cpd) and can be measured using sine-wave gratings (Figure 2.5). It could be argued that CS is a better representation of an individual's visual function than visual acuity, as everyday objects within our environment consist of varying contrasts rather than simply high contrast objects. Owsley and Sloane (1987) in their study of adults aged 20-77 years (N=93) suggest that impaired CS in the low to medium spatial frequencies (0.5-6 cpd) resulted in decreased ability to see faces, road signs, and commonplace objects. Reduced low contrast vision has been reported to be predictive of subsequent VA loss (Schneck et al. 2004) and a better measure of visual function than VA for identifying visual loss in cataract patients (Elliott, Hurst & Weatherill 1990; Hess & Woo 1978).

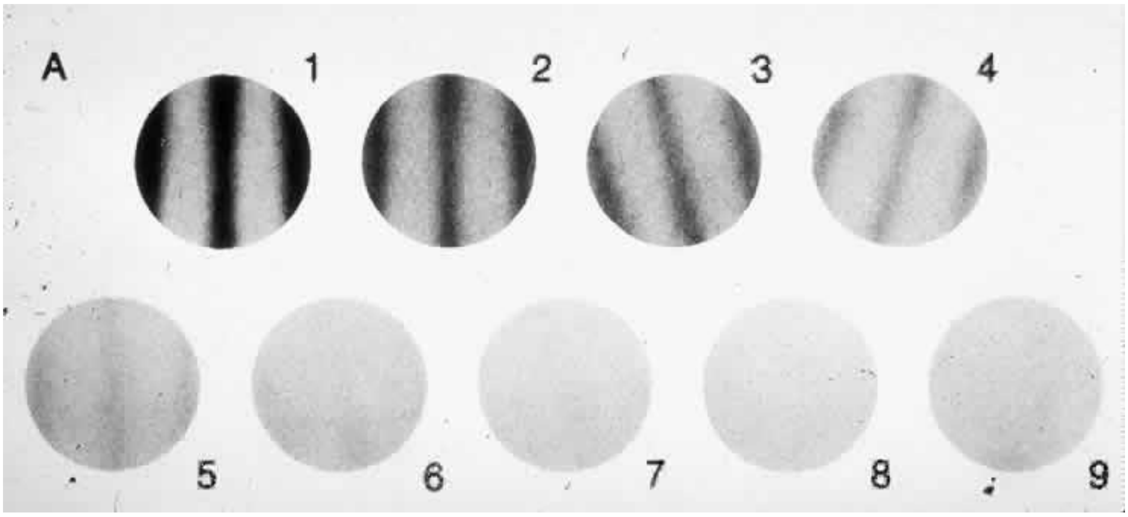


Figure 2.5: Sine Wave Gratings

CS has been reported to decline with age (Elliott, Whitaker & MacVeigh 1990; Owsley 2011; Owsley, Sekuler & Siemsen 1983) and around the age of 40-50 years, the deficit becomes more apparent at higher spatial frequencies (>6 cpd) (Owsley, Sekuler & Siemsen 1983). As well as the normal ageing effects on CS, it can also be impaired due to neurological and/or ocular causes, for example, cataracts (Hess & Woo 1978), cornea and retinal conditions (Marmor 1986; Richman et al. 2010; Rolando et al. 1998).

Clinical tests available to measure CS and are broadly based on letter-based charts where either the contrast (Pelli-Robson chart-Figure 2.6) or letter size reduces (low contrast acuity charts). The Pelli-Robson chart is a routinely used clinical test based on graded reduction in contrast at a spatial frequency of approximately 0.5-1 cpd and has been reported to have good reliability (Elliott, Sanderson & Conkey 1990; Elliott & Whitaker 1992; Mantyjarvi & Laitinen 2001; Rubin 1988). Age-specific normative values have been published for this test (Elliott, Sanderson & Conkey 1990; Mantyjarvi & Laitinen 2001) and Elliott, Sanderson and Conkey (1990) suggested 1.65 log units threshold as the lower limit for older participants (≥50 years). Reduced CS (1.50 log units) with the Pelli-Robson chart has been shown to elevate the risk of two or more falls by a factor of 1.63 (Table 2.5) (Klein et al. 2003). The authors set the threshold for impaired CS from those worse than the ninetieth percentile in the age group at the first examination which is in agreement with the threshold reported by Elliott, Sanderson and Conkey (1990).

Figure 2.6: Pelli-Robson Chart

Whilst the Pelli-Robson is a useful clinical test that is quick to use, it does not allow measurement across a range of spatial frequencies which would better reflect the contrast in a real-world environment. To overcome this issue, contrast can be measured using a sine wave-based test, for example, the VISTECH (Figure 2.7). It measures contrast across spatial frequencies ranging from 1.5-18cpd. Hence, I have chosen to use the Pelli-Robson as this is a routinely used clinical test to measure CS and also the VISTECH to measure contrast across a range of spatial frequencies.

The VISTECH or similar test has been used in a few studies evaluating the risk of falls with impaired CS (Table 2.5) (Cummings et al. 1995; de Boer et al. 2004; Ivers et al. 1998). Older people with reduced CS at the lower spatial frequencies (1.5 and 3 cpd) were reported to have a 1.5 fold increase in the relative risk of recurrent falling (de Boer et al. 2004). However, their findings need to treated with some caution as contrast was measured 30-32 cms from the participant which is not indicative of contrast when viewing objects in their environment at a further distance and determining falls risk.

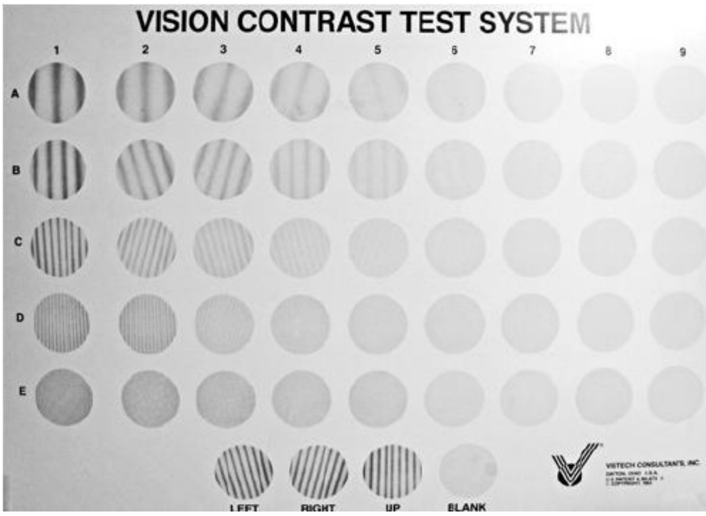


Figure 2.7: VISTECH contrast sensitivity test

Two studies by Lord and his group used the Melbourne Edge Test (MET) (Figure 2.8) to assess CS as a risk factor for falls (Lord, Clark & Webster 1991; Lord & Dayhew 2001). The basis of this test is that the peak CS is enough to determine the visual performance of an individual and edge detection has been suggested to be related to peak CS (Verbaken & Johnston 1986). CS is measured in decibels ranging from 1 to 24 dB and normal values of MET for individuals older than 65 years of age has been reported to be 16-17 dB (Verbaken & Johnston 1986). In a study comparing falls and non-falls individuals, Lord, Clark and Webster (1991) found that the individuals who had experienced a fall had a significantly lower MET CS (15.1 dB) compared to those who had not fallen (17.5 dB). A later study by Lord and Dayhew (2001) set the criteria for CS using the MET at 18 dB based on the lower bound of the fourth quartile of their study population when evaluating the risk of falls. They reported CS to be a significant risk factor for multiple falls after adjusting for age (RR=1.93, 95%CI: 1.01 - 3.68). The threshold set for their population was slightly higher than the reported norms by Verbaken and Johnston (1986) which may have influenced their findings.

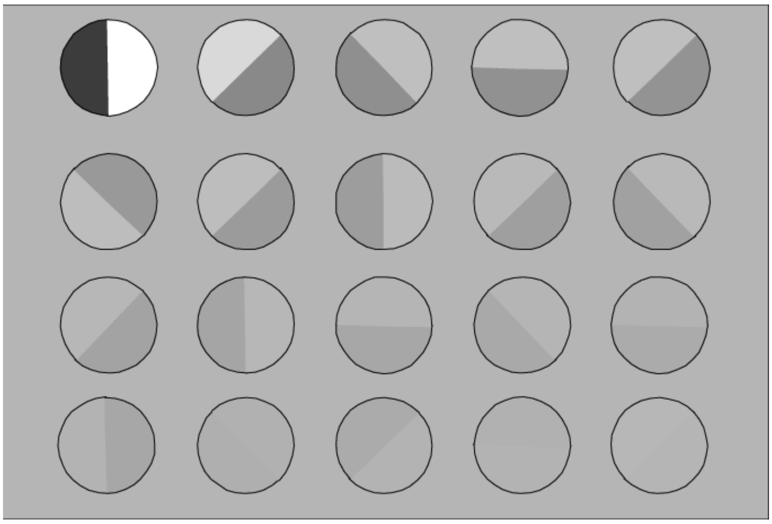


Figure 2.8: Melbourne Edge Test

Individuals not only rely on the ability to discriminate fine high contrast detail (distance VA) but when negotiating an environment, they also need to perceive objects under low contrast conditions and detect edges (contrast sensitivity) like stairs, kerbs and uneven pavements to prevent falls and trips. The nature of this visual loss may account for individuals who have fallen performing significantly worse on CS compared to VA testing when fallers and non-fallers were assessed in a cross-sectional study of older adults (N=95, aged 59-97 years) (Lord, Clark & Webster 1991). This finding was supported by a further study by the same group who reported that people with poor low contrast acuity were at higher risk of multiple falling compared with those with poor high contrast VA (Lord & Dayhew 2001).

Table 2.5: Published studies investigating the relationship between contrast sensitivity and falls

Author (Date) study design	Sample and size	Outcome	Contrast Sensitivity	Result of association
Nevitt et al. (1989) Cohort	Community-dwelling adults aged ≥60 yrs N=325	2+ falls Recorded by weekly postcards	Equal to or worse than 6/15 (logMAR 0.4) measured with Bailey Lovie chart	RR=1.5 (95% CI: 1.1-2.1)
Lord, Clark and Webster (1991) Cohort	Hostel dwelling older adults aged 59-97 yrs N=95	1+ fall Reported by monthly questionnaire	Melbourne Edge Test ≤18 decibels (distant)	15.1 decibels (fallers) vs 17.5 decibels (non-fallers), p<0.05
Dargent-Molina et al. (1996) EPIDOS study Cohort	Community-dwelling women aged ≥75 yrs N=7575	Hip fracture Recorded every 4 months	1.5, 3, 6 ,12 and 18 cpd spatial frequencies tested using the VISTECH	No significant association between contrast sensitivity and falls
Cummings et al. (1995) Cohort	Community dwelling women aged ≥65 yrs N=9516	Hip fracture Recorded every 4 months by postcard or telephone	CS measured at different spatial frequencies (1,2,4,8,16,24 cpd) with the Ginsburg test.	RR=1.2 (95%CI:1.0-1.5) for 1 SD decrease in low frequency CS
Ivers et al. (1998) Blue Mountains study Cross-sectional	Community-dwelling Australians ≥49 yrs N=3299	2+ falls in the last 12 months recalled by the participant	Low contrast measured at spatial frequencies (3, 6, 12, 18 cpd) using the VISTECH	PR=1.2 (95% CI: 1.1-1.3) for 3, 6 and 12 cpd spatial frequencies

Lord and Dayhew (2001) **Prospective Cohort**	Community-dwelling older adults age 63-90 yrs N=156	2+falls Monthly questionnaire over a 1-year period	Melbourne Edge Test ≤18 decibels (distant)	RR=1.93 (95%CI: 1.01-3.68)
Ivers et al. (2003b) **Blue Mountains study** **Cross-sectional**	Community-dwelling Australians ≥49 yrs N=3654	Hip fracture over a 5 yr follow up period by self-report or review of medical records	Low contrast measured at spatial frequencies (3, 6, 12, 18 cpd) using the VISTECH	CS was not significant in the adjusted model at 2 year follow up
Klein et al. (2003) **Beaver Dam Study** **Cross-sectional**	Institutionalised and non-institutionalised adults 43-84 yrs, N=3722	2+ falls in the last 12 months recalled by the participant	Pelli-Robson CS at 1.5 log units	OR=1.63 (95%CI: 1.11–2.39)
de Boer et al. (2004) **Longitudinal Aging Study Amsterdam (LASA)** **Cohort**	Community-dwelling older adults ≥65 yrs N=1509	1+ fall Recorded weekly and sent in every 3 months for 3 years	Integrated CS score determined by measuring contrast at spatial frequencies (1.5, 3, 6, 12, 18 cpd) using the VISTECH Low spatial frequency contrast at 1.5 and 3 cpd	HR= 1.53 (95% CI: 1.03-2.29), p=0.037 (after adjustment for confounders) HR=1.66 (95% CI: 1.11-2.48), p=0.013 (after adjustment for confounders)
Freeman et al. (2007) **Cohort**	Community-dwelling older adults aged 65-84 yrs N=2375	1+ Recorded on monthly falls calendar	Pelli-Robson CS	OR=0.96 (95%CI: 0.86–1.07) No significant association

A more recent cross-sectional study that was part of 'The Irish Longitudinal Study on Ageing' evaluated the relationship between visual function (VA and CS) and gait in 4,678 participants aged 50 years and over. They reported no association between VA and gait but those who had reduced CS at low spatial frequencies (1.5cpd and 3 cpd) had significantly shorter stride length (p=0.001) (Duggan et al. 2017), which has been linked to increased risk of falls (MacAulay et al. 2015). These findings are useful and indicate that further work is needed to compare the effect of age-related eye pathology induced CS decline on stride length, to ascertain whether it is modifiable.

The effect of contrast sensitivity has also been evaluated in a mixed-methods cohort study (Boon et al. 2015). The authors explored the perceptions of people with (N=58) and without visual impairment (N=22) using a diary with open-ended questions with regards to their vision as a cause of falls. They also conducted baseline measurements of visual function to corroborate the perceptions of the participants. The following quote given by a participant in their study captures the importance of contrast sensitivity and its perception as a cause of falls:

> *''I was stepping on an escalator which did not have a yellow line to mark the end of step in the shopping center…. I can't see well on metal escalators and sometimes I don't see things that are right in front of me especially if they are all the same colour''*

This narrative was further supported by the quantitative findings of CS measured using the Pelli-Robson. The authors reported a one-unit increase in log CS (20 letters) approximately halved the risk of a fall (Boon et al. 2015). Whilst the study sample (N=80) was sufficient for the qualitative element of the study, no power calculation was performed to ensure the sample size for the number participants in the visual impairment group (N=58) and control group (N=22) was sufficient for statistical analysis and they were not age-matched. Data collected during the study were not comprehensively presented in the paper to validate the conclusions of the study.

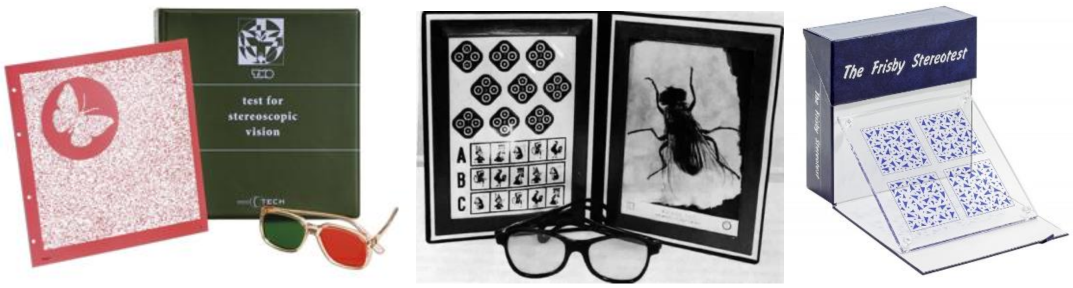
Although a number of the studies evaluated in this section have reported an association between reduced contrast and falls (Table 2.5), it has not been studied to the same extent as VA. Three studies report no significant association with falls but these studies are lacking in detail in the statistical analysis, or have incomplete data sets or small sample sizes (Dargent-Molina et al. 1996; Freeman et al. 2007; Ivers et al. 2003a). Similar to the studies that have investigated the relationship between visual acuity and falls, there are considerable differences in the methods used to test contrast, the outcomes and lack of adjustment for confounders therefore makes it difficult to compare studies. CS is an important measure to understand the extent of an individual's visual ability and functional performance problems (Owsley 2003). The evidence on the association of impaired contrast and falls though inconsistent, points towards impaired CS being a significant risk factor for falls. Future falls studies need to be adequately powered and include the assessment of CS across a range of spatial frequencies.

2.3.3 Binocular vision and depth perception

"Binocular single vision (BSV) is the ability to use both eyes simultaneously so that each eye contributes to a common single perception" (Ansons & Davis 2014). The development of normal BSV is dependent on clear ocular media in both eyes, intact retino-cortical elements and normal co-ordination of these elements. The degree of binocular vision of an individual is determined by assessing the different grades; simultaneous perception, fusion and stereopsis. Simultaneous perception is the ability of each eye to see an image at the same time and is the basic level of binocular vision followed by fusion which comprises of a sensory and motor component. Sensory fusion is the ability to fuse two similar images to view as one and motor fusion is to maintain this single image through a range of vergence eye movements. Stereopsis, or otherwise known as depth perception, is the highest grade of binocular single vision where individuals can perceive depth or 3D vision and judge distances of objects due to the cortical representation of slightly different images as one. To perceive normal stereoscopic depth, three processing stages are required: 1) both eyes are functional and aligned 2) control of the eye muscles to maintain vergence 3) initial matching of the retinal images and 4) integration of horizontal disparity information to appreciate the relative depth

(Bridge 2016). However, individuals who have a small ocular misalignment, termed *micotropia* will demonstrate a small degree of stereoacuity (Ansons & Davis 2014). It can be theoretically argued that impaired stereoacuity or a loss of binocular vision may increase the risk of a fall due to the diminished perception of depth and presence of diplopia (double vision) respectively. Despite this theoretical proposition, there is only one study to date that has evaluated the association between poor binocular vision and musculoskeletal injury, fractures and falls (Pineles et al. 2015). More studies have examined the relationship between stereoacuity and falls (Table 2.6) (Cummings et al. 1995; Friedman et al. 2002; Ivers et al. 2000; Lord & Dayhew 2001; Nevitt et al. 1989) which I critically evaluate throughout this section.

There are several clinical tests that can be used to measure stereoacuity and each has unique properties, which allow varying levels and different aspects of stereovision to be assessed. They can be broadly categorized into depth measured by random dot (Figure 2.9A) or contour-based (Figure 2.9B) stereograms. Contour based stereograms make use of local stereopsis where the horizontal disparity is evaluated without reference to other parts of the retinal field (Fricke & Siderov 1997). In contrast, random dot stereograms are based on global stereopsis whereby horizontal retinal disparities are correlated across a substantial area (Fricke & Siderov 1997).



A B C

Figure 2.9: A-TNO test (random dot), B-Wirt (contour), C- Frisby (real-depth)

The TNO test (Manufacturer: Lameris Ootech) (Figure 2.9A) is based on anaglyphic 3D where the observer uses red and green glasses to detect stereo. Other tests like Randot and Wirt are based on a vectographic design where polarizing glasses are used to view the stereoscopic images (Figure 2.9B). The Frisby stereotest (Figure 2.9C) is based on 'real depth' and an advantage of this test is that it can be used in a slight downgaze position to assess depth perception in the lower field. This is particularly useful in studies examining the association of depth perception and falls as individuals often negotiate obstacles or hazards in their lower field. The near Frisby test has been reported to be ideal for determining the presence of stereopsis and the level, compared to the Randot which the authors suggest is suitable for picking up subtle changes (Leske, Birch & Holmes 2006). Also, the Frisby test has coarse elements and its pattern tolerates a fair degree of blurring (personal communication with John Frisby). Therefore, the Frisby test is the most suitable to use with this sample as it can be used in a slightly depressed position of gaze and tolerate blur when older adults are potentially looking through the incorrect portion of their varifocals.

Binocular vision and eye movement disorders have been reported to be more prevalent in older adults and significantly associated with age (p=0.02) (Leat et al. 2013). The authors conducted a retrospective study of the files of 500 patients who they grouped into three age groups (60-69, 70-79 and 80+ years). They reported a prevalence of an abnormal result on BV or eye movement tests to be 27%, 30% and 38% for the 60-60, 70-79 and 80+ year groups respectively. However, the presence of symptoms with an abnormal test result was not established and owing to the retrospective nature of the review it may be subject to variation in the measurements by multiple assessors. The authors were unable to include a measure of stereopsis as this was not routinely tested in their sample.

Previous studies have reported the negative effect of ageing on stereopsis (or depth perception) (Bohr & Read 2013; Garnham & Sloper 2006; Lee & Koo 2005; Zaroff, Knutelska & Frumkes 2003). Yet, the sample sizes for older adults (>60 years) in these studies are relatively small consequently resulting in a lack of normative stereoacuity values for this demographic. Bohr and Read (2013) reported a median of 85” of arc using the Frisby test on 29 participants aged 50-82 years. However, Garnham and Sloper (2006) found the stereo threshold with Frisby to be 40” (median) in older adults (n=29) aged 50-83 years. Owing to small numbers of participants in these studies it is difficult to ascertain the normal median threshold for stereoacuity using the Frisby test.

Impaired depth perception has been linked to postural instability in older individuals (Lord & Menz 2000). Despite these findings, the association of impaired depth perception and falls is an understudied phenomenon as can be seen by the few studies measuring stereoacuity as part of their study in Table 2.6. All studies but one (Friedman et al. 2002) in the table suggest that impaired depth perception is a significant risk factor for falls (Cummings et al. 1995; Ivers et al. 2000; Lord & Dayhew 2001; Nevitt et al. 1989). Different stereotests, outcomes and methods have been used across these studies to conclusively assert that impaired stereoacuity is a risk factor for any fall.

Two prospective cohort studies with reasonable size samples both reported that reduced stereoacuity was an important risk factor in multiple falls (2+ falls) but not a single fall (Lord & Dayhew 2001; Nevitt et al. 1989). In a large case-control study (cases=911, controls=910), there was a strong association with impaired stereoacuity measured with the Randot stereotest and hip fracture (see Table 2.6 for ORs and 95%CI) (Ivers et al. 2000). The authors also reported a six-fold risk of having a hip fracture if the individual had no demonstrable stereopsis. On the contrary, Friedman et al. (2002) in their population-based study (Salisbury Eye Evaluation project) of 2,212 participants did not find stereoacuity measured with Randot to be a significant predictor of falls or fear of falling at a 20 month follow up. The authors recorded the number of circles identified correctly (1-10) and failed to report the level of stereoacuity data. The Randot test has monocular cues and has been reported to overestimate stereoacuity levels compared to random dot stereograms (Fawcett 2005). Therefore, the evidence from these studies cannot be substantiated and further work is needed to validate the association of impaired stereoacuity and falls using robust measures of stereoacuity.

Stereoacuity has also been measured with the Howard-Dohlman in falls studies (Cummings et al. 1995; Lord & Dayhew 2001). The test is performed at 3 meters where the individual pulls two cords to align a moveable rod in line with a stationary rod in a box. The error in aligning the rod is recorded in centimetres. Both studies reported a significant association between impaired depth perception and hip fracture (Cummings et al. 1995) and 2+ falls (Lord & Dayhew 2001). This test has not been validated in other studies and is not normally used in clinical scenarios. Future work should examine the most appropriate distance to measure stereoacuity for falls studies as the Howard Dohlman is carried out an intermediate distance (3m) compared to other near stereotests which are normally carried out at a closer distance (<1 meter).

Table 2.6: Published studies reporting the association of stereoacuity and falls

Author (Date) study design	Sample and size	Outcome	Stereoacuity	Result of association
Nevitt et al. (1989) **Cohort**	Community-dwelling adults aged ≥60 yrs. N=325	2+ falls Recorded by weekly postcards	≥200 secs of arc Randot stereotest	RR=1.56 (95% CI: 1.1-2.6)
Cummings et al. (1995) **Cohort**	Community-dwelling women aged ≥65 yrs. N=9516	Hip fracture Recorded every 4 months by postcard or telephone	Howard-Dohlman (lowest quartile for distant depth perception)	RR=1.4 (95%CI:1.0-1.9) No P value stated
Ivers et al. (2000) **Auckland Hip Fracture Study** **Case-control**	Community-dwelling older adults ≥60 yrs. Cases: 911 Controls:910	Visual impairments in hip fractures vs no hip fractures	No stereoacuity ≥400" of arc 140-<400" of arc >50-<140" of arc Randot stereotest	OR=6.0 (95%CI: 3.2-11.1) OR=3.9 (95% CI: 2.3-6.7) OR=4.1 (95% CI: 2.4-7.2) OR=3.0 (95% CI: 1.7-5.4) (Adjusted), P=0.0001 for trend
Lord and Dayhew (2001) **Cohort**	Community-dwelling older adults aged 63-90 yrs. N=156	2+ falls Monthly questionnaire over a 1-year period	Depth Perception with Howard Dohlman (distance) ≥2.4cm Frisby ≥ 215 sec arc	RR=2.26 (95%CI: 1.24-4.14) (Adjusted) RR=1.99 (95%CI: 1.11-3.59) (Adjusted)(No P values given)

Friedman et al. (2002) **Cross-sectional**	Community-dwelling older adults aged 65-84 yrs. N=2212	Falls in the last 12 months reported by the participant	Randot stereotest	Stereoacuity was not a significant predictor of falls

A few fall studies which have not included stereoacuity measurements have inferred poor depth perception based on a difference in VA between the two eyes (Close et al. 1999; Felson et al. 1989; Lamoureux et al. 2008). The Framingham study (Felson et al. 1989) followed 2633 participants for 10 years to determine the risk of hip fractures associated with visual impairment. Interestingly, they reported that those who had a difference in acuity between both eyes, for example, moderately impaired vision (20/30-20/80) in one eye and good vision (better than 20/25) in the other had a higher risk of fracture (RR= 1.94, 95%CI: 1.13-3.32) than those with a similar degree of binocular impairment (RR = 1.11, 95%CI: 0.55-2.24). Similarly, Lamoureux et al. (2008) in a study of 3280 Malay adults aged 40-80 years reported that having a severe visual impairment in one eye (equal to or worse than 6/60) and mild or moderate visual impairment (worse than 6/12 but better than 6/60) in the other, doubled the risk of falls (OR=2.1, 95%CI: 1.4-3.1). Falls were recorded retrospectively in this population-based cross-sectional study, therefore limiting the generalisability of these findings.

A key RCT, the PROFET study (Prevention of falls in the elderly trial), evaluated the benefit of having a structured interdisciplinary assessment (N=184) vs usual care (N-=213), in people who have fallen, to prevent further falls (Close et al. 1999). The authors considered the participants to have poor binocular vision if they had a disparity of two lines or more in acuity between the two eyes. Based on this criterion, they reported 62% (N=94) of the participants who attended A&E following a fall to have poor stereoscopic vision. The authors provide no evidence for choosing a two line disparity in acuity as an indicator for poor binocular vision. Odell et al. (2009a) reported a significant degradation of monocular VA (+0.7 logMAR or worse) would lead to worse than 60 seconds of arc with Frisby. Yet a much smaller degradation (+0.1 logMAR or worse) for a random dot stereoacuity test. Overall, the binocular vision evidence from the PROFET study needs to be validated in a study which examines the impact of unequal vision on stereoacuity in relation to falls.

Further evidence to support the association between poor binocular vision and musculoskeletal injury, fractures and falls was examined in a 10-year retrospective review of 2, 196 881 medicare beneficiaries (Pineles et al. 2015). A binocular vision disorder was present in 99525 (4.5%) of the patients. The authors reported that those with binocular vision disorders such as diplopia and strabismus had a higher risk of having a musculoskeletal injury, fracture, or fall after adjusting for confounding factors (OR= 1.27 (95%CI, 1.25-1.29; P < .001). Whilst this was a large study, the retrospective design does not allow for standardised data collection and diagnoses of conditions. Besides, data were not reported on whether binocular vision disorders were treated which may have affected the outcome.

There is a lack of knowledge on the association of poor motor fusion and falls. The evidence reviewed here, albeit less than that reported for VA and CS, suggests that impaired depth perception is a potential risk factor for falls but needs further validation with appropriate measures of stereoacuity. Also, if unequal VA is to be used as a marker for poor binocular vision or impaired depth perception, further robust evidence is required from a large cohort of people of different age groups to determine the relationship between unequal VA and stereoacuity. When investigating depth perception as a risk factor for falls, it would be more valuable to use a test that allows a measurement in a slightly depressed position of gaze to gain a better understanding of the effect of depth perception when negotiating stairs and obstacles in our lower visual field.

2.3.4 Visual field

The visual field (VF) can be described as the area in which all objects are seen in the periphery of an individual's vision as they fix on a central point. A normal visual field is an island of vision measuring 90 degrees temporally to central fixation, 50 degrees superiorly and nasally, and 60 degrees inferiorly (Spector 1990). Visual fields can be quantitatively measured using static or kinetic perimetry. The stimulus is moved from the non-seeing part of the field to the location where it is first seen in the periphery in kinetic perimetry, whereas in static perimetry the stimulus is shown briefly at fixed points in the periphery. Monocular visual fields are commonly performed to evaluate visual field loss and disease progression using a range of programs on automated perimeters (e.g. Humphrey Field Analyzer and Octopus) but can also be integrated for a binocular visual field (Crabb &

Viswanathan 2005). However, a binocular Esterman visual field assessment is available on the Humphrey Visual Field Analyzer which allows us to evaluate functional ability in activities of daily living and to describe visual disability (Esterman 1982). This test will be used in this study and will be described in more detail in Chapter 4.

Peripheral visual field defects can be caused by any lesion along the visual pathway for example in glaucoma, optic neuritis and stroke. Central field loss is commonly caused by disease of the macula e.g. age-related macular degeneration. Hence, visual field defects are associated with age-related ophthalmic conditions and are a risk factor for falls due to potentially missing obstacles in the inferior field or bumping into peripheral objects.

Ramrattan et al. (2001) in a population-based cohort study of 6250 community-dwelling adults aged ≥55 years reported the presence of unilateral VF loss in 5% and bilateral VF loss in 2% of the population. They found glaucoma to be the leading cause of visual field loss in the 55-74-year age group. The main objective of their study was to determine their prevalence and causes of visual field loss. They also set out to determine the association of visual field loss with daily functioning over a 3 year period and included recording a history of falls. The authors reported that unilateral and bilateral visual field losses were associated with a six-fold risk of recurrent falls. They reported 0.55% of individuals with no visual field loss fell >4 times in the previous 2 years compared to 3.4% of those with either a unilateral or bilateral visual field loss ($p<0.05$). This association of visual field defects and falls has been reported in several studies, some of which are highlighted in Table 2.7. However, similar to previous studies investigating the association of visual function risk factors and falls, there is considerable heterogeneity in the methodology and results to enable a robust comparison. For example, the outcomes and reporting, procedures for testing VF and thresholds for a VF deficit vary across the studies in addition to the strength of associations.

Table 2.7: Published studies reporting the association of visual field deficits and falls

Author (Date) study design	Sample and size	Outcome	Visual field	Result of association
Ivers et al. (1998) **Blue Mountains study** **Cross-sectional**	Non-institutionalised Australians (Sydney) ≥49 yrs. N=2003	2+ falls in the last 12 months recalled by the participant	5 points missed on a visual field increased risk of falls Humphrey visual field analyser (76-point, 30° visual field program)	OR=1.5 (95% CI: 1.0-2.3) (Adjusted) P=0.096
Ivers et al. (2003b) **Blue Mountains study** **Cross-sectional**	Community-dwelling Australians ≥49 yrs. N=3654	Hip fracture over a 5 yr follow up period by self-report or review of medical records	At 2 year follow up ≥5 points missed on a visual field increased the risk of hip fracture Humphrey visual field analyser (76-point, 30° visual field program)	HR=5.5 (95%CI:1.0-29.8) (Adjusted) P=0.047
Freeman et al. (2007) **Cohort**	Community-dwelling older adults aged 65-84 yrs. N=2375	1+Recorded on monthly falls calendar over a 20-month period	10 points missed on the binocular visual field increased the risk of a fall 5 points missed in the central VF	OR=1.08 (95%CI: 1.03-1.13) OR=1.05 (1.01-1.09)

			4 points missed in the peripheral VF Humphrey visual field analyser (81-point, full-field)	OR=1.06 (95% CI: 1.03-1.10) (No p values stated in the original paper)
Coleman et al. (2007) **Cohort**	Community dwelling white women aged ≥ 70yrs N=4071	2+ falls within 12 months Postcard or telephone every 4 months	Severe binocular VF loss (≥20 points) increased the risk of a fall Humphrey visual field analyser (76-point, 30° visual field program)	OR=1.5 (95%CI: 1.11-2.02) (Adjusted) P=0.05
Coleman et al. (2009) **Cohort**	Community dwelling white women aged ≥ 65 yrs. N=4773	Hip fracture Reported by postcard or telephone every 4 months	Mild binocular VF loss (1-9 points missed) was a risk for a hip fracture Severe binocular VF loss (≥20 points missed) was a risk for non-spine, non-hip fracture Humphrey visual field analyser (76-point, 30° visual field program)	HR=1.40 (95%CI:1.11-1.78 (Fully adjusted) P=0.006 HR=1.46 (95% CI: 1.13-1.89) (Fully adjusted) P=0.004

Patino et al. (2010) **Los Angeles Latino Eye Study** **Cohort study**	Community-dwelling latinos ≥40 yrs. N=3203	Falls in the last 12 months reported by participants	Moderate to severe VF impairment mean deviation≤6 dB associated with increased risk of falls Humphrey visual field analyser Monocular 24-2 Swedish Interactive Threshold	OR=1.42 (95%CI: 1.06-1.91) P=0.02
Black, Wood and Lovie-Kitchin (2011) **Prospective observational**	Community-dwelling older adults with glaucoma aged ≥ 60yrs N=71	1+ within 12 months Monthly falls diary	Inferior VF loss was associated with a greater risk of falls Inferior VF loss was associated with a greater risk of an injurious fall Humphrey visual field analyser Monocular 24-2 Swedish Interactive Threshold	RR=1.57 (95%CI: 1.06-2.32) (Adjusted) P=0.024 RR=1.82 (95%CI: 1.12-2.98) (Adjusted) P=0.016

Published evidence suggests that the risk of a hip fracture is associated with visual field loss (Coleman et al. 2009; Ivers et al. 2003b). In each of these studies, visual field loss has been defined in different ways (severe: missing ≥ 20 points and mild: missing 1-9 points by Coleman et al. (2009), missing ≥ 5 points by Ivers et al. (2003a)). Coleman et al. (2009) reported that binocular visual field loss was independently associated with hip, non-spine and non-hip fractures in older women. Whilst it is evident from their results that the highest incidence of fractures was in women with the most severe binocular visual field loss, their reporting of associations and risk is open to criticism. The authors claim that women with a severe binocular visual field loss had a 66% (HR=1.66, 95%CI, 1.19-2.32, p=0.003) and 59% (HR=1.59, 95%CI, 1.24-2.03, p<0.001) greater risk of a hip and non-spine, non-hip fracture respectively. However, these are only adjusted for age, race, study site and cognitive function. The results are different in their fully adjusted model which includes, for example, adjusting for falls in the previous year, use of medications, history of any fractures. In their fully adjusted model, there was no significant association between binocular VF loss and hip fractures (p=0.44) hence the posthoc p-values should not be interpreted. More importantly, it is not surprising that the association diminished, because they adjusted for falls in the previous year which is in the causal pathway and hence not a confounder. Also, they adjusted for use of medication and history of any fractures which also do not satisfy the criteria of confounding (Greenland, Pearl & Robins 1999) as they do not have a causal effect on binocular visual field loss. Therefore, while the authors suggest that mild and severe binocular visual field loss are a risk factor for hip fractures and severe binocular visual field loss is a risk factor for non-spine and non-hip fractures, a further study to validate these finding with appropriate adjustment for confounders is warranted.

Similarly, Ivers et al. (2003a) reported that missing 5 or more visual field points was a significant risk factor for hip fractures at a 2 year follow up in older adults aged 75 and over (HR=5.5, 95%CI: 1.0-29.8, p=0.047). The confidence intervals reported in this study were very wide owing to the small number of hip fractures at the 2 year follow up (N=17).

Studies have reported a 50% risk of having two or more falls associated with varying levels of VF loss (Ivers et al. 1998), e.g. missing 5 or more points (Ivers et al. 1998) or a severe binocular VF loss (missing ≥20 points) (Coleman et al. 2007). However, the adjusted prevalence ratio of 1.5 (95% CI, 1.0-2.3) when compared to no fall reported by Ivers et al. (1998) was not significant (p=0.096) when adjusted for age, sex, history of stroke, arthritis, self-reported health, past and current use of medications. Both studies (Coleman et al. 2007; Ivers et al. 1998) failed to adjust for potentially significant confounders in their study, therefore the evidence regarding the association between visual field loss and falls is unconvincing.

A cohort study of 3,203 individuals (aged ≥40 years) from a Latino community was evaluated to determine whether central or peripheral visual impairment were independent risk factors for falls (Patino et al. 2010). The study demonstrated that individuals with a moderate to severe VF impairment defined as a mean deviation of ≤6 dB are 1.42 times more likely to experience a fall than those without a visual field loss (Patino et al. 2010).

So far, studies have generally reported an overall loss in the visual field as a risk factor but the location of the field loss is important to identify deficits in the inferior fields for trips or temporal fields to avoid bumps. When negotiating steps, avoiding obstacles to prevent trips and slips, we use our inferior visual field. Visual field deficits in the lower field have been associated with poor mobility (Turano et al. 2004).

Studies have examined specific field losses e.g. inferior or superior in the risk of falls (Black, Wood & Lovie-Kitchin 2011; Coleman et al. 2007; Freeman et al. 2007). However, they were either not examined as independent contributors to the risk of a fall (Coleman et al. 2007) or were insignificant predictors (Freeman et al. 2007). Black, Wood and Lovie-Kitchin (2011) examined visual predictors for falls in 71 older adults with glaucoma in a prospective study and demonstrated an association between a loss of binocular inferior visual field and a greater risk of falls (RR=1.57, 95%CI: 1.06-2.32) and injurious falls (RR=1.82, 95%CI: 1.12-2.98). Visual field loss due to glaucoma is common and therefore the rate of visual field loss associated with this condition can help understand the risk of falls at different stages of the disease. A longitudinal study examined 116 patients with glaucoma with 6 monthly visual field tests over a follow-up period ranging from 2.0-10.0 years, to determine whether the rate of visual field loss was associated with risk of falls (Baig et al. 2016). The authors reported that a history of fast visual field loss (0.5 dB/year) due to glaucoma was associated with an increased risk of falling in addition to the severity of the visual field loss. An increase in the severity of visual field defects in patients with primary open angle glaucoma (POAG) has also been shown to be associated with an increased fear of falling (Ramulu et al. 2012; Yuki et al. 2013). Fear of falling associated with impaired visual function/ophthalmic conditions will be discussed in more detail in Chapter 3.

There is some evidence to suggest an association of visual field defects and risk of falls. However, further research is required to validate these findings with a robust study design including clear definitions of falls, thresholds for visual field defects and appropriate statistical analysis adjusting for visual and non-visual confounders.

2.3.5 Gaze stabilisation

Postural balance control is maintained by successful integration of the proprioceptive, visual and vestibular system (Horak 2006). The visual and vestibular system are linked neuroanatomically giving rise to the vestibular-ocular reflex (VOR). The role of the VOR is to the keep the eyes steady during head and body rotations. Oscillopsia often results from impaired VOR where an individual has poor visual acuity and an unstable view of the world. VOR has been reported to influence gait and has been suggested a useful measure to identify individuals at risk of falling (Honaker & Shepard 2011).

The dynamic visual acuity test is used to test VOR function where the individual’s head is moved from side to side and a reduction in one or two lines of acuity would indicate vestibular imbalance (Ansons & Davis 2014). Honaker and Shepard (2011) reported a link between computerised dynamic visual acuity and falls in a small sample of community dwelling older adults. They suggested a dynamic visual acuity logMAR score>0.25 as a cut-off for further evaluation of balance, orientation and falls risk. The same research group went onto use 'gaze stabilisation' in place of dynamic visual acuity to evaluate VOR whereby instead of varying the optotype size , varying head target speeds are presented (Lee & Honaker 2013). In a small case control study of falls and non-falls participants, the gaze stabilisation test was reported to discriminate between individuals at risk of falls versus those not at risk (Honaker, Lee & Shepard 2013). As a result, the authors suggested a gaze stabilisation test is used to screen for falls risk in older adults with a history of falls and potentially recommend gaze stabilisation exercises to reduce further falls. This was a pilot project based on a small sample size, hence further evidence from large longitudinal studies are needed to examine the effectiveness of testing gaze stabilisation to predict future falls. Therefore, I have not included a gaze stabilisation test in this present study as also the aim was to select standard clinical tests that are transferrable into a falls assessment.

2.4 Summary

Falls are a global public health challenge, and due to the inconsistency in defining and reporting falls, there is considerable variance in the incidence of falls worldwide. However, generally, 1 in 3 people over the age of 65 will experience a fall. The aetiology of falls is complex and can be due to the number and interaction of risk factors that adults experience in later life. There is considerable heterogeneity across the design of studies that have investigated the association of falls and risk factors, including the timing of measuring risk factors. It could be argued that certain risk factors may be a consequence of the falls, for example, impaired balance or fear of falling. The manifestation of visual risk factors following a fall is unlikely unless an individual has a brain injury. Two comprehensive systematic reviews with meta-analysis of risk factors for falls highlighted some common risk factors (Bloch et al. 2013; Deandrea et al. 2010): falls history, medication use, use of a walking aid, presence of specific co-morbidities, balance and limited physical activity.

I have used the evidence from these reviews and the risk factors highlighted by NICE (NICE 2019b), to inform the selection of non-visual risk factors that I have included in my study design described in Chapter 4. In addition to falls history and fear of falling, I have broadly grouped the remaining non-visual risk factors into socio-demographic (age, gender, socio-economic status including living situation), biological (co-morbidities, balance, medication use, hearing), and behavioural (socialising, physical activity, use of a walking aid). All of which have been included in this study.

A number of mostly cohort or cross-sectional studies have examined the relationship between either individual or a combination of measures of visual function and falls. The studies have all varied in methodology, outcome and statistical analyses. Only two cohort studies of varying sizes have been published where all measures of visual function were examined as risk factors for falls (Freeman et al. 2007; Lord & Dayhew 2001). Lord and Dayhew (2001, N=156) reported significant associations for each visual function and multiple falls but did not take into account any other potential risk non-visual factors like falls history, medications, co-morbidities. Freeman et al. (2007, N=2375) found that only visual field loss was associated with the risk of any fall (single or multiple). Participants in their study were required to complete a monthly calendar over a 20-month period, therefore had potential for under-reporting of falls. There has been no comprehensive age-matched case-control study conducted to evaluate all measures of visual function after an older adult has experienced a fall.

The motivation for the study that I describe in this thesis was to draw together in one study the impact of reduced measures of visual function on falls and fear of falling. I am keen to distinguish those aspects of vision which are significant in the risk of a fall. This allows me to explore further the link between impaired visual function (due to age-related conditions) and the psychosocial aspect of falls, fear of falling. In the following chapter, I critically examine the literature on fear of falling.

Chapter 3 Fear of falling, risk and resilience

3.1 Introduction

Fear of falling has been reported in older adults irrespective of their history of falls (Friedman et al. 2002; Jorstad et al. 2005; Kumar et al. 2014; Lavedán et al. 2018; Liu 2015). There is a growing body of evidence that fear of falling (FOF) is a consequence of having a fall (Howland et al. 1993; Kumar et al. 2014; Lach 2005; Lavedán et al. 2018; Murphy, Dubin & Gill 2003). However, as outlined in Chapter 2, it can also be a risk factor for a fall (Friedman et al. 2002; Lavedán et al. 2018). Much of the literature has been published in clinical journals where FOF has been measured using validated clinical tools. However, fear also exists within a socio-cultural context that needs to be considered when conceptualising the 'fear of falling'.

In this chapter, I initially review the literature on fear of falling from the biomedical perspective and present a critical review and evaluation of the measures, risk factors and consequences of the fear of falling (Section 3.2). Fear will then be discussed from a sociological point of view in Section 3.3. I use the discourse of 'risk' drawing on the work published by theorists established in the field; Beck (1992), Giddens (1990), Douglas (1982) and Lupton (1999). The influence of gender and age on risk perception will also be discussed and reference will be made to the falls literature where appropriate.

Relevant clinical and qualitative research will be discussed throughout the sections to provide a socio-medical discourse on the concept, 'fear of falling' that plagues older people and affects their quality of life. In the final Section 3.4, I will discuss the concept of resilience as this relates to how individuals manage their risk or fear in their daily lives which will lead into an analysis of the narrative accounts from the participants in the qualitative phase of my study.

3.2 Fear of falling

Howland et al. (1993) reported that the fear of falling was the most commonly reported anxiety amongst older people above the fear of robbery or financial worries. Early on, “ptophobia”, a phobia of standing or walking was used to describe the fear of falling (Bhala, O'Donnell & Thoppil 1982) and was later categorised as “post-fall syndrome” (Murphy & Isaacs 1982; Tinetti, Speechley & Ginter 1988). The fear of falling can also mean a loss of confidence in an individual’s balance (Tinetti, Speechley & Ginter 1988). It has also been defined as a “*lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing*”(Tinetti & Powell 1993).

The literature on the prevalence of FOF in older adults is of very limited value. The one systematic review of 21 studies reported a very wide range of prevalence of FOF (3-85%) (Scheffer et al. 2008). This variation can be explained by the differences in sample size, definitions used to define a fall and measures used to assess FOF across all the studies in their review. The authors also reported that in 8 of the studies, 50% of older adults who had FOF did not experience a fall, therefore it is not inevitable that FOF will result in a fall.

Fear of falling has been conceptualised in many different ways, for example; ‘fear of falling’, ‘falls-efficacy’, ‘balance-confidence’ (Jorstad et al. 2005; Payette et al. 2016). Falls-efficacy, originally conceived by Tinetti, Richman and Powell (1990) originally related to the confidence at avoiding a fall when performing activities of daily living. These measures will be explored in more detail later in Section 3.2.1 .

Rachman (1978) identified three components associated with fear that were further applied to the fear of falling by Hadjistavropoulos, Delbaere and Fitzgerald (2011): physiological (an increased autonomic reactivity); behavioural (walking slowly to prevent a fall); and a cognitive component (a subjective estimate of the level of risk and one’s ability to avoid a fall). The behavioural component could also be considered as avoidance of activities or adaptation, in line with the definition by Tinetti and Powell (1993). Hadjistavropoulos, Delbaere and Fitzgerald (2011) reconceptualised the fear of falling considering an individual’s belief and history of falls and make the distinction between falls efficacy and fear of falling while acknowledging that a relationship exists between the two constructs in the model (Figure 3.1).

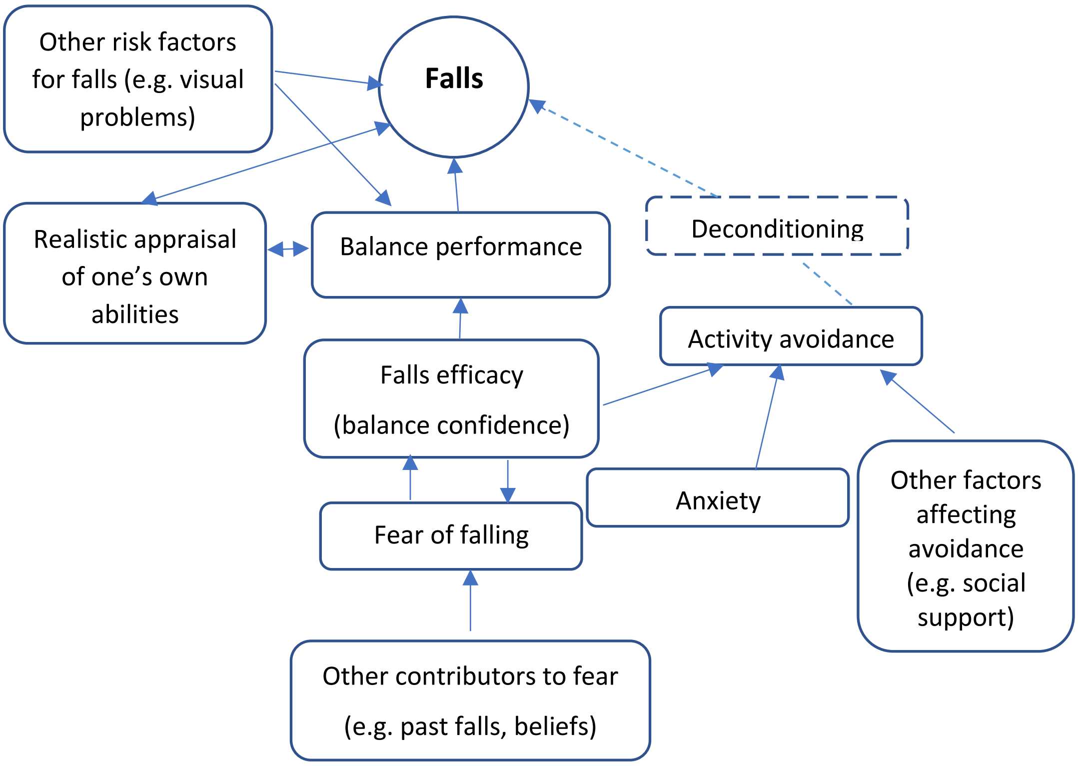


Figure 3.1: Re-conceptualisation of fear of falling (Hadjistavropoulos, Delbaere & Fitzgerald 2011)

Hence, there are two approaches to operationalise fear of falling; 1) to focus on the fear and 2) evaluating falls-efficacy i.e. to self-assess the ability not to fall in tasks of everyday life (Hadjistavropoulos, Delbaere & Fitzgerald 2011; McKee et al. 2002). Where 'fear' is the primary focus, studies have generally used a single item question to determine the fear of falling and a psychometric tool with multiple questions to measure 'falls-efficacy'.

The majority of research on the fear of falling has been conceptualised as falls efficacy in the clinical literature and measured using several tools. ProFaNE (Prevention of Falls Network Europe) recommended the use of a fall-related self-efficacy measure to measure the psychological consequences of falls (Lamb et al. 2005). In the following section, I briefly review the measures used for fear of falling.

However, more focus is placed on 'falls-related efficacy measures' as this is the standardised tool used for clinical and research purposes to examine the functional impact of having a fear of falling.

3.2.1 Fear of falling measures

Once FOF was recognised as a specific problem experienced by older adults (Bhala, O'Donnell & Thoppil 1982; Murphy & Isaacs 1982; Tinetti, Speechley & Ginter 1988), many studies employed different measurement techniques to diagnose FOF. Scheffer et al. (2008) carried out a systematic review of 28 studies to evaluate measurement instruments, prevalence, risk factors and consequences of FOF in community-dwelling older persons. They found that generally, FOF is determined by either using FOF single item questions, falls related-efficacy measures or activity related measures.

Single item questions to assess FOF

Several previous research studies measured FOF using a single item such as, "Are you afraid of falling?" or "Apart from being in a high place, in the past 12 months, have you been worried or afraid that you might fall?" (Friedman et al. 2002; Howland et al. 1993; Maki, Holliday & Topper 1991; Tinetti, Richman & Powell 1990; Yardley & Smith 2002). Whilst a dichotomous question is quick and easy to administer, it does not provide the detail regarding the level or circumstance of the fear. Two systematic reviews of FOF measures reported that there is limited evidence regarding the properties of single-item measures owing to few studies utilising them and no or weak evidence on reliability, validity and responsiveness (Jorstad et al. 2005; Scheffer et al. 2008).

Fall-related efficacy measures

The Falls Efficacy Scale (FES) (Tinetti, Richman & Powell 1990) and Activities-specific Balance Confidence (ABC) scale (Powell & Myers 1995) are both modelled on Bandura's theory of self-efficacy (Bandura 1982) where the individual appraises their own confidence or capability at performing an activity. Tinetti, Richman and Powell (1990) first operationalised the "fear of falling" as low perceived self-efficacy or confidence at avoiding falls and developed the FES. It consists of 10 items considered essential to independent living, each of which was developed with a range of therapists, rehabilitation nurses and physicians. The level of confidence to perform each activity was assessed on a 1-10 point scale (1 extreme confidence and 10 no confidence at all). Since its development, there have been tools which have evolved from the FES (rFES, mFES, FES-I) (Hill et al. 1996; Tinetti et al. 1994; Yardley et al. 2005) or the development of alternative scales like the ABC (Powell & Myers 1995).

The ABC scale assesses the individual's perception of their balance when performing sixteen activities of daily living of varying difficulty on a scale of 0% (no confidence) to 100% (full confidence). It differs from the FES, as the items on the ABC include more difficult hazardous activities of daily living. Also, the FES assesses confidence in performing activities without falling whereas for the ABC, confidence is ranked in response to the instruction: 'not losing balance or become unsteady' when performing the activities. Lajoie and Gallagher (2004) reported a score of ≤67% on the ABC scale as a risk factor for future falls. Powell and Myers (1995) found the ABC scale was better than the FES at detecting loss of confidence in maintaining balance in higher functioning older adults. They also replicated the results from the original FES study (Tinetti, Richman & Powell 1990) providing additional psychometric support for the FES.

The original FES focusses on the functional aspect of performing daily activities with confidence but that does not necessarily mean that the individual is not fearful. This was supported by McKee et al. (2002) who demonstrated that the FES was not significantly associated with fear of falling in 82 older people, which they assessed with two questions specifically addressing the fear of falling. The FES addressed basic activities of living and none that included the impact of FOF on social life (Lachman et al. 1998). The scale 1-10 has been suggested to be difficult for individuals to discriminate (Lachman et al. 1998). Therefore, owing to these issues raised regarding the use of the FES, Yardley et al. (2005) developed the Falls Efficacy Scale-International (FES-I).

Yardley et al. (2005) changed the responses on the FES-I to levels of 'concern' about falling whilst carrying out particular tasks and included an additional 6 questions including social activities. This was an improvement on the original FES, as it allowed for a more functional assessment of 'fear' rather than 'confidence' when doing activities of daily living including engaging in social activities and events. A shortened version of the FES-I has also been developed (ShortFES-I) with 7 items from the original FES-I (Kempen et al. 2007b). These authors developed the tool due to the high internal reliability estimates of the FES-I suggesting redundancy of some items. They suggested that both the FES-I and the Short FEI-I have good psychometric properties but that the FES-I is better at discriminating between subgroups and gives more information regarding concern when performing a wider range of activities.

The FES-I has been evaluated on a large sample of older people (> 60 years, N=704) and despite a bias towards the self-selected participants coming from higher occupational positions (managerial, professional, self-employed) the authors reported good internal and test-retest reliability (Yardley et al. 2005). Delbaere et al. (2010a) conducted a comprehensive longitudinal validation study of the FES-I in 500 older people (70-90 years) over one year. They assessed FOF and falls every 3 months and reported that the FES-I had good validity and reliability. They also suggested a cut-off score >23 as the individual having a high concern for falling. These two studies provide robust evidence that the FES-I is a reliable tool to measure FOF for both clinical and research use (Delbaere et al. 2010a; Yardley et al. 2005). Yet there is a need for a study to compare the FES-I to the perceptions of older adults' of their fear and risk of falls to ensure the FES-I is a valid tool for measuring 'fear' of falling. I have included FES-I in my study as it has good psychometric properties, measures concern on a wide range of activities including social participation and is used at the Broadgreen Falls Unit where I recruited the participants.

Activity related measures

The Survey of Activities and Fear of Falling in the Elderly (SAFFE) was developed by Lachman et al. (1998) due to the shortcomings of the ABC or FES; namely, the lack of items that focussed on physical or social activity and that older individuals found it difficult responding on a wide scale i.e. 0-10 or 0-100. Hence, they developed an instrument with 11 items which focussed on assessing activity restriction due to FOF. The authors tested the tool with 270 participants aged 62-93 years from a public senior housing development. They reported good internal consistency and convergent validity with other fear of falling measures; FES and FOF items developed by Howland et al. (1993). Fear of falling was associated with lower quality of life when all three FOF tools were correlated to poorer physical functioning and mental health (Lachman et al. 1998). The tool is useful for evaluating the relationship of FOF with activity restriction and quality of life. In a review of instruments that measure FOF, only two studies had evaluated SAFFE and the responsiveness and time taken to complete it has not been reported (Jorstad et al. 2005).

Since the review, Hadjistavropoulos et al. (2007), in a longitudinal study (6 months) of 482 older adults aged 69 years or over, compared FES, ABC and SAFFE to predict future falls and activity avoidance. They reported a good correlation between FES and ABC (r (569) =0.82) and found that FES and ABC were good predictors of a future fall while SAFFE was a better predictor of activity level.

To summarise, there are many clinical tools available to assess the fear of falling with each of them measuring different constructs, for example, fall-related efficacy, activity avoidance or balance confidence. The FES-I has been robustly evaluated in a large sample (Yardley et al. 2005) and has cross-cultural validation in the UK, Netherlands and Germany (Kempen et al. 2007a). The ProFaNE group recommend the use of the FES-I for the purposes of using a standardised validated tool for best practice and facilitate robust comparison of published studies (Skelton & Todd 2007). For these reasons and practical implications of the length of time it would take to use multiple measures with each older adult in this present study, I have employed the use of FES-I only. Also, the FES-I measures 'concern' which is most closely related to fear of falling.

3.2.2 Risk factors for developing FOF

Falls and fear of falling share common risk factors, and I have reviewed those for falls in Chapter 2. Here, I will briefly discuss the significant risk factors for FOF identified from two published systematic reviews (Denkinger et al. 2015; Scheffer et al. 2008) and any relevant studies published since. Scheffer et al. (2008) reviewed 17 cross-sectional and prospective studies published from 1990-2006 and found that age, female gender and having had at least one fall, were significant risk factors for FOF. Denkinger et al. (2015) later carried out a comprehensive systematic review of studies published from 2006-2013. A strength of their review is that they reported the outcomes for each construct of FOF, namely fear of falling, fear of falling related activity restriction and fear-related self-efficacy. The authors did not report any patterns across these constructs but demonstrated a robust association ($p<0.001$) between FOF and women, performance-based and questionnaire-based physical function and use of a walking aid. They also reported a less robust association with a history of falls and poor self-rated health. However, neither systematic review included a meta-analysis possibly due to the heterogeneity of the studies. The supplementary file was inaccessible to obtain the odds ratio for significant risk factors in the review by Scheffer et al. (2008).

Since these systematic reviews, cross-sectional and longitudinal studies have provided additional evidence that FOF is associated with increasing age and female gender (Hoang et al. 2017; Lavedán et al. 2018; Liu 2015; Rivasi et al. 2019). Interestingly, Liu (2015) in their study of 445 older people (≥ 65 years) from a Chinese community also reported FOF in 64.63% of the participants who had no history of falls. Across these recent studies, depression was also a significant predictor of FOF (Hoang et al. 2017; Lavedán et al. 2018; Liu 2015; Rivasi et al. 2019) and similar to the systematic review findings of Denkinger et al. (2015), increased use of a walking aid was reported to be a predictor for incident FOF at 2 years in a convenience sample of Irish community-dwelling older adults (≥60 years) (Rivasi et al. 2019).

Several studies have included impaired vision as a potential risk factor when examining fear of falling (Deshpande et al. 2008a; Ehrlich, Hassan & Stagg 2019; Liu 2015; Oh-Park et al. 2011; Rossat et al. 2009). Other studies have studied fear of falling in relation to specific ophthalmic conditions which affect different aspects of visual function and these will be explored in the next section (Adachi et al. 2018;

Donoghue et al. 2014; Nguyen et al. 2015; Palagyi et al. 2017; Ramulu et al. 2012; van Landingham et al. 2014; Wang et al. 2012; White et al. 2015; Yuki et al. 2013).

Visual function and FOF

Impaired visual acuity (VA), contrast sensitivity (CS), depth perception and visual field loss have all been identified as potential risk factors for falls (see Chapter 2). However, of the cross-sectional studies examining objectively measured visual acuity and contrast sensitivity (Deshpande et al. 2008a; Donoghue et al. 2014; Oh-Park et al. 2011; Rossat et al. 2009), only one study reported that activity restriction was significantly related to reduced contrast sensitivity (measured with Pelli-Robson) in a non-depressed group of individuals (Deshpande et al. 2008a). Self-reported poor vision has been reported to be independently associated with FOF and activity restriction due to FOF (Donoghue et al. 2014; Ehrlich, Hassan & Stagg 2019). Despite this association, Donoghue et al. (2014) reported no significant association between objective measurements of VA and CS with FOF. However, vision, as discussed in Chapter 2, includes depth perception and visual fields which were not assessed in their study.

Other studies used either an unconventional measurement of impaired vision (Kempen et al. 2009) or incorrect distance for measuring visual acuity i.e. Snellen at 50cms (Rossat et al. 2009) or a very high threshold for 'low vision' (<20/200) (Oh-Park et al. 2011) which does not allow testing moderate visual impairment as a risk factor for FOF. Daien et al. (2014) in a prospective cross-sectional study of 1887 people (≥63 years) determined the association between visual impairment objectively measured with a Snellen acuity and activity limitations. The authors reported that individuals with moderate to severe visual impairment (less than 20/70) and mild visual impairment (20/70-20/40) were more likely to limit their daily activities when measured with the IADL (Instrument for Activities of Daily Living) (OR=3.49, 95% CI: 1.93 – 6.32 and OR=1.77, 95%CI: 1.07 - 2.91 respectively). These findings do not demonstrate the association with fear of falling and instead are relevant to activity limitations, also due to the cross-sectional design of the study, activity limitations may have been present before the onset of visual impairment or vice versa. Hence, there is a need for a robust study to evaluate the association between objectively measured visual function and FOF as the evidence presented here is inconclusive.

There is little qualitative evidence published on the impact of impaired vision on FOF. Brundle et al. (2015), explored the views of older people with visual impairment on the causes of falls. They reported on participants' accounts of the impact of sight impairment on getting around the home and outdoor environment. The authors used focus groups and interviews to explore the experiences and views of community-dwelling older adults aged 65 and over from Greater Manchester (N=54). All participants in their study had moderate or severe visual impairment (worse than 0.6 logMAR and/or 20% binocular visual field loss). Following, framework analysis of their data, the authors identified five main themes on the causes of falls: 1) health issues and changes in balance, 2) cognitive and behavioural factors including risk-taking, 3) impact of sight impairment on getting around the home, 4) impact of sight impairment outside of the home in the environment and 5) unexplained falls. In terms of fear of falling, they reported some older people with moderate or severely impaired vision avoided going out on their own due to concern about having a fall in their outdoor environment. This is a unique study using qualitative methods to understand the causes of falls from the perspectives of individuals with sight impairment. The findings illustrate that more qualitative research is needed to further explore in terms of causes and consequences, the experiences of older adults with sight conditions who have had a fall.

Age-related ophthalmic conditions and FOF

The prevalence of age-related ophthalmic conditions namely cataracts, glaucoma, AMD and diabetic retinopathy increases with age. Older adults aged 80 years have a third of all cases of cataract, glaucoma and AMD (Klein & Klein 2013). Hence, with the increased risk of falls and eye diseases with age, there is potential for an associated increased risk of FOF.

Wang et al. (2012) in a cross-sectional study examined a total of 345 patients with AMD (N=93), glaucoma (N=98), Fuchs corneal dystrophy (N=57) and controls with normal vision and visual fields (N=97) to determine the activity limitation due to FOF. All cases had the disease in both eyes. For the AMD and Fuchs group, the VA was worse than 20/40 (6/12) in each eye and for the glaucoma group, the visual field loss was worse than -4dB in the worse eye (0 to -2dB is considered normal). The authors reported that 40-50% of individuals with eye disease limited their activities due to fear of falling compared to 16% of the individuals with normal vision and visual fields. They also reported that contrast sensitivity in the worse eye reflected the relationship between eye disease and activity limitation over visual acuity and visual fields. However, they did not adjust for history of a previous fall in their multivariable model despite finding that those who reported a fall in the previous year limited their activities due to FOF. Also, the inclusion of multiple eye conditions does not allow for robust conclusions for each specific ophthalmic condition.

A few studies have examined the association of FOF with specific ophthalmic conditions, for example, glaucoma, AMD, cataracts and diabetic retinopathy (Adachi et al. 2018; Hewston & Deshpande 2018; Palagyi et al. 2017; Ramulu et al. 2012; van Landingham et al. 2014). Whilst a scoping review reported FOF to be highly prevalent in older adults with type 2 diabetes (Hewston & Deshpande 2018), I have focused on reviewing the literature examining FOF in cataracts, AMD and glaucoma as participants with these conditions have been included in this present study.

Cataracts

A prospective cohort study demonstrated a substantial rate of falls in participants (≥ 65 years) with cataracts (1.2 falls/person per year) waiting to have surgery (Palagyi et al. 2016). The authors commented this was a higher rate than the 0.4-0.6 falls/person per year reported in the US by another study (Verma et al. 2016). In a later study, the same research group included the participants with cataracts to evaluate the fear of falling and the interaction between visual ability and physical function (Palagyi et al. 2017). The authors reported that a greater visual disability (reported by the participants using a validated patient reported outcome measure) was associated with a higher fear of falling measured with the Short Falls Efficacy Scale-International (SFES-I). They also determined that self-reported visual disability had a moderating effect in the relationship between physical function and fear of falling. Hence, in an individual who had high levels of self-reported visual disability there appeared to be a greater effect of the physical function score on fear of falling. However, no association was reported between objectively measured visual function and fear of falling. The participant's perception of their vision and falls-efficacy is of great importance for evidencing the impact of vision on fear of falling. Yet, there needs to be further research to determine the reasons behind the difference in FOF with self-reported visual disability and objective measures of visual function.

AMD

The risk of falls has been associated with AMD (Chung et al. 2017; Szabo et al. 2010; Wood et al. 2011). To date, there are only two studies that have explored the relationship between AMD and fear of falling (Barnes & Hall 2019; van Landingham et al. 2014). van Landingham et al. (2014) in a cross-sectional study compared AMD participants (N=65) with glaucoma suspects (N=60) who had normal vision and found that AMD was significantly associated with a greater fear of falling (p=0.045) and a multivariate analysis demonstrated that the FOF significantly increased with worse VA (p=0.02) and CS (p=0.001). A recent small study comparing men (N=27) and women (N=14) with AMD detected no significant difference between each gender but did report high rates of falls (men: 51.9% and women: 57.1%) and FOF (men: 37% and women: 57.1%) associated with AMD (Barnes & Hall 2019).

Glaucoma

It has been estimated that approximately 10,000 patients admitted for falls had a secondary diagnosis of glaucoma in the UK (McGinley et al. 2019). A specific study examining FOF in glaucoma participants found that bilateral visual field loss due to glaucoma was significantly associated with FOF and significantly increased with greater visual field loss (Ramulu et al. 2012). However, the authors did not record the history of a previous fall in their sample which is a significant risk factor for FOF.

Yuki et al. (2013), in their cross-sectional study, examined the association between visual field defect severity and FOF in 387 participants with primary open-angle glaucoma. The authors did include a history of falls in a multivariable-adjusted model and it remained a significant risk factor (OR=5.22, 95%CI: 3.11 - 8.75). They also reported adjusted odds ratio for having a fear of falling in the presence of mild (OR=1.44, 95%CI: 0.83 - 2.51), moderate (OR=2.33, 95%CI: 1.00 - 5.44) and severe (OR=4.06, 95% CI: 1.39 - 11.90) primary open-angle glaucoma. Neither of these studies identified the location of the visual field defect that was relevant to the fear of falling in their participants (Ramulu et al. 2012; Yuki et al. 2013). To address this limitation and the cross-sectional nature of the previous studies, Adachi et al. (2018) examined the relationship between primary open-angle glaucoma and fear of falling over a 3-year longitudinal study. They included 342 participants (aged 40-85 years) with glaucoma and examined them at baseline and asked them questions relating to the fear of falling and previous falls. Only the fear of falling question was asked every 12 months (Are you afraid of falling? (Not at all/Not much/Afraid/Very afraid). The authors reported that a defect in the inferior field was significantly associated with the fear of falling at baseline and for future falls (p=0.012) (Adachi et al. 2018) and therefore potentially increasing the risk of a fall (Friedman et al. 2002). It is important to differentiate whether the presence of fear of falling is due to having glaucoma or the location and extent of field loss associated with glaucoma.

3.2.3 Consequences of FOF

Apart from the psychological consequences of having a FOF, it can also lead to physical, functional and social decline (Legters 2002). The systematic review by Scheffer et al. (2008) comparing individuals with and without FOF reported physical, functional, psychological and social changes as a consequence of FOF. Physical consequences included injuries, further falls (Cumming et al. 2000; Friedman et al. 2002; Lavedán et al. 2018) or decline in physical health (Bjerk et al. 2018; Cumming et al. 2000; van der Meulen et al. 2014). Due to the various methods employed to measure activity or physical health using ADL (Activities of Daily Living), health-related quality of life questionnaires (SF-36) or gait and balance measures (Berg balance, TUTG), there is considerable heterogeneity to compare published studies (Schepens et al. 2012). The association of FOF and objectively measured physical activity has been studied in a large cohort of community-dwelling men (N=1680) (Jefferis et al. 2014). The authors reported that men who were fearful of falling took fewer steps/day and spent less minutes doing moderate to vigorous physical activity compared to the men who had fallen, suggesting that FOF is a barrier to walking and promoting more sedentary behaviour. Consequently, it can potentially lead to muscle deconditioning and the risk of further falls (Deshpande et al. 2008b).

As mentioned earlier, falls and FOF have a bidirectional relationship. Further falls have been widely reported as a consequence of FOF (Cumming et al. 2000; Friedman et al. 2002; Lavedán et al. 2018). The 24-month prospective longitudinal study of 640 people (aged ≥75 years) from Lleida described earlier in Chapter 2 aimed to determine whether FOF is a cause of falls or a consequence or both (Lavedán et al. 2018). The study was part of a large study assessing the frailty process and each participant underwent a face-face interview to capture the data for each of the variables at baseline and two years later. The authors reported that while a previous fall is a risk factor for fear of falling, a fear of falling was a predictor of a fall only in the unadjusted model as gender had a strong mediating effect on the association of FOF and subsequent falls. On the contrary, Friedman et al. (2002) reported that having a fall and the fear of falling were independent predictors of each other in their 20-month longitudinal study of 2212 participants. They suggest that fear of falling is not an acute outcome but having that fear is to acknowledge the potential risk of a fall and consequences of the fall. The study size and quality of evidence from Friedman et al. (2002) would suggest that there is a cycle of falls risk and fear of falling which could result in spiralling negative consequences for an older adult.

Functional activity limitation due to FOF can lead to loss of independence and consequently depression and poor mental health. An empirical review led by Hughes et al. (2015) examined the association between psychological factors with falls-related psychological concerns. The concept of falls-related psychological concerns (FrPC) encompasses four constructs namely, 'fear of falling', 'falls-related self-efficacy', 'balance-confidence' and 'outcome expectancy'(Hughes et al. 2015). Outcome expectancy is measured with the consequences of falling scale and the authors refer to it as an individuals' perception that certain behaviour will result in a specific outcome. This is a comprehensive review in the sense that the associations between the psychological factors were reviewed in relation to each measured construct and only studies with robust methods and statistical analysis were included. However, no meta-analysis was carried out as part of their review. The authors reviewed anxiety, depression, QoL, activity avoidance/restriction, activity levels and coping as the psychological factors. In Table 3.1, I have selected key findings from the review which demonstrate the evidence level for each of the constructs of FrPC that were predictive of the psychological factors. I have not included 'Outcome expectancy' in the table as this construct has not been widely researched.

Table 3.1: Level of evidence for the association between FrPC and psychological factors (Good: two or more well-designed studies with robust statistical methods and similar results, Moderate: one or more studies show evidence but measures employed were not psychometrically robust, or if only one study was well-designed studies with robust statistical methods, Tentative: studies no methodologically or statistically robust (Hughes et al. 2015)).

	Fear of falling	Falls-related self- efficacy	Balance confidence
Anxiety	No study exploring this relationship	No study exploring this relationship	No study exploring this relationship
Depression	No study exploring this relationship	Tentative	No study exploring this relationship
QoL	Good	Tentative	Moderate
Activity avoidance/restriction	Good	Moderate	Tentative
Activity levels	Tentative	Tentative	Tentative
Coping	Tentative	No study exploring this relationship	No study exploring this relationship

Based on the empirical review by Hughes et al. (2015) and a recent systematic review of thirty studies by Schoene et al. (2019) there is strong evidence to suggest that FOF measured mostly by single-item questions and SAFFE is predictive of QoL and activity limitation/restriction.

Ultimately, impaired physical and mental function could potentially negatively impact on social participation. van der Meulen et al. (2014) investigated the effect of fall-related concerns on physical, mental and social function in community-dwelling older adults in the Netherlands (N=256) over 14 months. They reported those with a higher level of fall-related concerns measured with the modified Falls Efficacy Scale (mFES) at baseline had more limitations in activities of daily living but also reduced social participation.

Most of the studies investigating associations between FOF and physical, mental and social dimensions are cross-sectional in design, therefore limiting their conclusion regarding causations (Denkinger et al. 2015; Kempen et al. 2009; Scheffer et al. 2008). Little qualitative evidence has been published specifically exploring FOF in older adults who have fallen (Bailey, Jones & Goodall 2014; Tischler & Hobson 2005) and none in those with age-related sight conditions.

Tischler and Hobson (2005) interviewed seven older adults from Ontario, Canada (aged 61-88 years) to explore the reason for their fear of falling and perceived consequence of the fear. Six themes emerged from the study; physical injury, the feeling experienced when falling, becoming a burden, losing independence, lying on the ground for a long period of time without being helped and being unable to walk again. As illustrated here the definition of 'fear' is contextual and the personal experience of the fall can shape the 'fear' experienced by individuals. A synthesis of the qualitative research on falling across the life course revealed that older people's perception of their falls did induce fear, but was also influenced by their attitudes and beliefs of falling in older age (Bailey, Jones & Goodall 2014). The following section examines the literature on fear and risk from a psychosocial perspective and the potential influence of risk perception and management on fear.

3.3 'Fear' and 'Risk'

Fear is a difficult concept to critically examine without exploring its meaning in a specific context. A review of this concept defined fear as an emotion being caused by threat-related stimuli (Adolphs 2013). However, this definition needs to be extended as 'fear' is more than an emotion that is brought on by objective stimuli as it is also a subjective experience. Fear, therefore, must also be explored for the meaning it gives to the people who experience the emotion and the social factors that shape it. The concept of fear is often described alongside ideas about 'risk' in the sociological literature (Beck 1992; Douglas 1992; Douglas & Wildavsky 1982; Giddens 1990). Lupton (1999, p. 18) in her book *Risk* describes, the concept of risk, '… has come to stand as one of the focal points of feelings of fear, anxiety and uncertainty'.

In the following section, I will set out how 'fear' is defined and conceptualised from varying perspectives and draw on the 'risk' discourse to discuss how it may impact on how older people view and interpret the fear of falling.

3.3.1 Fear

Sociologist Frank Furedi (2006), suggests that fear can be generated by society, media and politics and that fearfulness has become more prevalent in our lives. Furedi's theory of how fear is generated and make people more fearful can be applied to a qualitative study on falls by Yardley et al. (2006). The authors conducted focus groups and interviews with 66 people aged 61-94 years to gain an understanding of older people's perception of falls prevention advice in the UK. They reported that the discussion of falls risk was seen by some older adults as potentially anxiety-inducing and detrimental to their lifestyle and identity. This study provided good qualitative evidence on older people's views and perceptions of falls prevention advice. Based on their findings they suggested that the narrative should not be about risk reduction and instead the focus should be on health promotion (Yardley et al. 2006). Furedi (2004) also highlighted that peoples' fear about their health may actually pose a risk to their health, which is confirmed by evidence that having a fear of falling is a risk for having further falls (Cumming et al. 2000; Friedman et al. 2002; Lavedán et al. 2018; Murphy, Dubin & Gill 2003).

Fear or feeling fearful can be influenced by physiological, psychological, social, historical and cultural factors. Tudor (2003) proposed a useful scheme to define the parameters of fear by suggesting six analytical groupings; environments, cultures, social structures, social subjects, personalities and bodies. He suggests that a situation of fearfulness will involve all six parameters in various combinations, but cautions that the groupings should not be seen as 'systems' and that it merely represents an attempt to provide a model of the dimensions of fear (Figure 3.2).

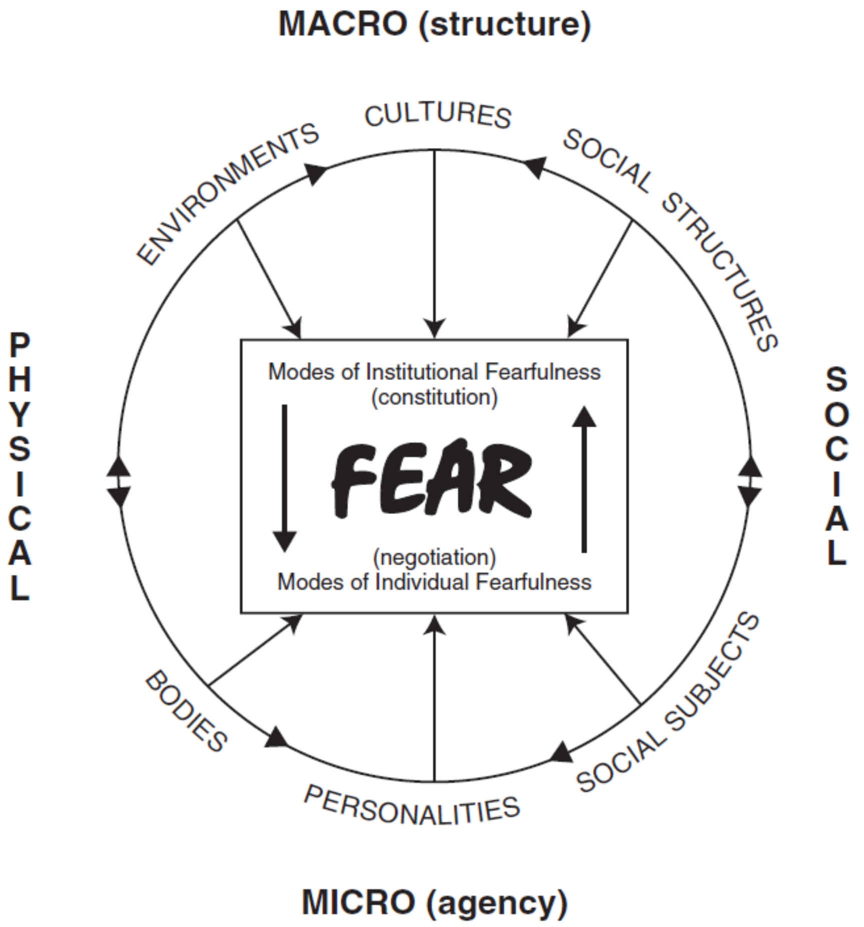


Figure 3.2: Parameters of fear (Tudor 2003)

Tudor's (2003) scheme can be applied to the fear of falling, where environments causing fear could include uneven roads and pavements, crowded places and slippery and icy surfaces. The cultures dimension refers to the beliefs, attitudes and values that an individual can draw on to manage their fear. For example, if a person decides to avoid the risk of a fall by not engaging with what they consider and value to be 'risky' behaviours, this will still generate fear due to continuing uncertainty about the outcome. Social structures, such as family and social networks/support, gender and social class, can influence how risks are managed, and so affect fear. For example, a family member, friend or carer's perception of how the individual should manage their falls risk may advise them to limit their physical mobility and engagement. This potentially can render the individual less independent and therefore be counter-productive to managing their fear. The awareness of our body (for example, the frailty) and existing capabilities (presence of co-morbidities) and consequences could potentially impact on the FOF. A fear response can be influenced by the personality of an individual which may be shaped by previous experiences and psychological dispositions but also interact with other parameters of this model. Finally, people are social subjects and therefore how fear is projected or managed will be influenced by their experience and involvement in the various social structures of their lives (Tudor 2003). The extent to which a situation is perceived as 'risky' may also influence how fear is managed, hence the following section will draw on the 'risk' literature to understand the fear of falling in older adults.

3.3.2 'Risk'

The Royal Society (1992) defined risk as:

> *"the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge".*

This positivist definition is how risk is interpreted in the medical and clinical literature, and it focuses on probabilities, that is, odds and risk ratios to quantify the likelihood of an event occurring depending on their risk factors. Risk factors commonly feature in medical journals, which demonstrates the dominance of the risk discourse in healthcare using surveillance medicine (Skolbekken, 2008 cited in Beddoe (2014). This suggests that we are vulnerable to disease as very few of us are without 'risk factors'(Beddoe 2014, pp. 51-62).

An example of this suggestion is illustrated in the paper by Tinetti, Speechley and Ginter (1988) where odds and risk ratios of a fall were calculated once data had been collected for specific risk factors: multi-morbidities, deficit visual functions and balance. The authors also gathered socio-demographic (age, gender and type of housing) and psychosocial (measures of depression) data. Theirs is one of the first studies that has comprehensively examined risk factors for falls. However, they did not include fear of falling as it was probably seen as a consequence rather than a cause at that time. Whilst this study did include some psychosocial risk factors, it did not include any information regarding social participation or living arrangements as potential risk factors for falls. This points to the lack of parity given to biological, psychological and sociological factors when examining the risk of falls and fear of falling in the clinical literature. Studies in the last decade have included psychological measures alongside clinical data (Delbaere et al. 2010b; Pauelsen et al. 2018; Schepens et al. 2012).

Delbaere et al. (2010b), for example, in their study measured a range of sociodemographic, cognitive, psychological and physical factors to determine the physiological risk of falls and assessed the perceived risk of falls with several neuropsychological constructs and the FES-I in 500 older adults aged 70-90 years. Based on their physiological falls risk profile and perceived fall risk, the authors used classification and regression tree analyses to categorise their sample into four groups: *vigorous, anxious, stoic* and *aware*. They reported that almost two-thirds of participants had an accurate perception of their fall risk and were mostly in the *vigorous* (30% with both low physiological and perceived fall risks) and *aware* (40% with physiological and perceived fall risks). However, a third had disparities between their physiological and perceived fall risks and these were categorised as the *anxious* group (10% with a low physiological risk of falls but high perceived fall risk) and the *stoic* group (20% with a high physiological risk of falls and low perceived fall risk) (Figure 3.3). Further analysis of the falls data allowed the authors to observe that the low perception of fall risk in the stoic group was protective for falling as these individuals had a positive outlook on life and maintained physical activity. This is a robust study with good statistical analysis to illustrate the differences in physiological and perceived risk of falls in older adults but the socio-cultural context was still lacking to illustrate the holistic view of the fear of falling.

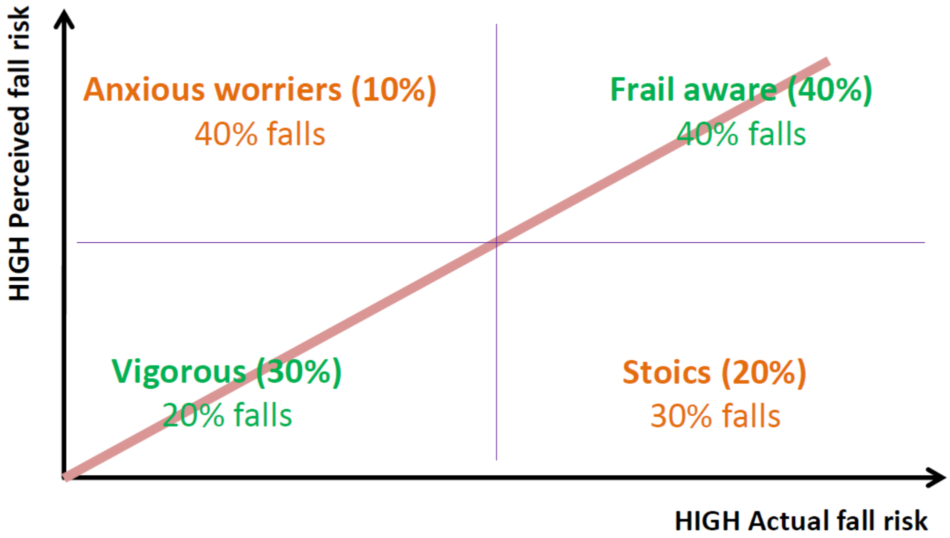


Figure 3.3: Disparities in physiological and perceived risk of falls in older adults (Delbaere et al. 2010b)

Alaszewski and Coxon (2009) in their paper discuss uncertainty conceptualised as risk which can be equated with worry or concern. The study explores how strategies which utilise an individual's social skills and judgements, based on experience and habitus, are used to manage these concerns. Habitus is a concept developed by Bourdieu (1977, p. 72) who described it as "*systems of durable, transposable dispositions, structured structures predisposed to function as structuring structures*". In other words, habitus relates to the beliefs, attitudes and values that guide the behaviour of individuals. Alaszewski and Coxon (2009) recommend that there is more work that needs to be done on documenting personal responses to risk with the use of qualitative research to gain an understanding of human responses to living in an uncertain world. Furedi (2006) suggested that 'all risk concepts are based on the distinction between reality and possibility'. The reality is that the individual may have physiological risk factors but there is only a possibility or 'chance' that the individual may fall.

3.3.3 Sociological theories of 'risk'

Modernity and risk

Much of the sociological literature on risk has been written since the emergence of modernity which can be defined as the time of the industrial revolution and advancement of science and technology. In the pre-modernity period, people were exposed to threats and dangers of a different nature e.g. epidemic diseases but these were managed in one of many ways that were not under the individual's control e.g. superstition, fatalism or religious faith. Giddens (1990) put forward the modernist concept of risk which assumes that unanticipated outcomes may be the consequence of human action rather than the result of a supernatural God's will, hence replacing the pre-modern concepts of fate. He further explains that a risk society is "a society increasingly preoccupied with the future (and also with safety), which generates the notion of risk". Giddens (1991) and Beck (1992) both speak of modernity and reflexive modernisation where risk society has evolved and that there is the increased accessibility of knowledge of risk which potentially enables individuals to make informed choices to mitigate risk. However, despite the accessibility to knowledge and the advancement of medical knowledge, the management of risk and fear is individualised depending on a person's resilience based on their life experiences, social structure, gender and class. The awareness of risk then raises associated uncertainties, anxieties and fear. Much of the work published by Beck (1992) on risk has a political agenda and, whilst some core ideas and theoretical arguments can be applied to risk in health and the elderly in terms of knowledge production and the common language changing from danger to risk, there is little argument offered in terms of the influence of class, gender and age on risk perception and management.

Culture and risk

Lash (1993) argued that individuals may respond to risk in emotive and aesthetic ways which are governed by their moral and cultural values. Accordingly Lash offers the concept of 'risk cultures', cultures which are more fluid and in which the perception of risk and its management will depend on habitual, embodied and affective judgements. This conceptualisation of risk is similar to that put forward by Douglas (1992) who suggests that the role of 'cultural dispositions' is central to how risk is shaped and managed. According to this theory, people respond to risk via frameworks that are assimilated and shared within a cultural context. Douglas and Wildavsky (1982) put forward a grid-group model of behaviour to understand how people respond and understand risk. The model consists of a high and low group ethos which refers to the boundary between themselves and the outside world and the high/low grid relates to the social distinctions and cultural constraints which gives rise to four approaches to risk (Figure 3.4). Although the model provides a cultural context within which risk may be approached, there is no fluidity and allowance for people to move between these types depending on the nature of the risk or other life course factors that change with age.

High grid	Fatalists	Hierachists
Low grid	Individualists	Egalitarians
	Low group	High group

Figure 3.4: Group-grid theory of risk (Douglas & Wildavsky 1982)

The cultural theory provides a counter-argument to Beck's theory of how people respond to risk by using cognitive judgement based on the facts of the risk presented. Studies have suggested the influence of cultural differences in the effectiveness of interventions for falls such as physical activity and exercise programs (Conde, Hendry & Skelton 2019; Horne & Tierney 2012). A study to explore the beliefs of South Asian and White British older adults about falls and exercise for falls prevention identified that most individuals from a South Asian background held a 'fatalistic' view of their health and illness (Horne et al. 2014). The South Asian participants were resigned to an inevitability to falls and therefore did not consider the risk of a fall within their control. As well as a cultural aspect to risk perception, our habitus or dispositions will influence our prior knowledge and shape risk perception and management.

3.3.4 Risk perception and management

Lupton (2013) describes different ways in which risks are conceptualised in her book, "Risk". She raises the idea of risk being viewed from the techno-science perspective where scientific methods are used to calculate probability and predictive models are constructed to estimate the effect of risks on individuals and populations. She goes on to discuss that those with a socio-cultural perspective define and conceptualise risk using a social and cultural context that is the lived experience, embodied and negotiated.

However, I agree with Paul Slovic's conceptualisation of 'risk' which he describes in a published interview (Heyman & Brown 2013). He suggests that the concept of risk is to not only regard it as a complex technical, scientific concept but to include the social, communicative and cultural aspects. Slovic (2000) addresses the concept of risk and risk perception from a psychometric viewpoint and talks about the 'affect heuristic' in risk judgement and decision making where we need to consider the influence of 'affect' which is described as an emotion: positive or negative towards a stimulus or hazard. He also suggests that the perception of risk depends greatly on the way relevant information is presented. Falls prevention programmes, as discussed earlier may heighten the awareness of risk and induce anxiety (Yardley et al. 2006) but if the information was to be presented in an individualistic and constructive manner, promoting health protection, the positive trade-off may be realised and there would be better engagement with falls programmes. Often, the circumstances surrounding a fall can play a more important role than the fall itself and affect how the individual views their risk. This is illustrated by one of the interviewees in the qualitative study by Tischler and Hobson (2005) exploring the fear of falling:

> *"When I fell before I was lying for so long and then when I got up, I don't know how I got up, but I came and phoned the ambulance myself. . . . The blood had all dried because I was on the floor for a while. This is my fear of falling, not being able to get help right away if I fall."*

For this individual, the fear relates more to the feared consequence of the fall rather than the fear of falling; the individual is worried about the 'long lie' on the ground before being found and helped.

Today, 'risk' is generally understood as a negative concept that would result in a negative consequence, for example, a loss or danger. This, however, has not always been the case. Green (1997) highlighted that in the past 'risk' would be associated with good and bad outcomes and rather than it be associated with a hazard, danger or loss, it would be more akin to 'chance'. This is particularly obvious in an economic/financial situation where taking a risk could result in a good outcome and perhaps in certain cases result in achieving personal gain and satisfaction, therefore, risk-taking can be viewed in a positive context. In the context of the fear of having a fall, it raises the question of whether individuals consciously make decisions about their risk in terms of positive and negative outcomes.

Naturally, an individual will appraise the fall-risk in a specific situation and this will affect their decision to act but it will also be based around their activities of daily living. Their appraisal of risk can affect their potential to become fearful of falling and their efficacy to perform those activities. However, a fear of falling is not just something that happens from a fall, rather, a fear of falling has been reported to be the recognition of being at risk of both falling and the adverse outcomes that may result from a fall (Bertera & Bertera 2008; Friedman et al. 2002).

Expert vs non-expert views

Views on risk have been described in the literature as *expert* or *lay* and may differ depending on the context in which both are understood (Lupton 2013; Tulloch & Lupton 2003). However, I will use the terms, *expert* and *non-expert* in this thesis. The expert or in this case the health professional's view of risk is communicated with a technical understanding around the risks of falling. However, by contrast, the patient's approach to risk will be shaped by experiences of their social role and self-identify (Jones 2007). It has been suggested that non-expert knowledge is far more contextual, localised, individualised, reflexively aware of diversity and change than the universalising tendencies of expert knowledge (Lash, Wynne & Szerszynski 1996).

The risk perceived by the individual is based on their personal traits and sociocultural parameters, for example, education, experience, habits, political orientations, beliefs and values (Michalsen 2003). Also, risk perceptions are influenced by life experiences, previous events, for example, the outcome of any previous falls and the imaginability of the future (Slovic 2000). The varying perspective of risk between health care professionals and the people they provide advice and treatment to, Lupton (2013) argues, gives rise to the phenomenon of risk being a production of competing sets of knowledge about the world. Douglas (1992) suggested it is not simply a matter of the non-experts' ignorance or inability to understand probabilities. Similar to Douglas's cultural/symbolic representations of perceptions of risk, Wynne (1996) suggests that as members of social groups and networks, peoples' responses to risk are embedded within these relationships and are therefore collective as well as developed through individual biographies. Lupton (2013) goes further to describe the reflexivity of non-expert people in relation to risk which may develop from their observations of the ways in which everyday life operates and from conversations and interactions with other non-expert actors.

3.3.5 Risk 'factors' in healthcare

Generally, in healthcare, individuals are considered as having 'risk factors' and the evidence suggests that the increased number of risk factors an individual has the more at risk they are of developing or experiencing the condition of interest (Tinetti, Speechley & Ginter 1988). Studies have found that whilst healthcare professionals are keen on raising the awareness of risk factors to individuals who have had a fall or perceived as at risk, they are inadvertently encouraging older adults to reduce physical and social activity to reduce the risk of a fall (Nakamura, Holm & Wilson 1998; Tinetti & Speechley 1989). This was further supported by the findings of a study where despite 70% of older adults being aware that physical activity was important for fall prevention, 80% of those who fell did not take up physical activity or in fact, reduced them (Boyd & Stevens 2009). The communication of risk or advice regarding falls is important in how individuals manage their risk as a participant in a study by Yardley et al. (2006) felt the falls prevention advice given to her made her feel more anxious:

> *"The advice can make you feel anxious, depressed".*

Therefore, there is potential for an individual to become inactive and immobile due to the fear of falling generated by increasing the awareness of risk. Currently, there are no published studies on the approach taken to communicate personal risk factor information to individuals who have experienced a fall.

The literature suggests that it is the attitude to risk that is important and shapes our approach to fear. Our response may be shaped by our personality and physical attributes but also our social, cultural and life experiences. Ward-Griffin et al. (2004) explored older peoples' perceptions of safety, fear of falling, independence and quality of life using a phenomenological study. They suggested that participants controlled by the fear of falling used strategies to strive for independence whilst exercising precaution at the same time. The authors reported that this dynamic tension between precaution and independence led participants to shrink and expand their life spaces at the same time. The strategies identified to exercise precaution were: depending on help, resisting activities, eliminating hazards, selecting safe places and assigning blame. In contrast, those developed to strive for independence included: minimising the impact of the fall, using assistive devices, resisting confinement, running the risk and accessing resources. All these strategies have an element of risk perception and management which are governed by the socio-cultural context of each individual but with shared moral values and knowledge.

3.3.6 Risk management in health

Healthcare settings are designed and run to minimise or remove hazards and uncertainties, that is, organisations manage risks through rational systems or clinical governance codes of practice (Beddoe 2014). Hillman et al. (2013) carried out an ethnographic study on an acute ward in a UK hospital to explore the provision of dignified care for older people. They suggested that 'governance' i.e. the systems of regulation, protocols and performance measures had contributed to de-humanising effects and consequently affected patient dignity and care. Similarly, Ballinger and Payne (2002) carried out an ethnographic study along with semi-structured interviews with service users aged 66-89 years to explore how risk was realised and managed in a day hospital for older people in the UK. The authors suggested that the management of risk by the health professionals effectively undermined the promotion of independence which was paradoxically a primary objective of the service. The service users described that their experience was more focussed on identifying physical deficits. Furthermore, from their observations, the authors inferred that the hospital focussed on prevention of falls by minimising physical risks; for example, by asking patients not to 'wander around'. The service users were more concerned about the social risk of their identity being threatened. The authors go on to challenge the 'positivist construction' of a fall which assumes it has recognisable precursors and foreseeable consequences as it does not account for the social context of the fall or the implications on the individual's social identity. Ballinger and Payne (2000), in their paper, describe the impact of falls on social identity and reported that it was a sensitive topic for older adults who were keen to distance themselves from a 'fall' due to the fear of being labelled as frail and vulnerable.

Bornat and Bytheway (2010), using interview and diary data examined how risks are perceived by older adults (≥75 years) and the people close to them. They found that risk was balanced against the preference to remain independent and that it was a dynamic ongoing process of negotiation. Bornat and Bytheway (2010) argue that for older adults the threat to autonomy and independence, which form a considerable part of their wellbeing, can come from financial insecurity, personal health, ill-health or death of a partner, pressures from family members and significant changes in housing and location. They suggest that in later life individuals use their choice and advantage to work out rational risk management for individualised lifestyles (Bornat & Bytheway 2010). Bailey, Jones and Goodall (2014), in their qualitative synthesis of the experience of having a fall across the life course, identified common themes from 11 qualitative studies; beyond personal control, taking control; rationalising; life change and identity; salience and self-management. The authors recommend from their synthesis that health care professionals need to recognise the individual's notion of risk and choice when discussing falls intervention and considering the individual's preference for preserving their autonomy and independence. Therefore, any loss of independence may result in being labelled 'at risk' with social dis-engagement.

3.3.7 Age, gender and risk

Although people may have inherent attitudes to risk, there is little known about the effect of age on risk perception in the medical domain (Hanoch, Rolison & Freund

2018) but there is a suggestion that age differences exist in risk perception (Kingston 2000; Tulloch & Lupton 2003). During interviews with Australian and British participants about risk, Tulloch and Lupton (2003, pg 28-38) suggested that age and gender influenced how they responded to risks. For example, young men in their interviews were generally more confident and appeared to be able to take control of their lives in the context of being victims of crime compared to others. However, women described themselves as vulnerable. Again, this was in the context of personal safety rather than health. Through the interviews with the participants, the authors learnt there was a life-course trajectory of risk-taking and risk avoidance. For example, younger adults demonstrated significant risk-taking compared to adults with families, therefore suggesting that risk perception varies depending on the position in their life course and priorities at that time. However, as the study included participants younger than 60 years, the later life trajectory of risk-taking was not discussed.

Kingston (2000) highlighted the difference in attitude to risk as people age. They used the example of when a child has multiple falls when learning to walk; the parents consider it as risk-taking behaviour, the benefit (learning to walk) outweighing the risk. However, if an older person takes a risk and experiences a fall, it may be considered 'fool-hardy' due to the danger to their long-term health outweighing the benefit of the short-term activity. This raises the issue of public perception of older adults and apportioning blame. Mary Douglas's work on 'risk and culture' and 'risk and blame' asserts the importance of culture in the construction of risk (Douglas 1992; Douglas & Wildavsky 1982). In the example given by Kingston (2000), we can see the influence of how older adults are perceived by society and the cultural meanings people have for what is 'risky' for older adults. Consequently, older adults could potentially be blamed if they operate outside of the cultural norms of acceptable risk to them. Hence, as well as the social context within which individuals live and have responsibilities, for example, caring for others, family support and community engagement, there is the cultural aspect of ageing and the effect on self-identity that potentially influences how risk is appraised and managed.

Dollard et al. (2012) using grounded theory, interviewed nine participants aged 65-86 years to understand older people's perception of falls and found that falling was a threat to their self-identity. In their study, older people were keen to distance themselves from being labelled "at risk of falling" or "fallers" to maintain their autonomy and competence. Similarly, a recent narrative synthesis conducted by Gardiner et al. (2017) found that falls were a threat to personal identity when older people's experiences of falling and the perceived risk of falling in the community were explored. They reviewed the qualitative research literature from 1999-2015 and as the identified studies (n=11) shared themes and concepts across the studies, a *reciprocal translation* method was used to synthesise the studies. This is a method whereby the concepts from each of the studies are translated into one another. In addition to older adults rejecting the label of being at risk of falls, they found falls were also a threat to independence and social interaction, and older adults used carefulness as a strategy to prevent further falls (Gardiner et al. 2017).

It has also been suggested that gendered ideology and practice affect risk perception (Gustafsod 1998). Gendered ideology is discussed in terms of individuals being socialised into specific gender roles and gendered practice is based on the assumption of men and women performing different activities in their daily lives (Gustafsod 1998). A gendered meaning of risk of falling has been reported in a grounded theory study exploring the influence of gender on older people's perceptions of their risk of falling (Horton 2007). Forty in-depth interviews were carried out on men and women aged 65-94 years in South East England. The author reported that older men were more likely to use the words, 'risk' and 'risky' whereas the women tended to blame themselves or others (Horton 2007). Similarly, a study examining the gender perspective on older people's exercise preferences in the context of falls prevention reported that women and not men expressed a fear of falling as a barrier for exercise (Sandlund et al. 2018).

To summarise, whilst there are specific personal attributes that may influence risk perception and management, external factors like healthcare mechanisms and the availability of support and resources will also contribute to how risks are managed. Resilience is closely linked to risk as it has been suggested to represent a successful adaptation to an adversity or risk (Masten, Best & Garmezy 1990) and is discussed in the following section.

3.4 Resilience

Resilience is predominantly viewed and studied from a psychological point of view (Bonanno 2005; Lazarus 1966; Masten, Best & Garmezy 1990). However, the concept of resilience has been explored from different perspectives to move beyond the individualisation of resilience and focus of personality characteristics and traits (Wild, Wiles & Allen 2013). The emphasis of resilience has shifted to the process of capacity for, or outcome of successful adaptation despite challenging or threatening circumstances (Masten, Best & Garmezy 1990).

Resilience can be associated with “successful” ageing (Wagnild 2003) which according to Rowe and Kahn (1987) is the avoidance of disease, high cognitive and physical function and engagement with life. Yet this definition of successful ageing also relies on individual agency (Stowe & Cooney 2015). Salutogenesis refers to an approach that focusses on an individual’s resources that support their health and well-being rather than the pathological factors that contribute to their disease. This concept was coined by Antonovsky (1981) and has similarly been associated with resilience or coping with stressors. Antonovsky and Sagy (1986) developed the Sense of Coherence (SOC) framework as a useful theory for applying the salutogenic approach. It is described as the way an individual can view the world and their own life. The SOC develops from an individual’s life experiences and Antonovsky proposed that the strength of SOC was a significant factor in moving towards health (Antonovsky 1996). He originally described three aspects of the SOC:

- Comprehensibility-the level at which the situation or stressors are understood
- Manageability-the extent of resources that are perceived as available to the individual to cope
- Meaningfulness-the degree to which an individual is motivated to see the situation as a challenge rather than a hindrance

There is no universally accepted definition of resilience in the academic context, and it is outside the scope of this thesis to review the entire multi-disciplinary literature on resilience. However, following a review to clarify the meaning of the concept of resilience from a multi-disciplinary perspective, Windle (2011, pg163) identified three components necessary for resilience; 1) occurrence of adversity/risk, 2) presence of protective factors or resources to compensate for the effects of adversity and 3) positive adaptation or the avoidance of a negative outcome. She produced the following definition based upon these components:

> *"Resilience is the process of effectively negotiating, adapting to, or managing significant sources of stress or trauma. Assets and resources within the individual, their life and environment facilitate this capacity for adaptation and 'bouncing back' in the face of adversity. Across the life course, the experience of resilience will vary".*

This definition builds on Masten's description of resilience but has a wider application and acknowledges that people exist and live in a world influenced by physical, social and environmental factors. Although not explicit in the derivation of this definition it does resonate with aspects of Antonovsky's sense of coherence theory, where the manageability dimension is dependent on the resources as perceived by the individual that are available to them.

The importance of the social and physical context that underpins resilience in ageing was demonstrated by Wiles et al. (2012). They explored resilience from the perspective of 121 older adults aged 56-92 from a range of cultural-ethnic groups, levels of wellness, mobility, gender and socioeconomic status. The authors conducted interviews and focus groups and reported that although the older people in their study identified personal characteristics and responsibilities for 'resilient ageing' they also highlighted how social relationships, external resources in a community and employment or government service opportunities contributed to building resilience. The findings from this study are compelling as the study not only included a large number of participants for a qualitative study but more importantly included people from different cultural-ethnic groups and socioeconomic status.

More specific to this present study, Thetford et al (2015) examined the impact and interactions between social, community and individual resources on visually impaired individuals' capacity for resilience. They found that access to resources was not exclusively responsible for a positive outcome of resilience and that individuals needed to be motivated to use the available resources. Using Windle and Bennett's (2011) model of resilience in caring relationships, Thetford et al (2015) developed a framework for resilience in individuals with visual impairment (Figure 3.5). The framework illustrates the range and interconnectedness of resources (namely, society, community and individual) that are available and have been identified by the authors and influence resilience. Whilst the aim of my study was not to identify the presence or absence of resilience in the participants, it is a useful framework to inform the findings from the interviews with participants who had experienced a fall or been recently diagnosed with an age-related ophthalmic condition.

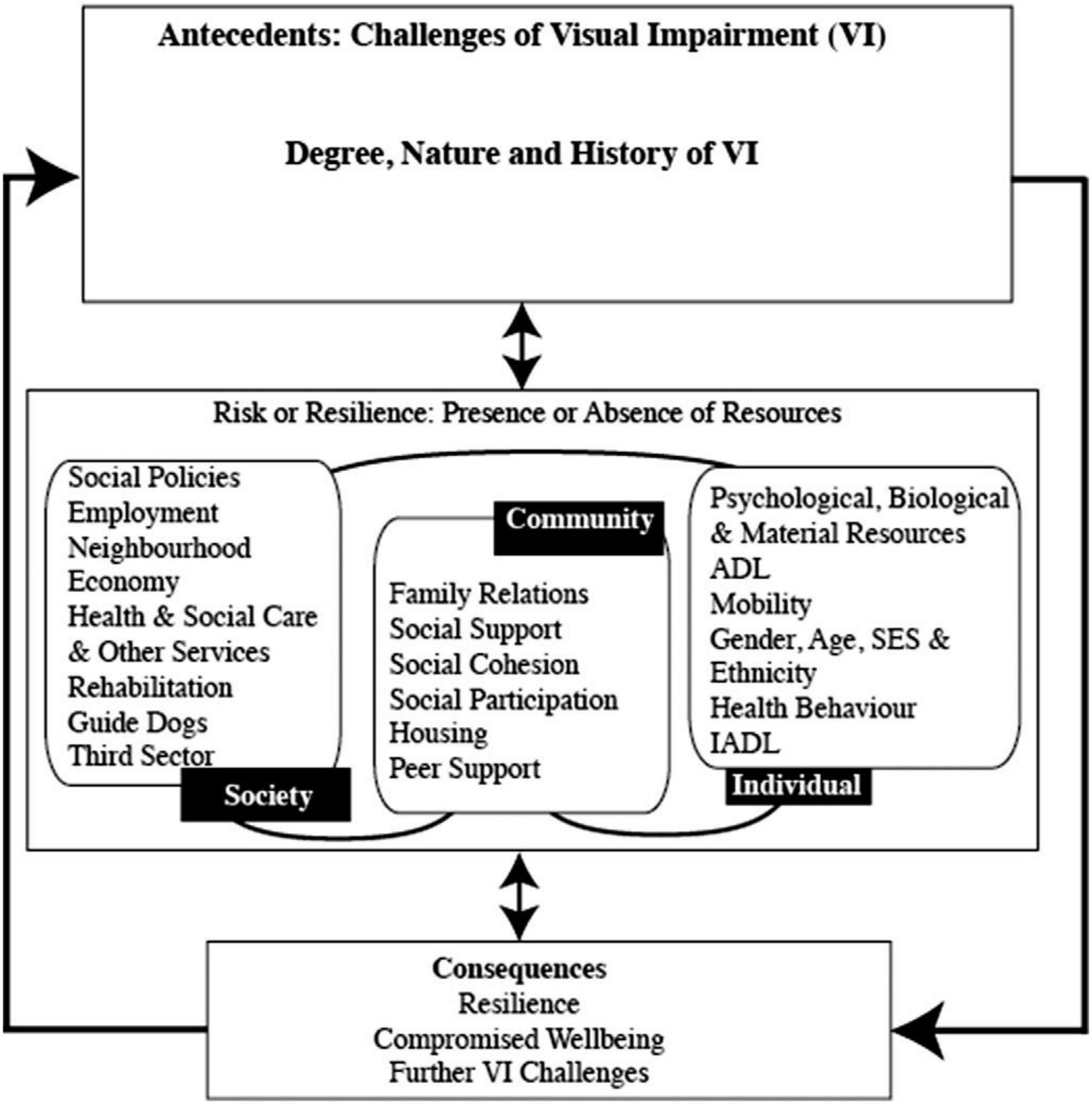


Figure 3.5: Resilience framework applied to individuals with visual impairment by Thetford et al, 2015

3.5 Summary

Fear of falling is a risk factor for further falls and can be experienced by older adults irrespective of their falls history. It is difficult to determine the prevalence of FOF in older adults due to the different constructs of fear of falling measured in published studies. There is a lack of published literature on examining how measures of fear of falling relate to the individual narratives of perceived risk or fear of falls. Identity was important to older adults who were keen not to be labelled 'at risk of falling' or as 'fallers' when their experiences of falling were explored. Therefore, in this study, although I will need to identify older adults who have experienced a fall, I will refer to them throughout this thesis as *falls participants* and not *fallers.*

Non-visual risk factors for FOF include previous history of a fall, age, female gender, physical function, use of a walking aid and, more recently, depression. There is some evidence to suggest the association of impaired self-reported poor vision with FOF but none to suggest that objectively measured impaired visual function is a risk for FOF. There is also a paucity of qualitative evidence on FOF in older adults with visual impairment. Clinical studies have reported greater FOF in older adults with specific age-related eye diseases, namely AMD and glaucoma, but again no qualitative studies have explored the fear of falling in individuals with these specific age-related eye diseases.

Fear of falling has been reported to have physical, mental and social consequences. Therefore, there is a need to understand this concept not just from a biomedical perspective but to consider the psychosocial dimensions. Fear and risk are conceptually linked and the management of these constructs is complex. Risk perception and management is influenced by many personal, social and environmental factors and is dynamic. The individual's beliefs, knowledge, culture and attitude to risk potentially influence the way risk is perceived and managed. It may also be influenced by the way risk is presented and communicated in the various social structures and healthcare system. The successful adaption or management of risk referred to as resilience is not dependent on the individual alone, but instead influenced by an interaction of social, community and individual resources.

Therefore, in this study when interviewing the participants, I will be sensitised to these concepts of fear, risk and resilience. I will explore the fear of falling from each participant's perspective taking into account their experiences, beliefs, attitudes to how risk and fear are managed with having experienced a fall and having an age-related ophthalmic condition.

Chapter 4 Study design and methods

4.1 Introduction

The preceding chapters have provided a critical discussion of the literature on visual risk factors for falls and 'fear of falling'. There is inconsistent evidence from cohort and cross-sectional studies on the association of particular visual risk factors and falls. This may explain the lack of adoption of a visual function examination in the multifactorial assessment of falls patients. Also, there is a paucity of qualitative literature specifically exploring falls and fear of falling through a sociological lens in individuals with age-related ophthalmic conditions. Hence, the overarching aim of this research is to explore the relationship between vision and falls and fear of falling in older adults using a mixed-methods design. To explore this relationship, it was necessary to consider the following broad research questions that would need to be addressed to fulfil the aims of the research being presented in this thesis:

Research questions

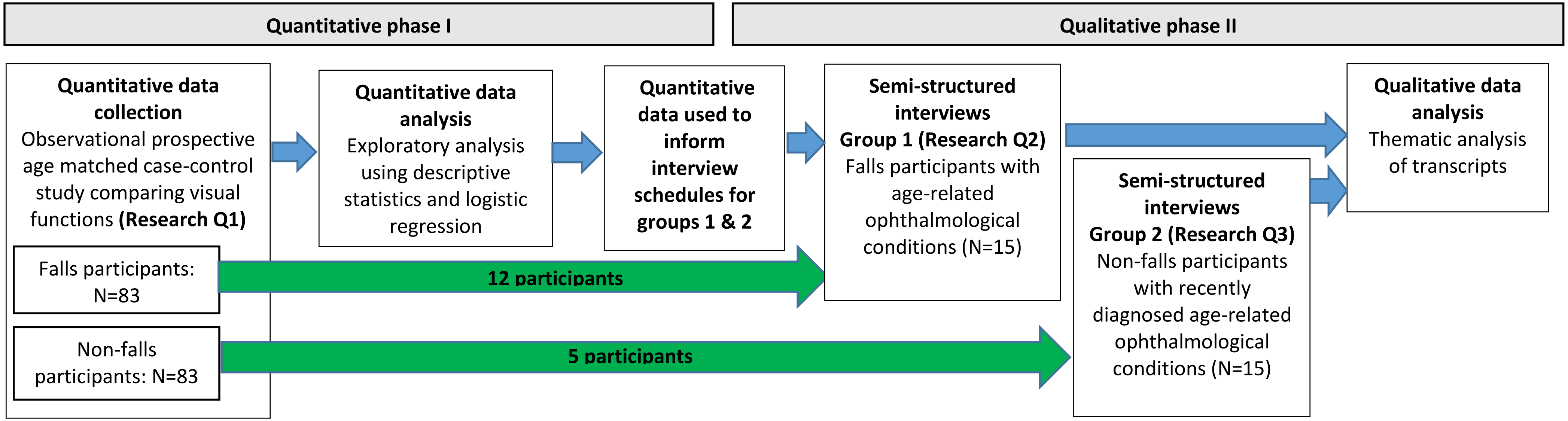
1. How does visual function in older adults who have experienced a fall compare to those of a similar age who have not fallen in the previous five years?
2. What is the lived experience of an older adult with an age-related ophthalmological condition who has fallen and their interpretation of the role of 'vision' in falls and fear of falling?
3. How do people who have recently been diagnosed with an age-related ophthalmological condition view their sight as a concern (fear) for having a fall and having an impact on their life?

I have employed a mixed-methods design to address these questions, comprising quantitative methods to answer question one and qualitative methods to answer questions two and three. I have illustrated the overall flow of the study in Figure 4.1 including both the quantitative and qualitative phases of the study. In section 4.2, I highlight my philosophical underpinnings before explaining how I have used pragmatism to frame my decision to adopt quantitative and qualitative methods in this thesis. Study ethics and research governance for the study is outlined in section 4.3 before the specific quantitative and qualitative methods are described.

Section 4.4 includes a description of the quantitative phase of the study with details on the clinical and statistical methods I used to compare measures of visual function between the falls and non-falls participants.

The qualitative work I have undertaken is described in section 4.5. In this section, I describe in detail the theoretical framework used for the qualitative phase of the study, including how I used reflexivity and positionality in this phase. This is followed by details on the fieldwork and analysis. Throughout this chapter, I have embedded discussion on the rationale behind my choice of methods within the relevant sections.

Figure 4.1: Overall flow diagram of the study illustrating the sequence and flow of participants between the quantitative and qualitative phase



4.2 Methodological approach for the study

A research paradigm is a set of beliefs or worldview that guides the researcher and is based on their ontology and epistemology (Guba 1990, p. 17). Therefore, the methodology and methods adopted for a research study are informed by the researcher's theoretical perspectives, philosophical assumptions or worldviews (Crotty 1998; Mason 2018; Silverman 2010). In the following section, I outline my philosophical worldview that has informed the theoretical perspective I have used to guide the mixed methods approach for this study.

4.2.1. Philosophical assumptions

Ontology

Ontology is concerned with the nature of reality, therefore, choosing an ontological position sets out one's perspective of the world and their place in it. There are two main ontological positions; *relativists* who believe in searching for meaning and that multiple realities exist and *realists* who believe that the world exists independently from human action and observation (Blaikie, 2007) and that the truth can be observed and measured.

I position myself as a realist as much of my work as a health scientist and quantitative researcher has been based on observing and measuring variables. However, working in health sciences and with people, I acknowledge that any observations or knowledge of people are not exclusive of human interaction. Also, since undertaking this fellowship, and outlining the core research questions for my study I have undergone a transformative journey through reflection and intellectual inquiry. This has enabled me to broaden my horizon to appreciate that a realist perspective is not enough to understand all knowledge and it needs to be augmented with the perspectives of people. Therefore, in this study, I use quantitative methods for measuring vision and fear of falling and a qualitative approach to allow me to explore the participant's lifeworld and experience of a fall and having an ophthalmic condition.

Epistemology

Epistemology is the theory of knowledge concerned with what can be known and can be traditionally thought of as either empiricist or rationalist and subsequently offers a range of theoretical perspectives or paradigms, for example, positivism, post-positivism, post-modernism, interpretivism, constructivism, critical realism, pragmatism and feminism (Crotty 1998; Denzin & Lincoln 2011).

Scientific inquiry is generally based on a positivist epistemology which assumes that there is one truth that can be known, explained and predicted normally using quantitative methods (Crotty 1998; Denzin & Lincoln 2011). Post-positivism is an attenuated form of positivism and acknowledges that a single reality may never be known because of hidden variables and that the absolute truth cannot be known (Crotty 1998; Denzin & Lincoln 2011). Post-positivism appears to bridge the conflict between positivism and interpretivism by acknowledging that reality cannot be fully attained; whereas pragmatism as a research paradigm does not enter into concepts such as truth and reality and instead is underpinned by knowledge that is based on experience (Kaushik & Walsh 2019).

The research in this thesis was driven by my experience and observation of the lack of vision assessment in older adults at risk of falls but to also understand the older adults' perspective of vision on falls and fear of falling. The desired end of this research is the utility of knowledge to apply to clinical practice. Pragmatism orients itself towards problem-solving and is a method of inquiry for practical-minded researchers (Cresswell & Plano Clark 2011). Reichardt and Cook (1979) argue that with a pragmatic approach, methods can be combined appropriately for a given research inquiry. Pragmatism is associated with mixed methods or multiple methods where the focus is on the consequences of the research and the research questions rather than the methods (Cresswell & Plano Clark 2011; Johnson & Onwuegbuzie 2004; Teddlie & Tashakkori 2009). Therefore, I have chosen pragmatism to underpin this research study. This allows me to draw on post-positivist based quantitative traditions and explore qualitative practice to produce knowledge that has the potential to make meaningful change in clinical practice. In the following section, I briefly describe the origins of pragmatism as a philosophy.

Pragmatism

Pragmatism allows for practical solutions to address the research problem, thus easing the tension of working between quantitative and qualitative paradigms. It allows the researcher to follow the tenets of objectivity and/or subjectivity (Shannon-Baker 2016) within their research. Pragmatism as a practical theory has allowed me to use questionnaires and validated methods of measuring visual function combined with depth narrative methods to help bridge research to practice.

Further reading has taught me that pragmatism is not merely a practicality for combining quantitative and qualitative methodologies but is a philosophy that extends beyond "what works" (Morgan 2014). Denzin (2012) highlighted the idea of pragmatism not as a methodology but as a doctrine of meaning, a theory of truth and that the emphasis is on consequences of an action or event in a social situation. Hence, I will explore pragmatism as a philosophy from its origin to the works of John Dewey.

Peirce, an American scholar was the first thinker to use the word 'Pragmatism', although not used in his early writings. He summarises it as a form of logic (Durkheim 1983). His opinion on pragmatism is well captured by Thayer in his book on the history of pragmatism (Thayer 1968):

> *"The word pragmatism was invented to express a certain maxim of logic...*
> *The maxim is intended to furnish a method for the analysis of concepts ...*
> *The method prescribed in the maxim is to trace out in the imagination the conceivable practical consequences that is, the consequences for deliberate, self-controlled conduct of the affirmation or denial of the concept.*
>
> *(Peirce, 1905)*

However, James was seen as the true father of pragmatism where for him *truth* has a personal character and *truth* and *life* are inseparable (Durkheim 1983). The pragmatist movement was further led by the American philosopher John Dewey and F.C.S. Schiller from Oxford (Durkheim 1983). John Dewey thought of pragmatism as a philosophy less concerned with abstract concerns but more emphasis on human experience (Morgan 2014). Morgan (2014) draws on the work of John Dewey to illustrate the importance of joining actions and beliefs when undertaking the process of inquiry for the search of knowledge. He describes the process of inquiry as viewing a problematic situation, reflecting to make self-conscious decisions to solve the problem (Morgan 2014). It is Dewey's idea of pragmatism being a process based approach to knowledge that has guided my work throughout this study. I identified a problematic clinical situation of vision being overlooked in falls assessments potentially due to the lack of robust evidence. There was also no evidence from the perspective of older adults on falls or visual deficits to understand the interplay between living with a sight condition and the fear of falling. Therefore, I chose a phenomenological approach for the qualitative line of inquiry to explore the lived experience of the participants in this study (discussed later in section 4.5) and quantitative methods to determine the association of impaired visual function and falls to create practical knowledge for application in managing older adults at risk of falls. Next, I describe the mixed methods design adopted for this study.

4.2.1 Mixed methods design

Green and Thorogood (2014, p. 10) claim that from a methodological perspective, the 'best' evidence is that which is most appropriate for the research questions we have. Using both quantitative and qualitative methods is "practical" to solve problems using words and numbers (Cresswell & Plano Clark 2011) but also situating the research in the social and behavioural context. The quantitative paradigm in this study is deductive and driven by a hypothesis that there is an association between impaired visual function and falls. Although this provides data regarding the visual status of people who have experienced a fall, it does not inform us about the meaning or context of that status in the individual's experience of the fall. Thus, a qualitative paradigm is better suited to capture the individual's point of view (Denzin & Lincoln 2011) and specifically on the role of their vision/sight in falls and fear of falling. The mixing of paradigms will give this study a unique breadth and depth of evidence regarding the impact of vision on falls.

The mixed-methods approach has been defined as not only a mixing of quantitative and qualitative methods but as a methodological orientation which includes the mixing of philosophical positions, inferences and interpretations (Teddlie &

Tashakkori 2009). In this section, I give an overview of using a mixed-methods approach. The theoretical framework chosen to inform the methodological approach for the qualitative phase is described in section 4.4.

Combining quantitative and qualitative methodologies may be open to a conflict of paradigms in a single study, but the emphasis in the present study is to draw on the strengths and applicability of each of the methodological approaches to answer the research questions. The research design has to be clear and logical to identify how the methods are used to fulfil the aim of the study.

Cresswell and Plano Clark (2011, p. 54) described two broad mixed methods designs; fixed and emergent. *Fixed* designs are where the quantitative and qualitative methods are pre-planned at the start of the study and implemented accordingly and *emergent* is where the use of mixed-methods becomes apparent during the research process. However, the authors do recognise that the mixed-method choice may lie somewhere in between, since the results of the first phase of the study may affect the design of the second phase. Cresswell and Plano Clark (2011) go on to list the different classifications that have been identified in the literature but here I will focus on those that have been used in health science research (Morgan 1998; Sandelowski 2000). Morgan (1998) has suggested two basic research design decisions when combining quantitative and qualitative methods: a *priority decision* that pairs a principal method with a complementary method; or a *sequence decision* where the complementary method precedes or comes after the principal method. The principal and complementary method can be either quantitative or qualitative. Morgan (1998) describes this as a 'Priority Sequence Model'(Figure 4.2).

	Priority decision		
Sequence decision		Principle method: Quantitative	Principle method: Qualitative
	Complementary method: Preliminary	Qualitative Preliminary qual→QUANT	Quantitative Preliminary quant→QUAL
	Complementary method: Follow-up	Qualitative follow-up QUANT→qual	Quantitative follow-up QUAL→quant

Figure 4.2: Priority sequence model for complementary combinations of qualitative and quantitative methods (Morgan 1998)

However, these *priority* or *sequence decision* methods do not allow for a concurrent or sandwich model which has been described by Sandelowski (2000). A *concurrent* model would be where both the qualitative and quantitative methods are undertaken at the same time and one may have priority over the other, whereas a sandwich model could be either quant→qual→quant or vice versa. Cresswell and Plano Clark (2011) recommend the use of key facets: priority, interaction, timing and mixing of the qualitative methods when designing an overall mixed-method design. For this study, I gave equal priority to the quantitative and qualitative methods and there was an interactive level of interaction as opposed to an independent level (Cresswell & Plano Clark 2011). Hence, I used a *'transformative design'* framework which allowed me to sequentially and concurrently collect and analyse the quantitative and qualitative data within a transformative theoretical framework (Cresswell & Plano Clark 2011, p. 73). The study began with the quantitative phase but the data which emerged from this phase guided the qualitative method of enquiry and also allowed me to identify potential participants for the qualitative phase (Figure 4.2)

The methodological frameworks for collecting quantitative and qualitative data vary, as the former requires a detailed method of how the data was collected with some justification of the methods chosen. However, the qualitative phase (Section 4.5) requires a more detailed account of the theoretical framework for the design and choice of methods.

In the next section, I present the ethics and governance procedures which are common for both the quantitative and qualitative methods within this study. Ethical issues pertinent to qualitative research will be addressed within the qualitative methods (Section 4.5.5)

4.3 Study research governance and ethics

I applied for Health Research Authority (HRA) ethical approval from the London-Harrow Research Ethics Committee as the study involved the clinical visual assessment of participants and qualitative interviews. The principles of research governance were followed (DOH, 2005). The ethics application was made through the Integrated Research Application System (IRAS). The University of Liverpool sponsored the study and are responsible for the data archiving. I have outlined the milestones and amendments made to the ethics committee for the duration of the study in a table in Appendix 1. Amendment 1.0 was submitted following further evaluation of the literature and clinical tests, consultation with the patient and public involvement group and the decision to included further socio-demographic data to give the quantitative and qualitative findings social context. Amendment 1.1 was submitted when issues with recruitment became apparent (see Section 4.4.4). In this amendment, I also revised the sample for the qualitative phase. Originally, the protocol included interviewing three groups of participants: 1) fall participants with age-related ophthalmic conditions, 2) falls participants without age-related ophthalmic conditions and 3) participants recently diagnosed with age-related ophthalmic conditions but not experienced a fall since. However, as the main objective of the study was to explore the fear of falling in individuals with age-related ophthalmic conditions, group 2 were not required for this study. The final amendment 1.2 was made to report a reduction in the sample size calculation of the quantitative phase as new evidence was published on the visual acuity of older adults (see Section 4.4.2).

In the following section, I describe the quantitative methods for this study including the design and statistical methods.

4.4 Quantitative phase

This phase of the study was based on an objective epistemology with a post-positivist perspective. This research was undertaken to create new knowledge whilst accounting for confounding variables in the context of this study. Therefore, the specific question addressed was; 'how does visual function in older adults who have experienced a fall compare to those of a similar age who have not fallen in the previous 5 years?', and was driven by the following null hypothesis:

Ho: There is no difference in measures of visual function between individuals (≥60 years) who have experienced a fall and age-matched individuals who have not experienced a fall in the previous 5 years.

The STROBE statement (Strengthening the Reporting of Observational Studies in Epidemiology) was developed to improve the reporting of observational research (Vandenbroucke Jan et al. 2007), therefore I will report the methods as per the STROBE checklist for observational studies (STROBE 2007) where appropriate. As discussed in Chapter 2, several cohort studies have been published that have estimated visual risk factors in falls patients and whilst they have an advantage of capturing data from large populations, they mostly relied on accurate recall and reporting of falls and required long follow-ups (Klein et al. 1998; Lord, Clark & Webster 1991; Lord & Dayhew 2001; Nevitt et al. 1989; Tinetti, Speechley & Ginter 1988). The main aim of this research was to determine the relationship between visual function and falls in older adults. The findings would provide evidence regarding the assessment of specific measures of visual function in older adults to prevent further falls. In the section, I describe the methods employed to capture the relevant data and the statistical methods used to analyse the data.

4.4.1 Study design

I employed a prospective observational case-control, individually age-matched study design for the quantitative phase to investigate the association between visual function and falls. A total of 83 cases which I will refer to as 'falls' and 83 control- 'non-falls' participants were recruited.

4.4.2 Study size

The original sample size was calculated based on a clinically important 3 line ETDRS visual acuity difference (Joussen et al. 2007) between the falls and non-falls participants. A previously measured standard deviation of 17.5 letters from the Beaver Dam study (N=2073) (Klein et al. 1991) was also used in the sample size calculation. The sample size was adjusted for seven confounding variables, missing data in outcomes and having two centres: Royal Liverpool University Hospital (RLUH) and Broadgreen Hospital. Hence a sample size of 206 was calculated: 103 falls and 103 non-fall participants (further statistical information in Section 4.4.7).

However, a more recent study comparing VA in individuals aged ≥ 60 years with early AMD and normal macular health was published after the start of my study. They reported a lower standard deviation of visual acuity letter score in healthy eyes (SD=8, N=1007 eyes) which may be more reflective of visual acuity in a current population (Owsley et al. 2016). Additionally, instead of recruitment from two sites, it was decided to recruit from one centre: Broadgreen Hospital.

Due to this large difference in reported standard deviations in 1991 (SD=17.5) and 2016 (SD=8) and recruitment from one site, I and my supervisors reviewed the initial sample size calculation. Using an approximate average of the two standard deviations reported in the literature (SD=12.75) was deemed to be appropriate. Therefore, a revised sample size of 166 (83 falls and 83 non-falls) participants was substituted and used for the study.

4.4.3 Participants

Individuals aged ≥60 years were included in the study sample. I initially recruited participants who had fallen so that I was then able to recruit age-matched (to within 2 years) non-falls participants. A participant was included as a 'falls participant' if they had experienced a fall in line with the ProFaNE definition (Lamb et al. 2005) given in Section 2.2.1 and were referred to the falls unit at Broadgreen Hospital. Falls participants were generally recruited and seen within 2 months of their fall. Non-falls participants were included if they had not experienced a fall in the previous five years. The rationale for choosing no falls in a 5 year period for the control group was to reduce the possibility of older adults feeling the physical and psychological effect of a fall in a more recent time period (e.g. the last 2 years). Although, difference in incidence of falls and fear of falling between males and females has been discussed earlier in Chapters 2 and 3, I was unable to include gender matching due to recruitment and time constraints.

Inclusion/exclusion criteria

Participants were screened for cognitive impairment using the 6-item cognitive impairment test (6CIT) (Appendix 2). Each participant performed this test at Broadgreen Hospital when they attended for their falls assessment, and the control group were screened when they attended for their visual assessment at the RLUH. Participants were excluded with a score >7 points. The 6CIT test was chosen after the Mini-Mental State Examination (MMSE) was discussed with the patient and public group and the members felt the MMSE was educationally and culturally biased. The MMSE also involved a copying task which required good visual acuity which could not be assumed in this sample.

4.4.4 Recruitment and setting

Falls participants were recruited from the falls clinic at Broadgreen Hospital where they were referred following a fall either by their GP or the A&E Department at RLUH. Falls patients were not referred to this clinic if they suffered a fall due to excess alcohol consumption or suffered a hip fracture. The falls nurses at Broadgreen Hospital facilitated recruitment by giving patients the participant information sheet (Appendix 3). Recruitment improved when I attended the falls unit as it allowed potential participants to discuss the study with me and ask questions. Recruitment took place from June 2017 to April 2018. Participants declined to take part in the study due to two main reasons: the number of hospital appointments they needed to attend or the cost of parking at RLUH. The study originally had no payment to participants for their participation. However, due to slow recruitment, I applied to the Clinical Research Network (CRN) for funding (£10/participant) to reimburse participants for taking part in the study.

Age-matched non-falls participants were recruited from personal networks, the Consent4consent database held at RLUH and via posters displayed around the hospital particularly in St. Paul's Eye Unit Clinic and the Clinical Eye Research Centre (CERC). It was challenging to recruit age-matched non-falls participants in the older age groups as they frequently reported falling. Recruitment of non-falls participants took place from June 2017 to July 2018.

4.4.5 Quantitative variables

Quantitative data from each participant for this phase of the study were captured during a single visit to CERC in the RLUH. As I was the sole investigator, all procedures and questions were standardised. I developed a case record form (CRF) (Appendix 4) to record data for each participant. There are two main sections for data capture: baseline and visual. Baseline data were recorded first and helped to put the participant at ease before the clinical assessments were carried out to record the visual data. Although termed 'Baseline' in the CRF, from herein I refer to these data as 'Non-visual'. In this section (4.4.5) I discuss the rationale behind the collection of non-visual data and the questionnaires employed in this phase. In Sections 4.4.6 and 4.4.7, I discuss the methods used to clinically assess each measure of visual function and the statistical analysis methods used in this study respectively.

4.4.5.1 Non-visual data

Owing to the mixed methods design, it was important to give the quantitative phase social context, hence in addition to recording gender and age, I noted additional demographic information such as postcode, living arrangements and social support. The non-visual data section also included recording details about the participant's falls history, general health and medication.

Postcode and index of multiple deprivation

Postcode data was collected to make quantifiable observations using the English Index of Multiple Deprivation (IMD) 2015 (National Statistics 2015) and highlight any inequalities in the two groups (falls and non-falls) within the study.

The English IMD comprises of the following domains with the weightings in brackets:

- income deprivation (22.5%)
- employment deprivation (22.5%)
- education, skills and training deprivation (13.5%)
- health deprivation and disability (13.5%)
- crime (9.3%)
- barriers to housing and services (9.3%)
- living environment deprivation (9.3%)

The data are commonly presented by indicating whether an area with a specific postcode, features among the most deprived 10%, 20% or 30% of small areas in England. To facilitate data analysis, deprivation 'deciles' are published alongside ranks. Deciles are calculated by ranking the 32,844 neighbourhoods in England from most deprived to least deprived and dividing them into 10 equal groups (Table 4.1). These range from the most deprived 10% of neighbourhoods nationally to the least deprived 10%. However, it is important to note that whilst the income deprivation data are useful for comparing the relative socio-economic status of one area compared to another, they do not identify individuals within them who are deprived or affluent.

Table 4.1: Indices of deprivation; deciles and ranks

Decile	Decile description	Ranks
1	10% most deprived	1 to 3,284
2	10-20%	3,285 to 6,568
3	20-30%	6,569 to 9,853
4	30-40%	9,854 to 13,137
5	40-50%	13,138 to 16,422
6	50-60%	16,423 to 19,706
7	60-70%	19,707 to 22,990
8	70-80%	22,991 to 26,275
9	80-90%	26,276 to 29,559
10	10% least deprived	29,560 to 32,844

Living arrangements, social support and activity

The purpose of surveying the participants about their living arrangements was to give the data a sociological perspective by considering the social relationships, structures, household composition and therefore caring responsibilities of that individual. Living accommodation was explored as three options: single storey, accommodation with stairs and accommodation with a stair-lift. This would allow me to identify issues around navigating around the house, and mobility. I asked participants about household composition by ascertaining the membership of the house and their relationship to the participant and in the case of children or grandchildren, whether they were over the age of 18 years. In addition to the household composition, I was interested in the available support to the participant beyond those who lived with them. I phrased the question as, "in the event of needing medical care or attention who would you call upon for support other than x (person/people living with them)?"

I asked each of the participants about the number of days and number of alcoholic drinks consumed in and out of the home to learn about their level of social activity and participation. I did not include alcohol consumption as a risk factor in this cohort of individuals as the sample included non-alcohol related falls. Moreover, evidence from a systematic review found a significant number of studies (21/26) reporting no association between alcohol use and falls or fall injuries; only four studies which found an increased risk of falls associated with alcohol use ranging from daily to ≥21 drinks/week (Reid et al. 2002). These questions about the participant's living arrangements, relationships and activities enabled me to situate their fall in a social context.

Falls history

Each falls participant was asked to recall the number of falls they had in the previous five years to determine the prevalence of recurrent falls in the sample. As I have shown in the literature review, (Chapter 2, Section 2.2.3) having a history of two or more falls in the previous year is a significant risk factor for having further falls. Non-falls participants were included as a 'control' if they had no falls in the previous five years. The descriptors for the type of fall were taken from the falls assessment form used at Broadgreen Hospital falls unit and 'slip' was added as many of the participants reported this description during the history. The 'just dropped' and 'leg gave way' categories were used in Broadgreen to identify participants whose fall may have been caused by syncope or an orthopaedic condition respectively. These conditions were addressed in the general health section of the CRF.

General health and medication

The general health section of the CRF included questions about the participants' hearing impairment, use of a walking aid, medical history and their current list of medications. The literature on the impact of these factors on falls has been discussed in Chapter 2, Section 2.2.3, hence it was important to record this data on the CRF for inclusion in the data analysis as potential confounders. Participants were recorded as having a hearing impairment if they had a diagnosis from a medical professional to eliminate the risk of incorrect self-diagnosis.

I asked participants if they used a walking aid before their fall(s) and categorised use as 'always', 'occasionally' or 'never'. Some participants indicated that they used a walking pole when out for long walks in the mountains, this response was not an affirmative for use of a walking aid in this context.

Multimorbidity has been defined as the "co-existence of two or more chronic diseases"(van den Akker, Buntinx & Knottnerus 2009). It has been estimated from a systematic review that 55-98% of older adults have two or more co-existing comorbidities (Marengoni et al. 2011). The presence of multiple co-morbidities is a recognised risk factor for falls (Chapter 2, Section 2.2.3). However, it was necessary to determine which chronic conditions were known to be associated with falls to pre-specify in the CRF. My review of the literature identified arthritis, cancer, chronic obstructive pulmonary disease (COPD), diabetes, depression, heart disease, hypertension and stroke as diseases that were most frequently listed for people 65 years and older as well as any study-specific diseases (Sibley et al. 2014). The falls pathway at Broadgreen Hospital has a specific list of co-morbidities, which I considered along with my protocol and literature review and decided to ask the participant whether they had any of the following and 'other' than those listed below:

- Postural hypotension
- Osteoarthritis
- Parkinson's
- Diabetes
- Stroke
- Osteoporosis
- Cardiopulmonary disorders
- Hypertension
- Renal Disease

Following questions about their general health, it was logical to ask them about their medication as polypharmacy is also recognised as a significant risk factor for falls (Deandrea et al. 2010). I noted the name and number of medications for each participant.

4.4.5.2 Questionnaires

Towards the end of the baseline (non-visual) data section, three questionnaires were completed for each participant: Falls Efficacy Scale-International (FES-I), Rapid Assessment of Physical Activity (RAPA) and EQ-5D, a generic measure of health status. Falls participants completed the FES-I (Appendix 5) at their falls assessment at Broadgreen Hospital and this data was copied from their electronic record onto the study form; the non-falls participants completed it on arrival for their clinical assessment. I completed the RAPA (Appendix 6) and EQ-5D (Appendix 7) with each participant during their study appointment in CERC.

Falls Efficacy Scale-International (FES-I)

Psychological consequences of falls have been captured using several outcome measures and have been discussed in detail in Chapter 3, Section 3.1.1. The Falls Efficacy Scale-International (FES-I) tool was used in this study for participants to indicate their level of concern whilst carrying out sixteen daily activities including social activities outside of the home.

Rapid Assessment of Physical Activity (RAPA)

Physical activity (PA) can be assessed objectively by using continuous measures, for example, body sensors monitoring activity or subjectively through self-report measures like validated questionnaires. I was keen to use a questionnaire that had been used for a large population set, to enable me to compare the activity levels to a national database. Hence, I explored the Health Survey England (2016) questionnaire used to gather data on adult physical health. However, it was not appropriate to use the HSE questionnaire as participants would be required to recall their PA in the previous 4 weeks and for the falls group, this period would be post-fall where they could be incapacitated or recovering.

Therefore, the RAPA (Rapid Assessment of Physical Activity) was used and has been reviewed in Chapter 2 (Section 2.2.3). I asked each falls participant about their level of physical activity (light, moderate or vigorous) before their fall to determine their fitness and evaluate the association with falls during analysis. An accompanying sheet of graphics for each intensity along with the text description of heart rate and intake of breath allowed the participant to understand what was meant by 'light', 'moderate' and 'vigorous'. Many of the respondents struggled to differentiate between 'light' and 'moderate' when they indicated that they walked for 30 minutes and we, therefore, talked through whether they would be slightly out of breath during the walk, in which case it would be 'moderate'. A score of less than 6 is considered suboptimal and can be classified as:

- Under-active regular (score 4-5)
- Under-active regular-light activities (score 3)
- Under-active (score 2)
- Sedentary (score 1)

EQ-5D (EuroQoL five-dimensional questionnaire)

The EQ-5D is a self-reported measure of health status with five items (Appendix 7) exploring mobility, self-care, usual activities, pain/discomfort and anxiety/depression. It also has a visual analogue scale which requires the participant to rate their health between 0 (worst health) and 100 (best health). Health-related quality of life tools are increasingly used in research and clinical practice as often the physiological status of a patient does not correlate to their functional capacity (Guyatt, 1997). The data from this questionnaire would determine a simple descriptive health profile of the participant that could potentially inform the interview schedule for exploring the fear of falling in participants with visual impairments.

4.4.6 Clinical assessment (data sources)

I performed all visual assessments except the visual field test in one room, under the same lighting conditions in the CERC. The room had standard overhead lighting and illumination levels. The clinical assessment followed the collection of the non-visual data and questionnaires. The Timed Up To Go (TUTG) test was carried out as per the method outlined elsewhere (Podsiadlo & Richardson 1991). Briefly, the participant was asked to stand up from their seat, walk 3 metres and back to their seat. They had a practice turn first and then timed on the second turn. Participants were first asked about their ocular history i.e. the type of glasses they wore and the last time they visited an eye professional to identify their habitual ocular status before their visual assessment.

Visual acuity (VA)

ETDRS VA can be tested at 4 metres and 1 metre and a logMAR score is recorded. If the ETDRS VA is measured at 1m, the number of correctly read letters are recorded. However, in this study, I measured habitual ETDRS VA (retro illuminated chart) of either eye at 4 metres in the dark using the participant's correction if worn as per the standardised procedure (Ferris & Bailey 1996). Near vision was also tested with either eye at 40cms using the logMAR chart. All VAs were recorded in logMAR. If the participant was unable to see the largest letters at 4m, I asked if he/she could count my fingers or see hand movements. If unable to see this level of vision I tested for light perception.

Contrast sensitivity (CS)

CS was measured using two methods: Pelli-Robson and CSV 1000E. The Pelli-Robson (PR) chart is routinely used in clinics to measure CS and is based on letters of fixed size reducing in contrast in steps of 0.15 log units from 0.00 to 2.25 log CS. The letters on the chart subtend 2.8° (Haymes et al, 2006) when tested at the recommended distance of 1 metre. The letters are arranged in eight rows of two triplets of letters (Figure 2.6, Chapter 2) and the contrast reduces from one triplet to the next. The testing instructions were followed as per the manufacturer's guidelines i.e. the log CS of the last triplet where two of three letters are named correctly was recorded. CS with the PR was measured with the participant's habitual correction and with either eye and both eyes open.

The CSV-1000E is based on four rows of sine-wave gratings (Figure 2.7, Chapter 2) and was measured at 2.5 metres. The CSV-100E allows measurement of contrast at 3, 6, 12 and 18 cycles per degree. The test was repeated with either eye and both eyes open. There are eight gratings for each spatial frequency and the participants were given three choices for each grating to indicate the location of the stripes: “top”, “bottom” or “no stripes”. The last grating identified correctly by the participant was recorded.

Assessment of binocular function

I was critical in my choice of binocular function tests as they needed to be practical and logistically possible to embed in a multi-factorial assessment of older adults at risk of falls. Hence, here I have utilised standard clinical tests of ocular motility, prism fusion range and stereoacuity.

Ocular motility

All participants were asked before the assessment of ocular motility if they had diplopia in the primary position or looking down. Ocular motility was assessed qualitatively using smooth pursuit. The participant was asked to follow a light into each of the nine positions of gaze (Figure 4.3) and a cover test was performed to identify any extraocular muscle anomalies and to report any diplopia. I was particularly interested in downgaze positions to determine the presence of diplopia or impaired control of binocular vision with the use of an alternate cover-test.

Dextro-elevation	Direct elevation	Laevo-elevation
Dextro-version	Primary position	Laevo-version
Dextro-depression	Direct depression	Laevo-depression

Figure 4.3: Nine positions of gaze for testing ocular motility

Prism fusion range

Prism fusion range assesses the ability of the participant to maintain fusion of the image through a range of vergences (simultaneous movement of both eyes towards or away from each other). I assessed motor fusion using the horizontal phasic prism fusion range at 33cms and 6m with the participant wearing their habitual correction for near and distance and a target commensurate with their weaker eye. The participant was encouraged to maintain binocular single vision throughout the test and instructed to report when the target became diplopic. The negative fusional amplitude was tested first (base in-BI range) followed by the positive fusional amplitude (base out-BO). I also objectively observed the participant's ocular position to ensure they were overcoming the prism and able to fuse the image. At 33cms participants were able to appreciate diplopia. However, at 6m most participants demonstrated a suppression response for the BO and BI range and reported the target moving. This may have been due to the participant fixing a target at 6 metres in a different surrounding environment to the one they were situated in. Normally, during a prism fusion range test, the blur, break and recovery points are noted. The blur point is a measure of relative fusional vergence which is free from accommodation. The break-point measures the total amount of fusional vergence and the recovery is the prism strength at which fusion is regained (Antona et al. 2008). Owing to the diminished accommodative ability in this sample the participants are unlikely to utilise accommodative vergence to maintain fusion. Hence, for this study, I have recorded the break-point, to determine the total fusional amplitude available to each participant to maintain binocular single vision. This would allow me to establish whether reduced fusional amplitude was a risk factor for falls. Due to no published normative data on prism fusion ranges for adults over 60 years, I am unable to set a normal threshold for this prism fusion range during the analysis.

Stereoacuity

Stereotests are generally based on random dot or contour-based patterns (Chapter 2, Section 2.3.3). However, the Frisby test is a hybrid case where the random jagged triangular shapes give rise to real depth (Frisby 2015). I was interested in measuring the participant’s presence or absence of binocular depth perception using a test that measured the most ‘real-life’ stereopsis i.e. the Frisby stereotest rather than the assessment of subtle differences as measured using random dot tests (Leske, Birch & Holmes 2006). Stereoacuity was assessed using the Frisby stereotest as per the manufacturer’s instructions, with the participant’s habitual correction for near sight. I was conscious of participants using the correct section of their varifocal or bifocal glasses. However, Frisby is unaffected by optical blur up to +3D (Costa et al. 2010). As discussed in Chapter 2 (Section 2.3.3), there are no large studies published with reference values for Frisby. Bohr and Read (2013) demonstrated a median of 85” of arc in 29 individuals aged 50-82 years. Analysis of their raw data revealed that in 13 participants (60+ years) with no orthoptic or visual problems, the median was 75” of arc. However, raw data analysis from the Garnham and Sloper (2006) study demonstrated a median of 40” of arc in 23 individuals aged 60-83 years, which increased to 72.5” for 70-83 year olds. Hence, in this study, I have chosen a conservative estimate of 85” as the cut off for a normal threshold for stereoacuity.

Visual field (VF)

There are many visual field test programmes available on an automated perimeter such as the Humphrey Analyser and the Octopus. The Esterman binocular visual field is a suprathreshold test that assesses 120 points; each with a 10dB light stimulus. The binocular field extends 75° nasally and temporally, 40° degrees superiorly and 60° inferiorly and has a higher concentration of points in the central field. Hence, it allows for more depth testing of the functionally important areas i.e. central and inferior (Esterman, 1982) and is plotted as the participant uses their eyes. Therefore, I chose to perform a binocular Esterman on each participant as it allowed for an assessment of the real-world view and particularly in downgaze where obstacles in this position may contribute to the risk of falls. It is also a functional field of vision test commonly used by the Driving Vehicle Licensing Agency (DVLA) to determine fitness to drive. The minimum field of vision approved by the DVLA is 120° on the horizontal and no significant defect in the binocular field that encroaches within 20° of the fixation above or below the horizontal meridian

(DVLA 2019). I adapted the DVLA criteria for group 1 car and motorcycle driving to categorise the participants as a fail on the binocular Esterman if they missed a cluster of 4 or more adjoining points in the central or peripheral field.

I performed the VF on each participant using the Humphrey automated perimeter at the end of their visual function assessment. Initially, I tested the VF with the participant's habitual correction. However, I found the frame of the glasses were producing visual field artefacts. Therefore, the test was repeated without the correction for these participants and the remaining tests were carried out without their habitual correction. I asked the participants to fix on the central fixation target (a light) at all times and to respond to stimuli in their peripheral vision by pressing the response button. I visually monitored fixation losses as the binocular Esterman does not assess fixation losses. However, false positives and negatives are tested throughout the program. A false-positive response is obtained when the participant makes a response in the absence of a light stimulus and a false negative is when there is possibly an area of visual loss as the participant does not respond to a stimulus but had on a previous occasion (Rowe 2016). If the visual field resulted in more than 20% of false positives or negatives, the test was repeated as it could not be deemed reliable. Each test point is assessed twice and is only marked as unseen if the participant failed to see it and respond on both occasions. The test took approximately 10 minutes with set up and therefore was not onerous on the participant to complete after the visual function assessment.

4.4.7 Statistical methods

This section will include an overview of the statistical methods used for the quantitative phase of my study. I employed SPSS 24 and SPSS 25 for the analyses and STATA/IC V13.1 to calculate the sample size. All raw data were initially entered into Microsoft Excel using separate sheets for non-visual and visual data for cases (falls) and controls (non-falls). Participants were identified by a unique code for data anonymisation and to maintain confidentiality. These were then exported to SPSS into three main databases: 'Non-visual & Visual' contained all the data for cases and controls for each of the data variables, 'Paired visual data' and 'Paired non-visual data' contained the paired data for the cases and controls for each of the measures of visual function and non-visual variables respectively.

Univariate statistical methods to compare groups

The Kolmogorov-Smirnov and Shapiro Wilk tests were used to investigate normal distribution. Then parametric and non-parametric tests were applied accordingly to determine any differences in the variables between the falls and non-falls participants: parametric and non-parametric for normally and not normally distributed data respectively. For the age-matched (i.e. paired) data, I used the (parametric) paired t-test and the (non-parametric) Wilcoxon signed-rank test of related samples to compare data between the two groups.

For unmatched data (i.e. not paired) I used (parametric) independent samples t-test and the Mann-Whitney (non-parametric) test. For categorical data, the Chi-squared test of association was used for comparing proportions of participants in each group for categorical data if, in each cell of the association table, the expected count was 5 or more. Otherwise, the Fisher Exact Test of equality of proportions was used.

Logistic regression analysis

Following univariate analysis of each non-visual and visual function variable, significant variables (at the level of significance $p<0.05$) were initially analysed separately (univariate) using binary logistic regression. The outcome was 'fall' or 'no fall' and each of the significant explanatory variables were regarded as predictors and considered broadly under 'Non-visual' and 'Visual function'. If an explanatory variable was highly skewed, then this was log-transformed for the analyses.

However, to account for potential confounding and adjust for interactions I built a multivariable logistic regression model. To facilitate the appropriate selection of explanatory variables into the model, I applied prior knowledge from the literature and *a priori* assumptions to develop a directed acyclic graph (DAG) (Greenland, Pearl & Robins 1999). The DAG was built to illustrate the causal relationship(s) between reduced visual function and falls with other plausible variables of interest, with concluded causal, biasing and bidirectional paths.

Multivariable logistic regression models were constructed in three stages. First, a model was built with all significant (at the level of 0.05) explanatory non-visual variables (Model 1), then the best set of visual function variables was found (Model 2) and finally a combination of non-visual and visual function variables was put together to identify the combination of specific non-visual and visual explanatory variables that predict falls risk (Model 3).

Addressing missing and out-of-range data

The data were checked by myself for any irregularities or missing data and double checked against the paper case record forms. The missing data tables in Appendix 8 includes details for incomplete or missing data and the pattern of missingness was explored to see if the missingness is at random or not.

All clinical tests were performed on each participant. However, some individuals did not achieve the minimum detectable (measurable) level on the clinical test and were therefore unmeasurable. For example, individuals who were unable to appreciate depth on the stereotest and therefore were stereodeficient were coded '999' as the minimum threshold measurable was 600". If individuals were unmeasurable on prism fusion range, they were given a value of '0'. In both scenarios, stereodeficiency of '999' and prism range of '0', the data are treated as NOT missing, but not measurable due to being out-of-range data (out of the range of the instrument or method). For these two variables I employed non-parametric methods as they do not depend on the choice of the coded value.

4.5 Qualitative phase

In section 4.2.1, I outlined how pragmatism informed my study design to include a qualitative approach. This would allow me to deepen the understanding of the lived experience of falls and fear of falling in older adults with age-related eye conditions. Two groups of participants with age-related eye conditions were interviewed, those who had experienced a fall and those who had not experienced a fall since their ophthalmic diagnosis to address the following research questions (2 and 3 from section 4.1):

2. What is the lived experience of an older adult with an ophthalmological condition who has fallen and their interpretation of the role of ‘vision’ in their fall and fear of falling?
3. How do people who have recently been diagnosed with an ophthalmological condition view their sight as a concern (fear) for having a fall and having an impact on their life?

There is a consensus amongst clinicians and academics of the value of qualitative methodologies in health and social care research (Clement et al. 2018; Green & Britten 1998; Pope & Mays 1995). Qualitative approaches have the scope to pursue research questions which are not answerable with quantitative methods as they allow individuals to give subjective meaning to their experience and situate it in their societal and cultural context.

The following section (4.5.1) outlines the theoretical framework of *phenomenology* that has been adopted for this phase of the study. This is followed by a reflection on my positionality within this study (4.5.2). In the remaining sections, I describe the sampling and recruitment (4.5.3), methods employed to collect data (4.5.4), ethical considerations specific to this phase of the study (4.5.5), fieldwork (4.5.6) and method of analysis of the interview data (4.5.7).

4.5.1 Theoretical framework for the qualitative phase

Theories allow researchers a different lens through which complicated problems and social issues can be viewed. They bring their focus on different aspects of the data and a framework to conduct the analysis (Reeves et al. 2008). Whilst theories are rarely described in quantitative studies, production of knowledge begins with a ‘theory’ or ‘hypothesis’ and is deductively tested. In contrast, qualitative researchers try to understand the complex interrelated functions of societies and therefore use a theoretical framework to make sense of complex social reality (Reeves et al. 2008). As a novice to qualitative research, I spent time studying the various theoretical perspectives I could use in the qualitative phase of my study. I aimed to explore the ‘lived’ experience of a fall in older adults with age-related eye conditions, their perspective on the role of their sight in falls and fear of falling.

This would involve the study of the person's subjective and everyday experience (Crotty 1998, p. 83) or in other words the experience of the phenomenon from the person's point of view (Earle 2010), termed *phenomenology*.

Phenomenology

> *"Phenomenology is neither a science of objects nor a science of the subject; it is a science of experience"*
>
> *(ThÉVenaz, Wild & Edie 1962, p. 19).*

Phenomenology is the study of the lived experience or the life world (van Manen 1997). Phenomenology, originally a philosophy, is now commonly employed as a qualitative research method by nurses and healthcare researchers (Dowling 2007; Rodriguez & Smith 2018). Paley (2017, p. 2) describes phenomenology as qualitative research that may take a particular form for example, 'descriptive', 'Husserlian', 'Heideggerian', 'interpretive', 'hermeneutic' or something similar. However, the premise is that a small number of people are interviewed to talk about their experience of a particular phenomenon. Paley (2017, p. 18) makes a distinction of phenomenology qualitative research by emphasising that the purpose is to focus on the experience and engages in meaning attribution.

Although Husserl (1859-1938) is the founding father of phenomenology (Moran 1999), many other philosophers namely; Heidegger (1889–1976), Sartre (1905-1980), Schutz (1899-1959), Merleau-Ponty (1908-1961), Derrida (1930-2004) and Gadamer (1900-2002) have contributed to phenomenological beliefs and is therefore not a single doctrine of thought (Aspers 2009). It is outside the scope of this thesis to give a detailed overview of every philosophical approach to phenomenology, hence here I have given an overview of the phenomenological approach that has informed my thinking and analysis for this study.

Broadly, phenomenology is divided into two schools: descriptive (Husserl) and hermeneutic (Heidegger and Gadamer). Edmund Husserl brought us descriptive phenomenology whereby the lived experiences are described with the researcher's perceptions 'bracketed' to set aside any of the researcher's presuppositions (Crotty 1998). On the other hand, Heidegger's' philosophy aims to understand existence and interpret the description to develop phenomenology in a hermeneutic manner

(Davidsen 2013). The interpretative or Heidegger form of phenomenology rejects 'bracketing' of the researcher's own knowledge and experience (Earle 2010; Rodriguez & Smith 2018) allowing the researcher to co-create research knowledge.

Similarly, Merleau-Ponty also pointed out that by being in the world our reflections on life are in a temporal flux and therefore it is difficult to bracket our perceptions entirely (Merleau-Ponty 1962). Merleau-Ponty utilizes Husserl's description of perception with Heidegger's insight of the practical, skilful nature of our interpretation (Käufer & Chemero 2015) to develop his understanding of phenomenology as human experience based on perception (Merleau-Ponty 1962). He goes further to describe perception as an embodied activity and the unification of the body and mind.

The body, as well as being physical, is the source of emotions, sensations and perceptions and therefore can be a subject-object that can be experienced from a first and third point of view (Carel 2011). Merleau-Ponty deals with human behaviour as a dialectic relationship between a person as a body and the world where the person and the body are located (Sadala & Adorno 2002). In a paper on 'Phenomenology and its application in medicine', Carel (2011) suggests that Merleau-Ponty's view on phenomenology allow us to think of a human being as perceiving, feeling, and thinking within a meaningful context and interacting with people and objects in their environment. The nature of my inquiry is to explore the lived experience of having a fall and a sight condition in the context of the participants' life-world. Therefore, I will be informed by Merleau-Ponty's approach to phenomenology.

In this study, I explore the lived experience of the fall and having an age-related sight condition, both of which are associated with the body and mind. The phenomenology of perception can be used to describe the fall with respect to the individual's body and their suffering during this fall as an embodied experience. Therefore, I was sensitised to these phenomenological concepts of the embodied experience during the interview with the participants, focussing on the emotions, sensations and perceptions of the fall and living with a sight condition.

Furthermore, the interviews with the participants were informed by the four lifeworld existentials identified by van Manen (1997): temporality (lived time), spatiality (lived space), corporeality (lived body) and sociality (lived relationships) which are implicit to understanding lived experience when interviewing the participants. I was sensitised to each of these existentials in each of the participant's life world with respect to their fear of falling. However, temporality and corporeality were important due to the 'lived time' period between the fall and the interview and the consequences on their 'lived body'.

I have adopted a pragmatic approach to the use of interpretive phenomenology in this study but it has been informed by the philosophy of Merleau-Ponty (1962) and the ideas of van Manen (1997). In the following section, I will describe my reflexivity and positionality, which are essential when carrying out interpretive phenomenological research, as they influence my interpretations of the lived experience of the participants in this study (van Manen 1997).

4.5.2 Reflexivity and positionality

Reflexivity is crucial throughout all phases of the research process, including the formulation of a research question, collection and analysis of data, and drawing conclusions (Bradbury-Jones 2007; Guillemin & Gillam 2004). It also reflects on one's own positioning in the research and the effect of that on the relationship with the researched. Reflexivity and positionality are generally made explicit in qualitative work and textually elaborated on at different stages of the research process (Corlett & Mavin 2018). The authors recommend that acknowledging our epistemology, the 'doing' of research (choice of methodology and method) and our position within the research process, for example, the relationship with participants, should form part of our research process (Corlett & Mavin 2018)

The epistemology and methodology underpinning this study have been discussed earlier where I have articulated the multi-perspective reflexive practice adopted to think about different theoretical perspectives on knowledge production (Alvesson, Hardy & Harley 2008, p. 483). Alvesson and Sköldberg (2018, p. 10) speak of 'a reflexivity that constantly assesses the relationship between "knowledge" and the ways of "doing knowledge." This belief allowed me to approach this study by interpreting the knowledge from the quantitative analysis, which generated further knowledge to open up opportunities for understanding the realities in other ways with qualitative methods. However, there is a need to acknowledge my subjectivity and consider the effect of my connections to the research from an experiential and theoretical perspective (Haynes 2012, p. 78).

Peshkin (1988) argues about the importance of researchers making explicit their subjectivity during the research process in his paper 'In Search of Subjectivity-- One's Own'. In his paper, he identifies systematically six subjective I's through audit of his subjectivity. Similarly, drawing on Peshkin's work, Bradbury-Jones (2007) identified her own subjective I's from her journal entries; the paladin I, maverick I, impatient I and the pragmatic I, which guided my own reflexivity and positioning during the research process. As an orthoptist working in the field of vision and visual deficits, I have prior professional knowledge that not only motivated this research but also meant it was not value-free and could affect my relationship with the participants.

One goal of reflexivity in qualitative research is to monitor the effects of identity and positionality and thus enhance the accuracy of the research and 'the credibility of the findings by accounting for researcher values, beliefs, knowledge, and biases' (Cutcliffe 2003). Berger (2015) talked about the need for researchers to understand their role in the creation of knowledge and to self-monitor the impact of their biases, beliefs and personal experiences on their research.

There was potential for a shift in my relationship with participants who took part in both phases of the study. During the clinical quantitative phase, I may have been perceived as a researcher in a knowledgeable position with clinical authority. However, in the interview, the participant was privileged with the role of knowledge production as they narrated their experience of the fall and their eye condition. I was aware of my professional identity as an orthoptist in this research context and that it would affect the access to the 'field' as the participants could potentially expect the accessible knowledge and resources that could become available to them (Berger 2015). Alternatively, the participants might feel more comfortable to share their experiences with me as someone who can understand

and be sympathetic to their situation, therefore, helping to shape the researcher-participant relationship. Kacen and Chaitin (2006) suggest that the worldview of the researcher can also affect the way he/she constructs knowledge, uses language, poses questions and chooses the lens for filtering the information from participants and making interpretations. I was avoiding the use of clinical terminology, but was aware of my clinical knowledge potentially influencing the questions and interpretation during the interview process. Throughout both phases of the research I was conscious of my position as a researcher and this led me to build a good rapport with each of the participants.

4.5.3 Sampling and recruitment of participants

Sampling is generally considered a concept for discourse in quantitative research, however, the mixed methods design of this study required a sampling strategy that encompassed both the quantitative and qualitative phases of the study. Tashakkori and Teddlie (2003, p. 713) would describe the sampling for the quantitative phase of this study as *probability sampling.* This means a relatively large number of individuals were selected from a falls population in a random manner where the "probability of inclusion for every member of the population was determinable". This type of sampling, contrary to qualitative research, aims to establish representativeness or generalisability of any findings and is governed by sample size calculations (see Section 4.4.2 for quantitative sampling).

In contrast, qualitative inquiry is not governed by sample sizes and a *purposive or purposeful sampling* approach is normally adopted. Patton (1990, p. 169) broadly describes all types of sampling in qualitative research as 'purposeful sampling' and that it generally focuses on depth in relatively small samples. The author describes 15 different types of purposeful sampling strategies of which 'criterion sampling' is one. Criterion sampling is based on selecting individuals with pre-specified criteria or characteristics. Palys (2008) usefully explains that individuals may be chosen based on their medical condition or life experience. Therefore, I have used a criterion sampling strategy for this study, where I selected two groups of participants:

Group 1: 15 adult individuals who had experienced a fall since the diagnosis of an age-related ophthalmic condition (cataracts, AMD and glaucoma).

Group 2: 15 adult individuals with a recently diagnosed (within the last 2 years) age-related ophthalmic condition (cataracts, AMD and glaucoma) and had not experienced a fall since their diagnosis.

In group two, I selected individuals who had been diagnosed with an age-related visual impairment within the last two years so that they would be able to recall and recount a narrative about their diagnosis and any subsequent impact the condition has had on them to address research question three.

Teddlie and Yu (2007), in their paper, discuss the different techniques employed to answer research questions in a mixed-methods study. Here, I intended to use a sequential mixed methods sampling (Teddlie & Yu 2007) where the purposive sample for the qualitative phase would be drawn from the quantitative probability sample. I recruited 12/15 participants in group 1 and 5/15 in group 2 from the quantitative phase of the study. However, it was not possible to recruit all the participants from the quantitative phase as there were no further participants that met the criteria for the sampling. Therefore, I also used the concurrent mixed method sampling technique where purposive sampling was used to access the remaining participants for the qualitative phase. The remaining participants for group 1 (N=3) and group 2 (N=10) were recruited from St. Paul's Eye Unit and a database of recently diagnosed patients with age-related macular degeneration (AMD) in the Clinical Eye Research Centre in the Royal Liverpool Hospital. I attended the outpatient clinics for each of the specific age-related conditions and spoke to patients in the waiting area regarding the study to recruit participants that met the inclusion criteria. The characteristics of each of the participants in this phase are outlined in Table 4.2.

There is debate on whether an *a priori* sample size decision should be made in qualitative research as it does not align with the inductive, conceptual notion of qualitative research (Sim et al. 2018). I chose to make an *a priori* sample size decision (N=15 in each group) for the purposes of applying for my fellowship grant and ethical approval. Also, broadly, I aimed to explore the impact of vision on falls and fear of falling in older adults, therefore the sample needed to include individuals with commonly occurring age-related ophthalmic conditions; AMD, cataracts and glaucoma. The aim of the interviews with both groups of individuals was not for them to be representative of all people with ophthalmic age-related conditions but the interview findings to inform us about how respondents viewed their sight either related to the fall or potential for having a fall. Therefore, to address this, I needed to include a reasonable number of people with each age-related eye condition to construct a narrative that could resonate across different ophthalmic conditions.

Table 4.2: Characteristics of the interviewees in the qualitative phase of this study
(Group 1- N=15, Group 2-N=15)

Group 1: Falls participants with an age-related ophthalmic condition					Group 2: Non-falls participants with a recently diagnosed age-related ophthalmic condition				
Participant code-Pseudonym	Age	Gender (F/M)	Age-related ophthalmic condition	Recruited from Quantitative phase (Yes/No)	**Participant code**	Age	Gender (F/M)	Age-related ophthalmic condition	Recruited from quantitative phase (Yes/No)
001MHCF-Marg	79	F	Cataract	Yes	**001WBCVI-Wendy**	79	F	Cataract	No
002MMGF-Mary	74	F	Glaucoma	Yes	**002LHMVI-Lizzie**	61	F	AMD	Yes
003JHMF-Joan	74	F	AMD	Yes	**003DKCVI-David**	77	M	Cataract	No
004JWMF-Jacqui	85	F	AMD	Yes	**004ISMVI-Isaac**	67	M	AMD	No
005BCMF-Betty	87	F	AMD	Yes	**005JMMVI-Julian**	71	M	AMD	No
006JKGF-Jenny	70	F	Glaucoma	Yes	**006JCMVI-Jackie**	71	F	AMD	No
007JACF-Joanne	74	F	Cataract	Yes	**007JSGVI-Jenny**	65	F	Glaucoma	Yes
008GMacGF-Glenda	60	F	Glaucoma	Yes	**008PWGVI-Paula**	71	F	Glaucoma	No
009TJDRF-Tessa	67	F	Diabetic retinopathy	Yes	**009KHCVI-Kevin**	74	M	Cataract	Yes
010STMF-Sally	62	F	AMD	No	**010BKCVI-Bronwyn**	79	F	Cataract	Yes
011PMGF-Peter	86	M	Glaucoma	No	**011AOCVI-Alice**	76	F	Cataract	Yes

012JO'BCF-Jack	72	M	Cataract	Yes	**012JBGVI-Jean**	75	F	Glaucoma	No
013RMcSCF-Robert	71	M	Cataract	Yes	**013BWGVI-Bob**	69	M	Glaucoma	No
014JBGF-Joy	69	F	Glaucoma	No	**014JCGVI-Janet**	53	F	Glaucoma	No
015SGCF-Susan	68	F	Cataract	Yes	**015FTMVI-Fred**	77	M	AMD	No

4.5.4 Method selection for collecting data

I outlined the study research questions before the methodology and methods were chosen. Therefore, a conceptual map of the phenomenon of interest already existed. The exploration of this map has been informed by an interpretive (or Heideggerian) phenomenological approach underpinned by the philosophy of Merleau-Ponty and ideas of van Manen (Section 4.5.1). This approach includes the researcher's preconceptions in the generation of data and therefore data is co-constructed (Lowes & Prowse 2001). As an orthoptist with preconceptions of vision and falls, my own beliefs and experiences formed part of the interview and research process.

The use of focus groups was not considered with the separate groups of individuals with cataracts, AMD and glaucoma as the aim was to explore the lived experience of the falls with each individual in the context of their own life. Conducting an interview has been suggested to be the most dominant method for data collection in phenomenological research (Bevan 2014). Interviews allow participants the freedom and flexibility to talk about their experience but for the researcher to gain access to the individual's life-world. Therefore the use of face-face interviews in this study would allow me to highlight the relevant context and construct situated knowledge (Mason 2018, p. 110). The goal of each research question was for the participants to describe their lived experience of having a fall (research question 2) or being diagnosed with an ophthalmological condition (research question 3) and situate the role of vision in falls and fear of falling.

Interview method

Semi-structured interviews informed by a narrative-episodic approach (Flick 2000) was adopted to address both qualitative research questions. A narrative form of inquiry allows participants to describe their experience as narrated by them and as a lived experience (Denzin & Lincoln 2011, p. 422). Individuals may put actions and experience into a sequence which therefore becomes an act of storytelling (Ricoeur 1980) which can help highlight the experiences, circumstances, issues and themes (Gubrium & Holstein 2002, p. 125) of the participant's lifetime. My original thought was to use the biographical narrative interpretative method of interviewing

(Wengraf 2001) which would allow the individual to recount all the falls they had suffered throughout their life-course and how they interpreted these in terms of their individual agency and structure at different life points. A narrative of their life would also give meaning to how they construct who they were and how their behaviours have evolved with age. However, whilst this was interesting to explore, the aim of the qualitative research question was not to explore the participant's life course of their falls history or sight. Consequently, I felt that the single narrative question may not facilitate the individual to explore the impact of their vision/sight on falls or fear of falling. Nevertheless, a narrative of the participant's fall and diagnosis of their eye condition would provide a context driven description of their experience and allow an exploration of the resulting themes surrounding the event or episode. Hence, I used Flick's method of episodic interviews (Flick 2000, pp. 76-92) enabling me to use specific episodes, for example, 'the fall' or 'the diagnosis of the ophthalmological condition' as objects of the narratives to build the participant's routines and normal everyday phenomenon (Flick 2009, p. 190).

Therefore, my semi-structured interview had elements of a narrative and episodic approach with purposive questions added following the analysis of the quantitative data, to give the narratives context and meaning within the scope of this study. For example, my narrative question was phrased as, "Tell me about your recent fall and any other falls you have experienced in your life?", thereby exploring the lived experience of the fall. The purposive question would be, "How would you describe your sight?" Using this approach, I was able to integrate the clinical findings of their sight to how the individual constructed their narrative about the fall and the role their sight played in the fall and fear of falling.

Semi-structured interview

Indicative interview schedules were prepared in advance for each group of participants (Group 1-falls participants with age-related ophthalmic conditions, Group 2-recently diagnosed individuals with visual impairments) to meet the conditions of ethical approval by the HRA (Health Research Authority) (Appendix 9). The schedule was used as a guide and prompt if needed during the interview. The questions were designed to be open and were guided by the content of the quantitative results to some extent but also allowing the participant freedom to offer a narrative from which themes could emerge. Semi-structured interviews are where the participant's responses cannot be predicted in advance. Therefore, the interviewer has to improvise for 50-80% of their response to what the participants say in response to the initial question (Wengraf 2001, p. 5). Semi-structured interviews are more difficult to undertake as they require more discipline and creativity in the session as well as more time for analysis and interpretation (Wengraf 2001). However, they do offer in-depth realities.

The participants who had fallen were asked to give a narrative of the fall (event). Narratives have been considered as stories about past events with six common elements; summary, orientation (e.g. the time, place and situation), sequence of events, the significance of the action, resolution and perspective of the present (Labov 1972, p. 363). However, narratives from older people do not always follow a particular model and the relationship between the interviewer and interviewee must be considered. This raises issues of positionality that have been discussed in section 4.5.2. I had to be mindful that the interviewee is privileged with the space and time to present their narrative during the interview but also may depart from the topic guide. Robertson and Hale (2011) found that storytelling was expected when interviewing older people and that they often digressed, leaving the researcher with a lot of biographical material which was not always related directly to the research topic. However, the authors point out that the relevant information may be woven into the fabric of the stories which are offered within the wide familiar context. As some participants took part in both phases of this study they were able to stay within the context of the study. A few of the participants were good story tellers and offered rich narrative of their experience. Therefore, whilst I have included data from every participant, some may feature more than others.

4.5.5 Ethical considerations

Ethical issues concerning the governance of the study have been discussed in section 4.2. Dicicco-bloom and Crabtree (2006) identified 4 specific ethical issues to consider during the interview process:

1. reducing the risk of unanticipated harm

2. protecting the interviewee's information
3. effectively informing interviewees about the nature of the study
4. reducing the risk of exploitation

All interviews were tape-recorded with no identifiable information attached and each participant was given a unique code. Codes ending in 'F' were falls participants and codes ending in 'VI' were non-falls participants recently diagnosed with an age-related ophthalmic condition. Each participant was given the relevant participant information sheets and consent forms (Part 2 for Group 1 and Part 3 for Group 2, Appendix 10 and 11 respectively). The act of listening and reflecting back the interviewee's narrative, Dicicco-bloom and Crabtree (2006) warn could cause unanticipated harm in the way of undue stress or unexpected grief and therefore the researcher should be prepared to provide psychological support. During this study, the Eye Clinic Liaison Officer in St. Paul's Eye Unit was able to offer support in the event of any participant needing it. Some participants who were upset during the interview when narrating past experiences of grief or trauma were offered support but declined. Indeed, they were grateful for the opportunity to talk and be heard. Since there was no reimbursement built into the study for participants contributing to the research and for reducing the risk of exploitation, I took a small gift of a plant to each participant who invited me to their home. Participants who came to the hospital for the interview were offered tea and biscuits during their visit. A report of the results of the study will also be sent to every participant who ticked a box on the consent form indicating they would like to receive a copy, therefore reducing the risk of exploitation of research participants.

4.5.6 Fieldwork

I contacted all participants the day before their scheduled visit either to their home or the hospital to confirm arrangements and that they wanted to continue with participation. Following consent, I completed the CRF (Section 4.4.5) with the participant to gather the relevant data and found that during this exchange the participant would start to describe their fall, sight or visit to the optician. Hence, I decided to record this exchange as part of the interview and capture the depth and context of each of the questions from the CRF and avoid the participant having to repeat a similar narrative when interview questions were asked. Thirteen participants from this phase of the study were not recruited from the quantitative phase (Table 4.2), therefore a full set of clinical visual function data was not available for these participants. Since these participants were recruited from St. Paul's Eye Unit, visual acuity data were available from their routine appointments but none of the other visual function data was available. Of the visual functions measured in the quantitative phase, there were indications that stereoacuity and contrast sensitivity may be deficient in the falls participants. Practical issues with transporting equipment and measuring contrast sensitivity outside of a clinical setting meant that I was only able to assess stereoacuity with participants in their homes. Generally, completing the consent, case record form and stereoacuity took 10-15 minutes before the interview questions were introduced.

Interviews with participants

In group 1, I was broadly interested in learning about the participants' experience of the last fall, any other falls, and their view on the role of their 'sight' in their fall and fear of falling. All interviews were carried out subsequent or towards the latter stages of the quantitative phase of the study and after their clinical assessments. Therefore, specific questions guided by the quantitative findings were included, for example questions about depth perception and contrast. The questions for the participants in group 2 focussed on their age-related ophthalmic condition, for example, their experience of the diagnosis and how their 'sight' affects them in their everyday life and concern for having a fall. The structure of each interview schedule was flexible and the order may have varied depending on the interviewee's responses. The wording of the questions can vary depending on the participant's vocabulary and understanding (Britten 1995). As the interviews are personal with interviewees often sharing intimate information, it was important that they felt comfortable and secure in the physical space of the interview, therefore the interviewees were invited to take part in a setting that was convenient to them.

Timing of the interview

I interviewed thirteen participants within a year of their fall (6 weeks-11 months). The two remaining falls participants were interviewed within two years of having experienced a fall. As a result, there was a temporal perspective to their narrative and was potentially influenced by their memory and effects of the fall.

The participants who had not experienced a fall since the onset of their age-related ophthalmic condition were interviewed within two years of the diagnosis. This was so that they were able to recall their experience of daily living before and since the onset of their age-related sight condition with respect to falls and fear of falling.

Interview setting

All interview locations were chosen by the participants and the majority (22/30) were carried out in the participant's own home. Seven participants chose to be interviewed in the Clinical Eye Research Centre, Royal Liverpool University Hospital and one participant (Joy-014JBGF) was interviewed in an academic office at the University of Liverpool. Herzog (2005) argues that the setting for a qualitative research interview plays an important role in how reality is constructed and should be considered in the social context of the study. The interview and what takes place around and during it should play a role in the analysis and construction of knowledge (Herzog 2005).

The choice of setting for the interview in this study was based on pragmatic considerations such as ease of travel, timing and convenience for the participant. The power dynamics between the researcher and interviewee need to be considered for the interview (Elwood & Martin 2000). In the clinical setting, it could be argued that it would lead to a shift in power relations threatening the equal partnership of the interviewer and interviewee and authenticity. Joy (014JBGF) was an employee of the University recruited from St. Paul's Eye Unit and was insistent that the interview would take place at the University. I was initially concerned about whether this participant would feel comfortable and equally part of the interview process in this setting. However, she felt quite comfortable and the familiarity of the location put her at ease. As identified by Gagnon, Jacob and

McCabe (2015) in their paper on reflecting on space and place in nursing research, it may have given the participant a sense of place and validation.

Interviews carried out at home, whilst convenient for the interviewee, did pose challenges for me. Quite often the interviewee would be distracted by their surroundings or family members. During five different interviews (005JMMVI, 0013DKCVI, 009KHCVI, 015FTMVI, 011PMGF), the spouse intervened during the interview process and made contributions on behalf of the interviewee making it difficult to differentiate the experience of the spouse and the participant. However, on one occasion the spouse of 009KHCVI was able to offer their experience of having a cataract and the impact it had which added to my personal knowledge of sight impairment and concern for having a fall. Notes were taken following the interview regarding the setting, other verbal and non-verbal cues and my own reflections from the interview.

Recording and transcribing the interviews

All interviews were recorded on a digital recorder that was placed between myself and the interviewee. Precautions were taken before each interview to ensure the device worked properly and spare batteries were taken to each interview. Participants were made aware of the recording device and were informed that they were able to raise their hand to stop the recording if at any time they became uncomfortable for their narrative to be recorded. This did not occur in any of the interviews. Each interview was then uploaded to an electronically shared folder on 'Dropbox' (password protected) for each audio recording to be transcribed into verbatim scripts by a professional transcriber. Each file was anonymised to maintain confidentiality and once transcribed was deleted from the shared folder.

Each transcript and audio was sampled for accuracy and where the transcriber was unsure of the speech, she gave the time and '?' (e.g.? 14.56) to enable me to playback the audio and complete the speech. Whilst I acknowledge that transcribing the interviews myself would have allowed me to build an intimate knowledge of the data, I reviewed the data with the audio recordings and made the necessary edits. I was then able to read and re-read the data to feel immersed in their narratives. I also added in the margins any emotions displayed by the participant during the interview or specific notes about the setting or interview process from my journal.

4.5.7 Method of data analysis

The method of data analysis, similar to the research methodology was informed by a phenomenological approach. Generation of knowledge from the transcripts was inductive and iterative, therefore allowing themes to emerge from the data. I read through each *whole* transcript to identify the essential nature of the participant's experience (Bazeley, 2013, p101) before re-reading and looking at the detail and applying codes to the content. However, I was conscious that it did not become a mechanical application of a frequency count or coding of selected terms and instead was sensitised to the idea of thematic analysis described by van Manen (1997, p. 78). The author describes phenomenological themes as the *structures of experience* and that it can be the process of insightful invention, discovery or disclosure (Van Manen 1997, p. 79). Hence, I predominantly used a thematic analysis informed by a phenomenological approach to enter the participant's life-world.

I used NVivo 10, a software programme to manage the transcripts, organise the data and subsequent codes. During the initial phases of analysis, I adopted 'line by line' coding to open up the data as suggested by Bazeley (2013, p. 162). I reviewed the first three interviews to identify dimensions of the participant's narrative that were common and it also allowed me to generate ideas that I could explore in further transcripts. For example, participants were asked to describe their sight in more detail as they predominantly described the physical nature of the fall during the interview. Also, I was sensitised to depth perception following the analysis of the quantitative data.

The analysis was a discursive and iterative process with my supervisor (JR) where we examined half of the scripts together. I coded every aspect of their interview, initially giving it descriptive labels. From the initial analysis, I developed a coding framework which I discussed with JR, and then merged some codes, brought some to the foreground and renamed some to reflect my ongoing thinking and analysis. There was no disagreement on the codes and I was advised by JR to develop the codes and the framework into broader interpretive themes and we both reached a consensus on the themes (Appendix 13). For example, 'support' was a code that was related to 'getting on with it' in some participants who had experienced a fall or being recently diagnosed with an ophthalmic condition. The broader themes form the basis of the qualitative findings chapters (Chapter 6, 7 and 8). Data from the quantitative phase will be considered alongside the narrative data and connected to highlight similarities or inequities in the data to answer the research questions (Cresswell & Plano Clark 2011, p. 220)

4.6 Summary

Using pragmatism as my theoretical perspective, I designed a mixed-methods study to construct knowledge that has the potential to impact on clinical practice. The quantitative phase was underpinned with a postpositivist approach, to compare visual function in age-matched falls and non-falls participants. This will determine whether impaired measures of visual function are risk factors for falls whilst accounting for explanatory non-visual risk factors.

In the qualitative phase, I aimed to explore the lived experience of older adults with age-related sight conditions with respect to falls and the fear of falling. Hence, this phase was informed by an interpretive phenomenological approach and I was specifically sensitised to the phenomenology of Merleau-Ponty (1962) and van Manen (1997). Semi-structured interviews were conducted with two groups of fifteen participants with age-related ophthalmic conditions (1-falls participants, 2-no falls since diagnosis of the ophthalmic condition). Interviews were thematically analysed using a phenomenological lens.

Chapter 5 Quantitative analyses of potential risk factors for falls

5.1 Introduction

In Chapter 4 (Section 4.4.7) I described the methods employed for the statistical analysis of the quantitative phase of the study. This chapter aims to present the quantitative analyses from this prospective observational case-control age-matched study. First, I present the non-visual data that includes demographics, falls characteristics, general health, social and living arrangements, physical activity and quality of life across the falls and non-falls participants (Section 5.2), followed by the analysis of the visual function data (Section 5.3). Finally, Section 5.4 will include multivariable-adjusted logistic regression models to study the relationship between falls and visual function while adjusting for other confounders, which were significant in the univariate analyses. The structure of this chapter is as follows:

- Non-visual data in falls and non-falls participants (5.2)
  - Demographic data (5.2.1)
  - Fall characteristics, use of a walking aid, Falls Efficacy Scale (FES-I) and Timed Up to Go test (TUTG) (5.2.2)
  - General health (5.2.3)
  - Social and living arrangements including support (5.2.4)
  - Physical activity and generic quality of life (5.2.5)
  - Summary of the univariate non-visual data (5.2.6)
- Visual function data in falls and non-falls participants (5.3)
  - Ocular check and glasses (5.3.1)
  - Visual acuity (5.3.2)
  - Contrast sensitivity (5.3.3)
  - Binocular function (5.3.4)
  - Visual field (5.3.5)

- Summary of the univariate analyses of visual function (5.3.6)

- Visual function data in falls and non-falls participants adjusted for confounders (i.e. a multivariable logistic regression) (5.4)
  - Univariate logistic regression of non-visual variables associated with falls (5.4.1)
  - Univariate logistic regression of visual function variables associated with falls (5.4.2)
  - Multivariable model for the association between falls and vision while adjusting for confounders (5.4.3)
  - Summary of the multivariable logistic regression models (5.4.4)
- Discussion of the quantitative results (5.5)

5.2 Non-visual data in falls and non-falls participants

The causes of falls are multi-factorial and several non-visual risk factors have been described in Chapter 2. Hence, in this section, I aim to first develop an insight into the differences in demographics of the falls and non-falls participants followed by a description of the falls characteristics, general health, social and living arrangements, physical activity and generic quality of life data recorded on the first part of the case record form (Appendix 5-Case record form).

5.2.1 Demographic data

The demographic data of the age-matched falls and non-falls participants are illustrated in Table 5.1. Both groups had similar proportions of males and females (Falls: Male-35%, Female-65%, Non-falls: Male-43%, Female-57%, p=0.3, Chi-square). However, within the falls group, there were significantly more female than male falls participants (p=0.0008, Binomial exact test for proportions).

The falls and non-falls groups had a similar mean age since this was an age-matched study. The mean and median age of both groups was 72 years (SD 6.5) and 71 years (SD 6.5) respectively. The age distribution of the falls and non-falls participants can be seen in Figure 5.1.

Almost 50% of the falls participants were between 70-79 years and only 12% of the falls participants were ≥80 years. Participants of this age group (≥80 years) were reluctant to take part in the study as they either required assistance with transport to attend their visual function assessment appointment at another site on a separate day or had multiple hospital appointments.

Table 5.1: Comparing gender, age, IMD and IDAOPI (1-most deprived to 10-least deprived) of falls (n=83) and non-falls (n=83) participants

	Falls participants (n=83)	**Non-falls participants (n=83)**	**P Value (statistical test)**
Gender	Female: 54 (65%) Male: 29 (35%) p=0.0008 (Binomial exact test for proportions)	Female: 47 (57%) Male: 36 (43%) p=0.272 (Binomial exact test for proportions)	0.3 (Chi square test of association)
Age years (mean±SD)	72±6.5 (60, 71, 86) (min, median, max)	72±6.5 (61, 71, 88) (min, median, max)	0.13 (Paired samples t-test)
Index of multiple deprivation (IMD) decile median (quartiles)	2 (1, 5.75)	6 (3, 8)	<0.0001 (Wilcoxon signed rank test)
Income deprivation affecting older people index (IDAOPI) decile median (quartiles)	2 (1, 4)	6 (2, 8)	<0.0001 (Wilcoxon signed rank test)

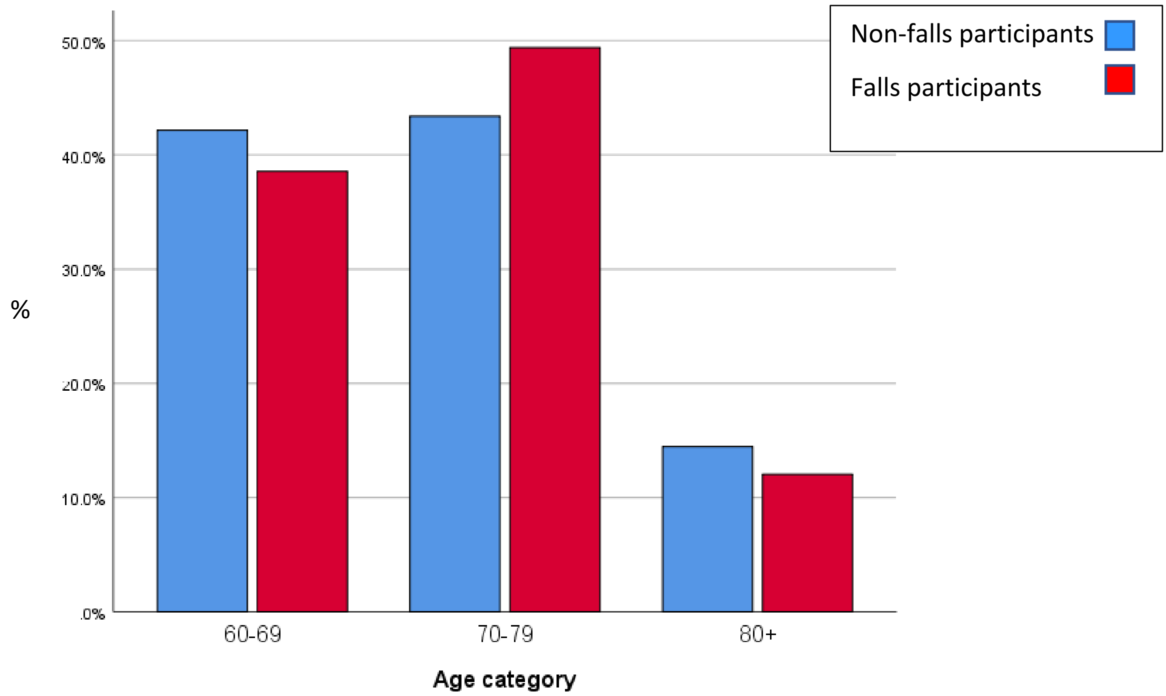


Figure 5.1: Age distribution of falls participants (n=83)

In this sample, participants in the falls group lived in areas that were 4 deciles (out of 10) more deprived compared to the postcode areas of the non-falls participants ($p<0.0001$, Table 5.1). Further analysis of the dataset provided by income deprivation affecting older people index (IDAOPI) demonstrated the same significance ($p<0.0001$, Table 5.1) suggesting the impact of lower socio-economic status on the increased risk of falls and confirming the pattern of health inequality amongst those who come from the most deprived areas (Figure 5.2). This puts IDAOPI as a confounder of the outcome (fall vs no fall) and the primary risk factors (i.e. visual function measures), hence I will include IDAOPI as a confounder when analysing the relationship between vision and falls in the later analyses.

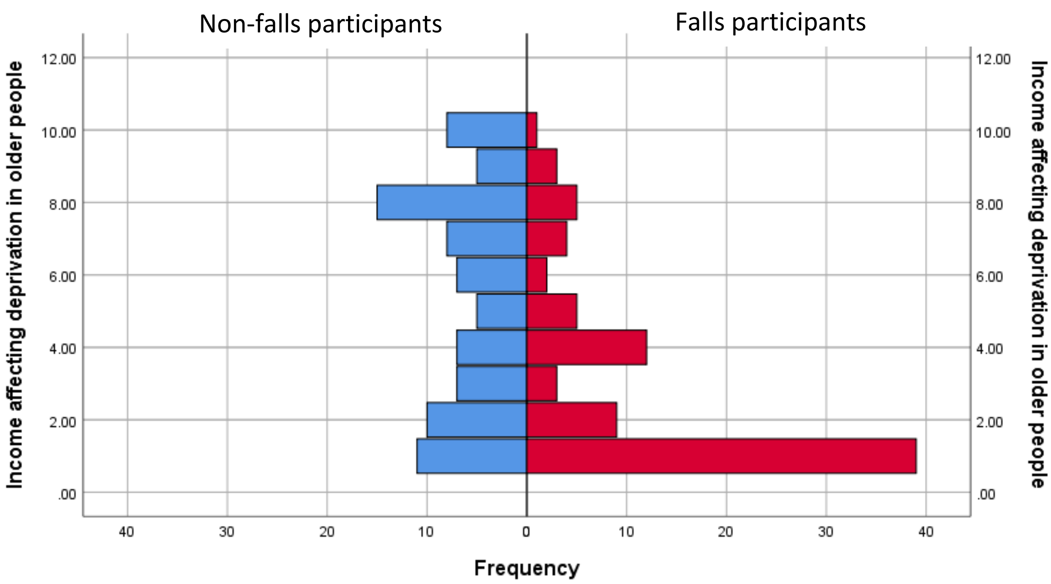


Figure 5.2: Income affecting deprivation in older people (IDAOPI) of falls vs non-falls participants

5.2.2 Falls characteristics, the use of a walking aid, fear of falling and balance

This section explores four aspects of the participants' data: the fall characteristics (number of falls and description of the last falls), the use of walking aid(s) in falls and non-falls participants, fear of falling and balance.

Masud and Morris (2001) defined a recurrent faller as someone who has experienced two or more falls in a specific time period usually 6 or 12 months. In this study, participants were asked about the number of falls experienced in the last five years due to the eligibility criteria for non-falls participants (no falls in the last 5 years). There was considerable variation in the number and type of falls in the falls participants. The number of falls experienced by each faller and the nature of their last fall is illustrated in Figure 5.3 and Figure 5.4 respectively. Surprisingly, 26.5% of the participants had suffered five or more falls when they were enrolled in the study. Further analysis by gender demonstrated that significantly more females (n=42, 50.6%) than males (n=17, 20.5%) had experienced ≥2 falls (p=0.0001, Chi-square). The most common cause of the fall described by the participants was a trip (n=36, 43%). The 'other' category included the events of falling down the stairs and losing balance.

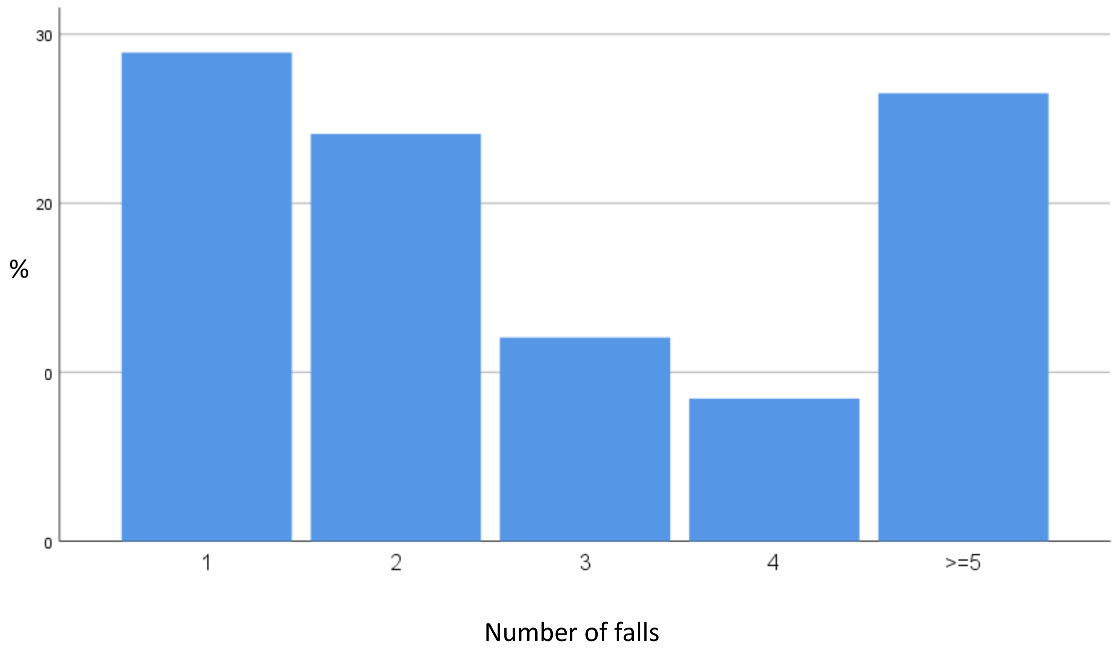


Figure 5.3: Number of falls experienced over 5 years including the last fall in 83 study participants in the falls group

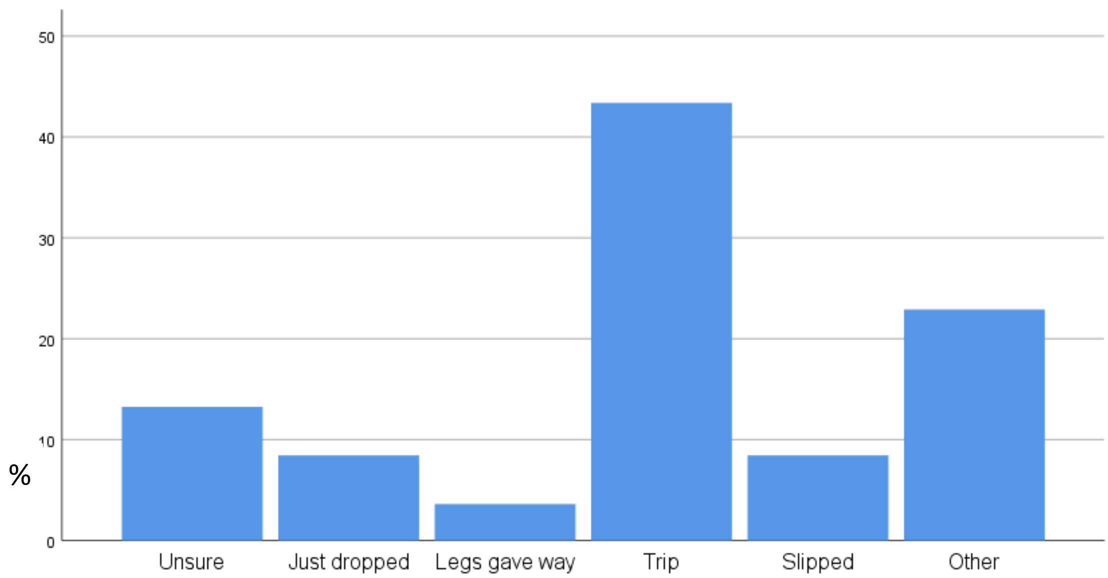


Figure 5.4: Description of the most recent fall given by each of the 83 study participants in the falls group

Invariably, during the clinical assessment, participants would describe tripping over an environmental hazard outside of the home, for example, pavements and kerbs. Significantly more non-falls participants 'never' used a walking aid compared to the falls participants, suggesting that the falls participants used a walking aid either ‘always’ or ‘occasionally’ due to a pre-existing mobility issue or previous falls (Table 5.2, p=0.001, Fisher’s exact test-2 sided). In the ‘always’ category of walking aid use, there were significantly more falls participants (81.3%) compared to non-falls participants (18.7%) (p=0.01, Binomial exact test for proportions), suggesting an association between using a walking aid and a fall. Among those who used the walking aid ‘occasionally’, there were more falls participants (p=0.03) and among those who ‘never’ used the walking aid, there were more non-fall participants (p=0.04). There were no gender differences in using a walking aid between the groups (p>0.05, Chi-square).

Table 5.2: Walking aid use in falls and non-falls participants.
The differences in counts across groups were significant (p=0.001, Fisher’s exact test-2 sided) with posthoc comparisons shown here (binomial exact test for proportions)

	Frequency	Falls participants	Non-falls participants	p-value (binomial exact test for proportions)
Walking aid N(%)	Always	13 (81.3)	3 (18.7)	0.01
	Occasionally	22 (68.8)	10 (31.2)	0.03
	Never	48 (40.7)	70 (59.3)	0.04

In the design of this study, fear of falling (FES-I) and balance (TUTG) were measured post-fall, therefore, I am unable to categorically determine whether poor balance or fear of falling are risk factors for falls. However, to investigate an understanding of the impact of the fall on these two measures, I measured and compared FES-I and TUTG in both groups of participants. Each participant completed a FES-I, and ‘Timed Up To Go Test’ (TUTG) (see Chapter 4 for methods). As expected, those who had experienced a fall were significantly more fearful of falling and had worse balance than the non-falls participants in this sample (p<0.0001, Wilcoxon signed-rank test, Table 5.3). Across both groups, female participants had worse scores on the FES-I than the males (p<0.05, Mann-Whitney U test, Table 5.3). The TUTG was significantly worse in participants who had fallen compared to the non-falls participants (p<0.0001, Wilcoxon signed-rank test, Table 5.3) but there was no significant difference in scores between males and females within the groups (p>0.05, Mann-Whitney U test, Table 5.3). Two falls participants (both female) were unable to undertake the TUTG test due to being wheelchair-bound. Hence, these were not included in the analysis.

Table 5.3: FES-I and TUTG measures of falls vs non-falls participants and males vs females. Note that two female falls participants were unable to undertake the TUGT test due to being wheelchair-bound (*p<0.05)

<table>
<tr><th></th><th colspan="2">Falls participants (n=83)</th><th colspan="2">Non-falls participants (n=83)</th><th>P-value</th></tr>
<tr><td rowspan="2">FES-I score Median (quartiles)</td><td colspan="2">31
[21,45]</td><td colspan="2">18
[17,22]</td><td><0.0001*
(Wilcoxon signed rank test)</td></tr>
<tr><td>Males
(n=29)
25
[18,40.50]</td><td>Females
(n=54)
32.50
[23,46]</td><td>Male
(n=36)
17
[16,19.75]</td><td>Females
(n=47)
19
[18,23]</td><td>0.042*
(Falls participants)

0.002*
(Non-falls participants)

(Mann-Whitney U Test)</td></tr>
<tr><td rowspan="2">TUTG secs Median (quartiles)</td><td colspan="2">10
[7.25,13]</td><td colspan="2">7
[6,8]</td><td><0.0001*
(Wilcoxon signed-rank test)</td></tr>
<tr><td>Males
(n=29)
9
[7.25, 12]</td><td>Females
(n=52)
10
[7.25, 13]</td><td>Male
(n=36)
7
[6, 8.25]</td><td>Females
(n=47)
7
[6,7.75]</td><td>0.39
(Falls participants)

0.91
(Non-falls participants)

(Mann-Whitney U Test)</td></tr>
</table>

Falls and non-falls participants were compared in terms of having a normal or compromised balance. Lysack (2010, p. 625) suggested a score below 10 seconds on TUTG indicated normal balance and a score of more than or equal to 14 seconds to indicate a high risk of falls. The falls participants had a median TUTG score of 10 seconds (Table 5.3). However, a greater proportion of the falls participants (N=14, 16.9%) had compromised balance (TUTG≥14) compared to the non-falls participants (N=3, 3.6%) (p<0.0001, Chi-square test). I also examined the TUTG mean scores of the falls participants by age categories to compare them to those published in the meta-analysis of TUTG (Bohannon 2006). Table 5.4 demonstrates that the 70-79 year old fall participants I examined had a worse TUTG score compared to the reference values of that age given by Bohannon (2006). Moreover, the non-falls participants performed better than those published in the meta-analysis of TUTG. The data also demonstrate the decline in balance indicated by the increase in TUTG in the 70-79 and 80+ age groups compared to the 60-69 years group. Since there is a decline in TUTG across age and between falls and non-fall participants, this suggests impaired balance can be due to age as well as having had a fall. However, the number of participants in the 80+ group are small, to draw any firm conclusions about the difference in balance between the two groups.

Table 5.4: TUTG values for falls participants across the 3 age categories (60-69, 70-79 and 80+) and compared to reference values for normative groups from (Bohannon 2006)

Age-category	Reference values for TUTG Mean secs (range)	Falls participants Mean secs (range)	Non-Falls participants Mean secs (range)	p-value (Independent samples t-test)
60-69	8.1 (7.1-9.0)	8.95 (6.0-15.0) (n=31)	6.4 (4.0-11.0) (n=35)	<0.001
70-79	9.2 (8.2-10.2)	12.1 (5.0-36.0) (n=40)	7.5 (4.0-16.0) (n=36)	<0.001
80+	11.3 (10.0-12.7)	11.3 (6.0-16.0) (n=10)	8.7 (6.0-15.0) (n=12)	0.022

5.2.3 General health

The next objective was to investigate the role of general health in falls. As outlined in the methods (Chapter 4, Section 4.4.2), participants were asked whether they had a hearing impairment and specific co-morbidities. A diagnosed hearing impairment was found to be more prevalent in the falls participants (n=32, 38.6%) compared to the non-falls participants (n=11, 13.3%) (p<0.001, Fisher's exact test-2 sided). I asked participants if they had any specific conditions that have been associated with falls in the literature (Chapter 4, Section 4.4.2) which I will call 'pre-specified' throughout this section. Of the pre-specified conditions, significantly more falls participants had osteoarthritis (p=0.005, Fisher's exact test-2 sided) compared to the non-falls participants (Table 5.5) and these were more prevalent in women (72% in osteoarthritis and 90% in osteoporosis) compared to men. Table 5.5Table 5.5: Pre-specified co-morbidities by condition of falls participants and non-falls participants (*p<0.05)

Falls participants presented with a significantly greater number of the pre-specified co-morbidities (falls participants, median [quartiles]= 2 [1,2] and non-falls participants, median [quartiles]= 1[1,2]) than the non-falls participants, and this remained significant when I added the 'other' conditions in the total for both groups (Table 5.6 and Table 5.7) (p=0.01, Wilcoxon signed-rank test). 'Other' comorbidities included asthma, cholesterolaemia, depression, hypo- or hyperthyroidism to name the most commonly reported conditions. This is consistent with the finding of a greater proportion of falls participants (n=52, 62.7%) taking ≥4 medications compared to the non-falls participants (n=28, 33.7%) (p<0.001, Fishers exact test-2 sided). There were no significant gender differences in the number of comorbidities (p>0.05, Mann-Whitney U Test). There were more female falls participants (n=25, 80.7%) taking less than 4 medications than their male counterparts (n=6, 19.3%) (p=0.02, Chi-square) but no significant difference between genders in the non-falls participant sample. Medications were listed on the case record form; however, it is out of the remit of this study to review and analyse the effects of each medication on falls.

Table 5.6: Proportions of falls participants and non-falls participants with pre-specified co-morbidities.

Number of pre-specified co-morbidities	Falls participants n (%)	Falls participants cumulative counts (%)	Non-falls participants n (%)	Non-falls participants cumulative counts (%)
0	11 (13.3)	11 (13.3)	20 (24.1%)	20 (24.1)
1	23 (27.7)	34 (41.0)	36 (43.4%)	56 (67.5)
2	29 (34.9)	63 (75.9)	15 (18.1)	71 (85.6)
3	14 (16.9)	77 (92.8)	8 (9.6)	79 (95.2)
≥4	6 (7.2)	83 (100)	4 (4.8)	83 (100)

Table 5.7: Proportions of falls participants and non-falls participants with total co-morbidities (pre-specified and 'others')

Number of total co-morbidities (including 'others')	Falls participants n (%)	Falls participants cumulative counts (%)	Non-falls participants n(%)	Non-falls participants cumulative counts (%)
0	5 (6)	5 (6)	12 (14.5)	12 (14.5)
1	12 (14.5)	17 (20.5)	22 (26.5)	32 (41.0)
2	25 (30.1)	42 (50.6)	23 (27.7)	55 (68.7)
3	21 (25.3)	63 (75.9)	17 (20.5)	72 (89.2)
≥4	20 (24.1)	83 (100)	9 (10.8)	83 (100)

5.2.4 Social and living arrangements

Previous studies have shown that living alone is a risk factor for having a fall (Lee et al. 2011) and increased fear of falling (Zali et al. 2017) in older adults. Furthermore, a review of stairway falls reported 7-36% of falls occurred during ambulation on stairs or steps (Jacobs 2016). Therefore, I recorded the type of accommodation, social and living arrangements for each participant, as potential risk factors for falls. It also allowed me to understand the social context of each participant's living arrangements for the qualitative phase of the study. Therefore, in this section, I have analysed the living accommodation and arrangements of the falls and non-falls participants.

Although more non-falls participants lived with their spouse or partner and lived in accommodation with stairs compared to the falls participants, these differences were not significant (p>0.05, Chi-square test, Table 5.8 and Table 5.9).

Table 5.8: Accommodation type for falls participants and non-falls participants

Living Accommodation	Falls participants n (%)	Non-Falls participants n (%)	P-value (Chi-square)
Single storey	13 (15.7)	7 (8.4)	0.15
Accommodation with stairs	68 (81.9)	76 (91.6)	0.07
Accommodation with a stair-lift	2 (2.4)	0	0.16

Table 5.9: Living arrangements of falls participants and non-falls participants

Living arrangements	Falls participants n (%)	Non-Falls participants n (%)	P-value (Chi-square)
Live alone	38 (45.8)	32 (38.6)	0.35
Spouse/Partner	32 (38.6)	43 (51.8)	0.09
Child/grandchild > 18 years	6 (7.2)	3 (3.6)	0.31
Spouse and child	6 (7.2)	4 (4.8)	0.52
Grandchild<18 years	0	1 (1.2)	0.32
Relation - other	1 (1.2)	0	0.32

As well as the living arrangements of each participant, I was interested in the relationship between the social support available to the participant and falls. Hence, all participants were asked about their sources of support during a medical event or situation and the majority of individuals relied upon ‘family’ and ‘friends’ (Table 5.10). More fallers (n=11) reported that they had no support compared to the non-fallers (n=5), but this was not statistically significantly ($p>0.05$, Fisher’s exact test).

Table 5.10: Sources of support available in falls participants and non-falls participants. Participants could tick more than one support available to them (‘Others’ included wardens in assisted living complexes).

Support (n)	Falls participants n (%)	Non-Falls participants n (%)	P-Value (Fishers exact test)
Family	61 (73.5)	65 (78.3)	0.586
Carers/statutory	2 (2.4)	4 (4.8)	0.682
Friends	35 (42.2)	45(54.2)	0.162
Nil	11 (13.3)	5 (6.0)	0.187
Other	3 (3.6)	2 (2.4)	1.000

To investigate whether a relationship between social engagement and falls exists, I collected data on the participants’ level of social activity by asking them how often they socialised in and out of the house with friends or family. Being more social would point to a more active lifestyle and potentially less risk of falls. Social activity data were recorded as the number of days/weeks the participant socialised in and out of the home. Non-falls participants were found to socialise out of the house more often than the falls participants ($p<0.0001$, Wilcoxon signed-rank test). Within the same question, I also asked them about their alcohol intake in and out of the home. There was no difference between the groups in the number of alcoholic drinks consumed in or out of the home (Table 5.11).

Table 5.11: Social activity and alcohol intake for falls participants (N=83) and non-falls participants (N=83)

Social activity	Falls participants	Non-falls participants	p-value Wilcoxon signed rank test
Socialise out of the home no. of days Median (quartiles)	5 (3,6)	6 (5,7)	<0.001
Socialise in the home no. of days Median (quartiles)	1 (0,2)	1 (0,2)	0.062
Alcohol at home-drinks/wk Median (quartiles)	0 (0,2.5)	1 (0,4)	0.963
Alcohol out –drinks/wk Median (quartiles)	0 (0,2.5)	0.5 (0,2)	0.888

5.2.5 Physical activity and generic quality of life

Moderate physical activity has been shown to reduce the risk of falls by improving strength and balance (Gregg, Pereira & Caspersen 2000; Skelton 2001). Hence, all participants were asked questions about their engagement with physical activity before the fall. The level of physical activity was ascertained using the 'Rapid Assessment of Physical Activity' (RAPA) tool. The RAPA has two sections: 'aerobic' with a maximum score of 7 and a positive response to the 'strength' and 'flexibility' questions score 1 and 2 respectively (Appendix 6). A score below 6 on the aerobic section is regarded as suboptimal and a score of 4 is considered 'under-active regular'. Here I have compared the aerobic score for both the falls and non-falls participants and then compared the proportion of participants who undertook any strength, flexibility or 'both' activities.

Falls participants carried out significantly less aerobic physical activity than the non-falls participants (RAPA 4 vs 6, Table 5.12) (p<0.001 Wilcoxon signed-rank test Table 5.12). When the falls and non-falls participants were compared for the level of strength and flexibility exercise performed, there was a significant difference in the proportions of falls and non-falls participants performing strength and flexibility exercises overall (p=0.048, Fisher's exact, 2-sided). This result was driven by the fact that 73.5% of the falls participants responded to say they did not perform any strength or flexibility activity compared to 54.2% of non-fallers (p<0.001, Chi-square, Table 5.12) and more non-falls participants doing flexibility exercises (p=0.011, Chi-square, Table 5.12).

Table 5.12: RAPA data for falls participants and non-falls participants (*p<0.05)

	RAPA aerobic physical activity score median (quartiles)	Nil strength or flexibility activity (%)	Strength activity only (%)	Flexibility activity only (%)	Both strength and flexibility activity (%)
Falls participants	4 (3,6)	73.5	6.0	15.7	4.8
Non-falls participants	6 (4,6)	54.2	6.0	32.5	7.2
P-value	<0.001 Wilcoxon Signed-rank test	0.001* Chi square	1.00 Chi-square	0.011* Chi-square	0.52 Chi-square
		0.048 (Fisher's exact test-2 sided)			

I also chose to determine the impact of falls on the participant's quality of life using the EQ-5D tool. It has been previously reported to be negatively associated with falls within the previous 12 months, independent of a number of general health conditions (Thiem et al. 2014). I used the EQ-5D to measure the participant's generic quality of life and the EQ-5D VAS score indicated the participants' perceived health status with a grade ranging from 0 (the worst possible health status) to 100 (the best possible health status). The significantly low EQ-5D VAS score (mean±SD) in the falls group (53±21) compared to the non-falls group (84±15.4) (p<0.001, Paired samples t-test) is not unexpected due to them having a higher number of co-morbidities than the non-falls participants (Table 5.6). A further explanation for the low perceived health in the falls group is that they were seen within 2 months of having the fall.

Each of the domains measured for quality of life i.e. mobility, self-care, ability to carry out usual activities, pain/discomfort and anxiety/depression were compared across both groups of participants. A significant proportion of falls participants felt worse about their health status in each of the domains compared to the non-falls participants (Table 5.13)

Table 5.13: Comparison of EQ-5D domains between falls and non-falls participants

EQ-5D Domains		Falls participants (n)	Non-falls participants (n)	p-Value Chi-square test
Mobility	No problem	18	59	<0.001
	Slight	25	15	
	Moderate	23	8	
	Severe	8	1	
	Unable	9	0	
Self-care	No problem	32	80	<0.001
	Slight	20	2	
	Moderate	16	1	
	Severe	7	0	
	Unable	8	0	
Usual activities	No problem	14	75	<0.001
	Slight	17	3	
	Moderate	16	4	
	Severe	5	0	
	Unable	30	1	
Pain/discomfort	No	6	52	<0.001
	Slight	7	19	
	Moderate	28	10	
	Severe	32	1	
	Extreme	10	1	
Anxiety/depression	Not	28	69	<0.001
	Slightly	22	9	
	Moderately	23	3	
	Severely	5	0	
	Extremely	5	2	

5.2.6 Summary of the univariate analyses of the non-visual data

Almost half of the participants who experienced a fall(s) were aged 70-79 years and there was a greater preponderance of females. The commonest cause of a fall in this study was a 'trip'. The falls sample displayed typical characteristics or risk factors consistent with the literature. They had multiple co-morbidities, polypharmacy, poor balance, hearing impairment and a greater fear of falling. The lack of association between falls and alcohol intake is consistent with Cawthon et al. (2006) who reported an inconclusive relationship between moderate alcohol intake and fall risk. Across all EQ-5D domains (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) fall participants had worse health outcomes compared to their counterparts. However, these results are indicative of their health outcome in the acute phase following their fall. The emphasis of being physically active to prevent falls has been widely reported (Gregg, Pereira & Caspersen 2000; Skelton 2001) and the results of my study add further evidence that people who fall are less physically active and did fewer 'flexibility' type exercises. Non-falls participants engaged in more social participation outside of the home which may also contribute to an individual's physical activity.

5.3 Visual data

In the following section, I investigate the question of association between visual function and falls by presenting the univariate analyses of the visual function data collected for each group. To investigate any difference in the measures of visual function between the two groups, paired t-tests were used where the data were normally distributed and Wilcoxon signed-rank test used when data were either non-continuous or skewed, for example, for Frisby and prism fusion range, as these are measured in stepwise increments with ceiling effects for both.

5.3.1 Ocular check and glasses

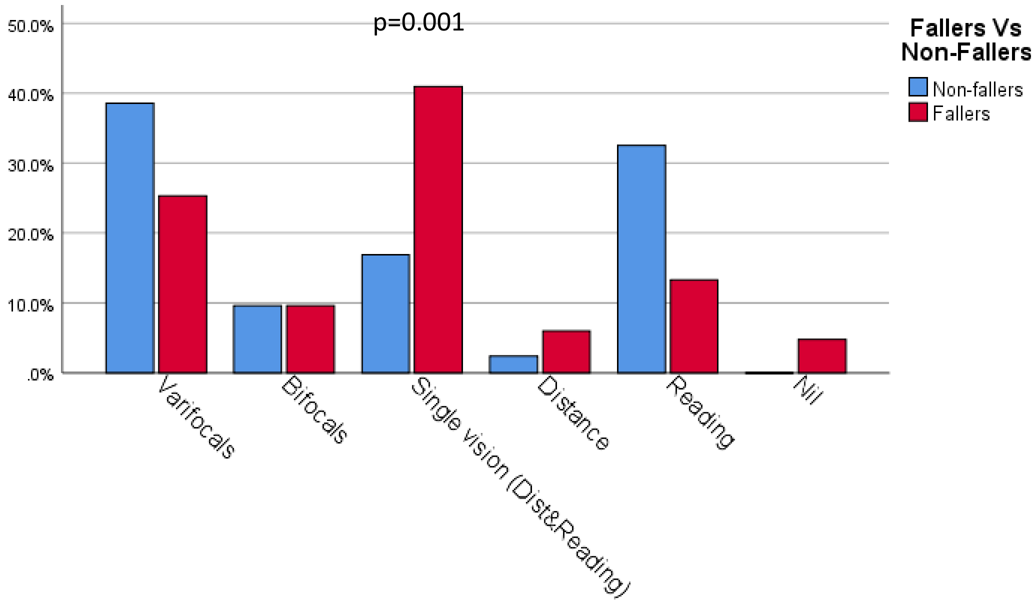
The NHS recommended that people get their eyes tested every two years. Older adults (≥ 60 years) are entitled to a free annual eye test if they are over the age of 40 and have a family history of glaucoma or aged 70 or over (NHS). However, the RNIB recommends that all adults over the age of 60 years have an annual eye test. In a survey carried out by the RNIB (2007), 47% of older adults (60 years and over) were reported as not having an annual eye test. Of the participants I asked about their visit to an eye professional, 60% of the falls participants had seen an eye care professional in the last year compared to 67% of non-falls participants (p=0.70, Pearson Chi-square, Table 5.14). Significantly more falls participants had separate pairs of single vision glasses for near and distance; more non-falls participants had just reading glasses (p=0.001, Chi-Square,

Figure 5.5). While an increased number of non-falls participants had varifocals compared to the falls group, the difference did not reach significance (p=0.07, Chi-square) therefore cannot be generalised and may be due to chance or the sample size. When both sets of participants were anecdotally asked about their glasses, many of them indicated that although they had distance glasses they did not like to wear them either due to feeling that their sight was "not that bad" or the inconvenience of having to "swap between pairs of glasses". In light of more non-falls participants having only reading glasses, it would suggest that they potentially did not require a distance refractive correction due to having better acuity.

Table 5.14: Frequency of visits to an optometrist or ophthalmologist by falls (n=83) and non-falls (n=83) participants (p=0.70, Pearson Chi-square test of association)

Last visit to eye professional (%)	Falls Participants (n)	Non-falls Participants (n)
<6 months	28	34
6-12 months	22	22
>12 months	15	14
≥24 months	18	13

Figure 5.5: Comparison of the types of glasses worn by falls participants (n=83) and non-falls participants (n=83) (Chi-square test)



5.3.2 Visual acuity

Visual acuity (VA) is the most commonly assessed visual function, hence I chose VA as the primary outcome in both groups. Five falls and three non-falls participants had VA in one eye that was either counting fingers, hand movement or perception/no perception to light and were assigned an arbitrary logMAR value of +2.00, +3.00 or +4.00 respectively. This makes the VA data non-symmetrical. Therefore, I used non-parametric tests for their robustness to analyse this asymmetrical VA data. Distance and near VA data from the better eye with their habitual correction were analysed using paired sample t-tests as the values were within range (Table 5.15). 'R eye VA', 'L eye VA' and 'Better eye VA' were analysed using the Wilcoxon signed-rank test (Table 5.16). Falls participants had poorer distance VA (4.5 letters, 0.09 logMAR) and near VA (5.5 letters, 0.11 logMAR) than the non-falls participants when the better eye VA was compared across both groups using paired t-test analysis (Table 5.15). Wilcoxon signed-rank test analysis also demonstrated significantly worse visual acuities of the R, L and better eye for falls compared to non-falls participants (Table 5.16). In

Figure 5.6, the significant number of pairs (n=54) with negative differences demonstrates where the best eye VA in non-falls participants is better than that of the falls participant. Significantly more falls participants (n=15, 18 %) had VA equal to or worse than +0.30 logMAR in their better eye compared to the non-falls participants (n=5, 6%)(p=0.018, Chi-square test).

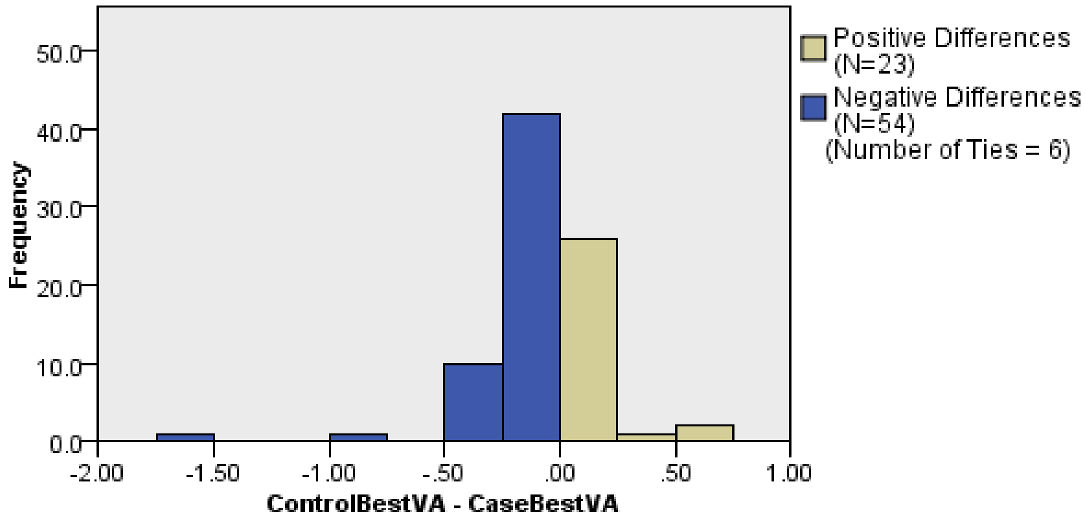
Table 5.15: Paired t-test of distance and near visual acuity (falls participants vs non-falls participants), (*p<0.05)

ETDRS visual acuity logMAR	Falls participants (n=83)	Non-falls participants (n=83)	Paired samples t-test
Better eye VA- 6m (mean±SD)	0.16±0.23	0.07±0.14	p=0.004* (n=83 pairs)
Better eye VA- 1/3m (mean±SD)	0.25±0.45	0.14±0.16	p=0.04* (N=83 pairs)

Table 5.16: Wilcoxon signed-rank test for distance and near visual acuity (falls participants vs non-falls participants), (*p<0.05)

ETDRS visual acuity logMAR	Falls participants (n=83)	Non-falls participants (n=83)	Wilcoxon signed rank test
R eye VA- 6m median (quartiles)	0.14 (0.04, 0.3)	0.10 (0.02, 0.2)	p=0.02*
L eye VA- 6m median (quartiles)	0.14 (0.06, 0.3)	0.10 (0.00, 0.2)	p=0.058
Better eye VA- 6m median (quartiles)	0.1 (0.02,0.22)	0.04 (0.00, 0.14)	p<0.001*
R eye VA- 1/3m median (quartiles)	0.2 (0.15, 0.34)	0.14 (0.1, 0.24)	p=0.006*
L eye VA- 1/3m median (quartiles)	0.2 (0.1, 0.4)	0.16 (0.1, 0.3)	p=0.007*
Better eye VA- 1/3m median (quartiles)	0.2 (0.1, 0.3)	0.1 (0.04, 0.2)	p=0.003*

Figure 5.6: Wilcoxon signed-rank test illustrating the differences in best VA between falls participants and non-falls participants.
For each case and control pair, the difference in their Best VA was calculated (Control-Case)



5.3.3 Contrast sensitivity

Next, I investigated the relationship between contrast sensitivity (CS) and falls vs no-falls as this visual function is seen as a better measure of functional vision particularly in older adults with cataracts (Ginsburg 2003). I measured CS with the Pelli-Robson chart with a fixed letter size with reducing contrast, and also the CSV-1000E measured at different spatial frequencies (3, 6, 12 and 18 cpd) (see Chapter 4 for methods). The CS function can be described as a bandpass shape (inverted U) where it is at its peak at about 4-6 cpd and can be seen to diminish with age at higher spatial frequencies (Figure 5.7).

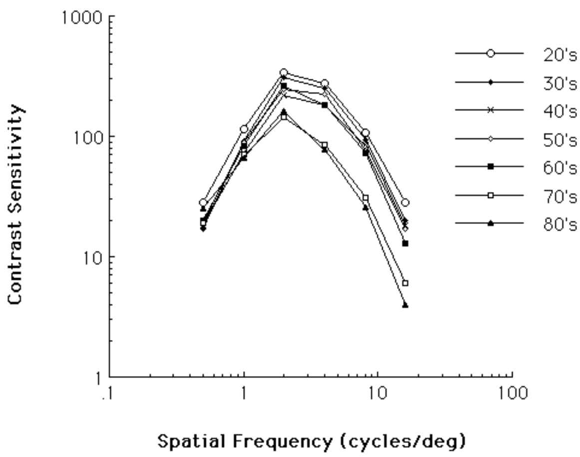


Figure 5.7: Contrast sensitivity function of different age groups
(Schieber, F. (1992). Aging and the senses. In J.E. Birren, R.Sloan & G. Cohen (Eds.), Handbook of mental health and aging. New York: Academic Press. pp. 251-306.)

Analysis of my data showed significantly worse contrast function in falls compared to non-falls participants with both eyes open illustrated in Table 5.17. This includes findings for both eyes only, I was interested in the contrast function under binocular habitual conditions. Although the medians are the same in both groups for the Pelli-Robson test, non-falls participants generally performed better than the falls participants. At the higher spatial frequencies (12 and 18cpd), a larger difference in contrast function was found between the two groups.

Table 5.17: Pelli-Robson and CSV 1000E contrast sensitivity in falls participants vs non-falls participants (n=83 in each group)

Pelli-Robson (log units)	Falls participants	Non-falls participants	P-value Wilcoxon signed rank test
Both eyes- median (quartiles)	1.65 (1.35, 1.80)	1.65 (1.35, 1.80)	0.006
CSV-1000E (log units) Both eyes	**Falls participants**	**Non-falls participants**	**P-value Wilcoxon signed-rank test**
3 cpd median (quartiles)	1.63 (1.49, 1.78)	1.63 (1.56, 1.78)	0.009
6 cpd median (quartiles)	1.70 (1.38, 1.84)	1.84 (1.7, 1.99)	<0.0001
12 cpd median (quartiles)	1.08 (0.61, 1.40)	1.40 (1.25, 1.54)	<0.0001
18 cpd median (quartiles)	0.64 (0.17, 0.81)	0.96 (0.47, 1.10)	<0.0001

In order to get an intuition of how the participants' CSV values compared to the normative data, I plotted the CSV 1000E data (medians) of the participants in this study to the published norms of a population of older adults aged 50-75 (means) (Pomerance & Evans 1994) in Figure 5.8. Significantly less falls participants passed the CSV for each spatial frequency compared to the non-falls participants (Table 5.18, p<0.05). The pass threshold was chosen as equal to or better contrast than the lower limit of normal CSV reported by (Pomerance & Evans 1994). These differences become greater at the higher spatial frequencies (12 cpd and 18 cpd) (Figure 5.8 and Table 5.18). (Pomerance & Evans 1994)

Figure 5.8: Comparison of contrast sensitivity curve of falls and non-falls participants (median) with mean normative data for 50-75 year old adults (published by Pomerance and Evans (1994)

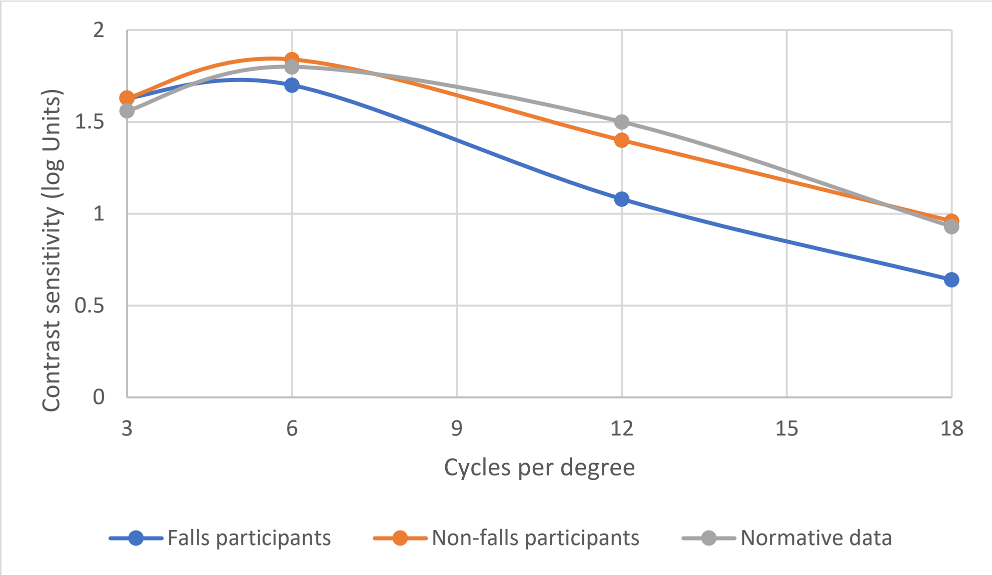


Table 5.18: Proportion of falls participants vs non-falls participants passing the CSV 1000E according to the published norms (Pomerance & Evans 1994)

CSV-1000E	Falls participants	Non-falls participants	Comparison of proportions (Chi-square test)	Difference in pass rate between falls and non-falls participants
	Pass %	Pass %	P	(%)
3 cpd (log units ≥1.41)	77	89	0.04	12
6 cpd (log units ≥1.635)	51	82	<0.0001	31
12 cpd (log units ≥1.35)	26.5	60	<0.0001	33.5
18 cpd (log units ≥0.68)	32.5	73.5	<0.0001	41

5.3.4 Binocular function

Depth perception or stereoacuity as it will be referred to in this chapter and prism fusion range are measures of binocular vision function. The association of impaired depth perception and falls has been reported in the literature (Cummings et al. 1995; Ivers et al. 2000; Lord & Dayhew 2001; Nevitt et al. 1989) and one study found that individuals with diplopia and strabismus had higher odds of having a fall (Pineles et al. 2015). There is no study to date investigating the role of binocular vision specifically prism fusion range and falls. Reduced prism fusion range can affect binocular control and in turn impact on stereoacuity. Lack of binocular control can also result in diplopia and potentially increase the risk of falls. Twice as many falls participants (n=18) reported diplopia compared to the non-falls participants (n=9) during the clinical investigation in my study. However, the difference did not reach statistical significance (p=0.09, Chi-square test) possibly due to the size of the sample. Fusion was absent for near or distance either due to poor acuity in one eye, the presence of a manifest strabismus or poor control of a latent strabismus. The base out range for distance fixation was the only fusional amplitude significantly reduced in the falls participants (Table 5.19).

Table 5.19: Prism fusion range (BO=base out and BI=base in) in falls participants vs non-falls participants excluding those who had no fusion, $^{*}p<0.05$

Prism fusion range(prism dioptres)	Falls participants		Non-falls participants		Wilcoxon signed-rank test	
Near (median) (quartiles)	**BO (n=83)**	**BI (n=83)**	**BO (n=83)**	**BI (n=83)**	**BO (n=83)**	**BI (n=83)**
	20 (12, 30)	12 (8, 14)	30 (14, 35)	14 (10, 16)	P=0.146	P=0.481
Distance (median) (quartiles)	**BO (n=83)**	**BI (n=83)**	**BO (n=83)**	**BI (n=83)**	**BO (n=83)**	**BI (n=83)**
	12 (8, 20)	6 (4, 6)	20 (12,25)	6 (4, 8)	P=0.012*	P=0.166

Loss of binocular control can result in diplopia or suppression and consequently lead to loss of stereoacuity. Stereoacuity has been shown to decline in older adults over the age of 60 years and as described in Chapter 2 can also be due to loss of monocular or binocular visual acuity. In the sample I examined, there was a significant association between stereoacuity (logSV) and the difference in acuity between the right and left eye for both near (Spearman's rank correlation=0.353, p<0.0001) and distance (Spearman's rank correlation= 0.334, p<0.0001). The scatterplots in Figure 5.9 and Figure 5.10 illustrate that the data are skewed towards the lower end of the scale as differences in acuity are generally less than +1.00 logMAR and therefore it is advisable to fit a regression line for data that is not normally distributed.

Figure 5.9: Scatterplot of stereoacuity vs difference in near VA between either eye (logSV-Log of stereoacuity)

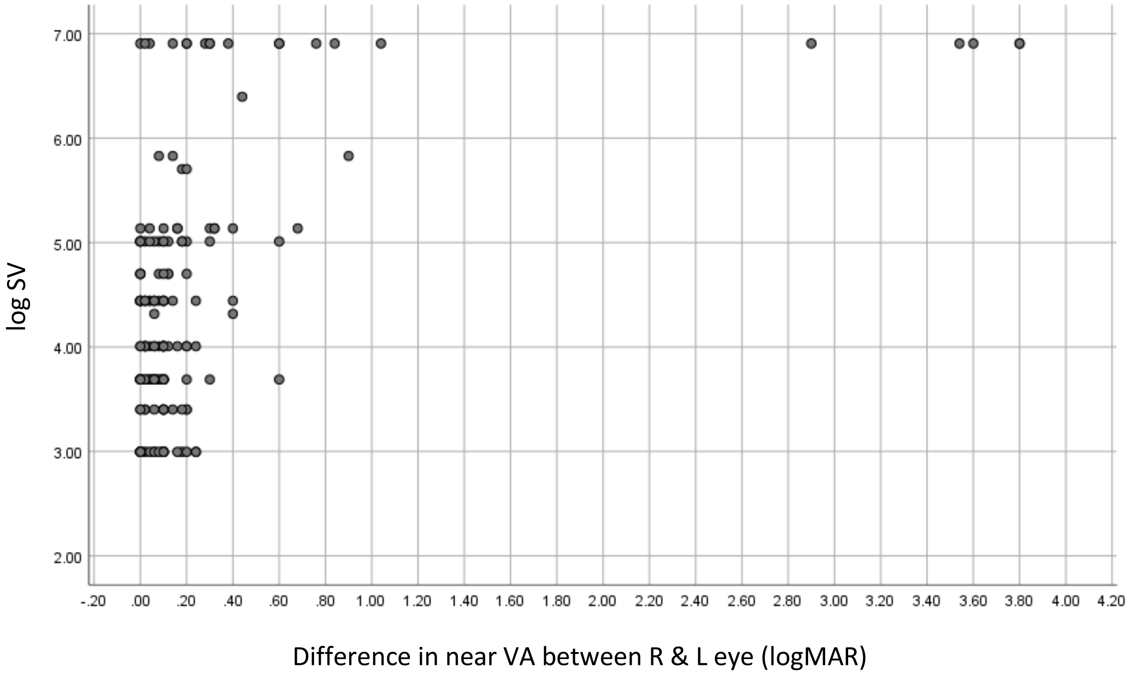
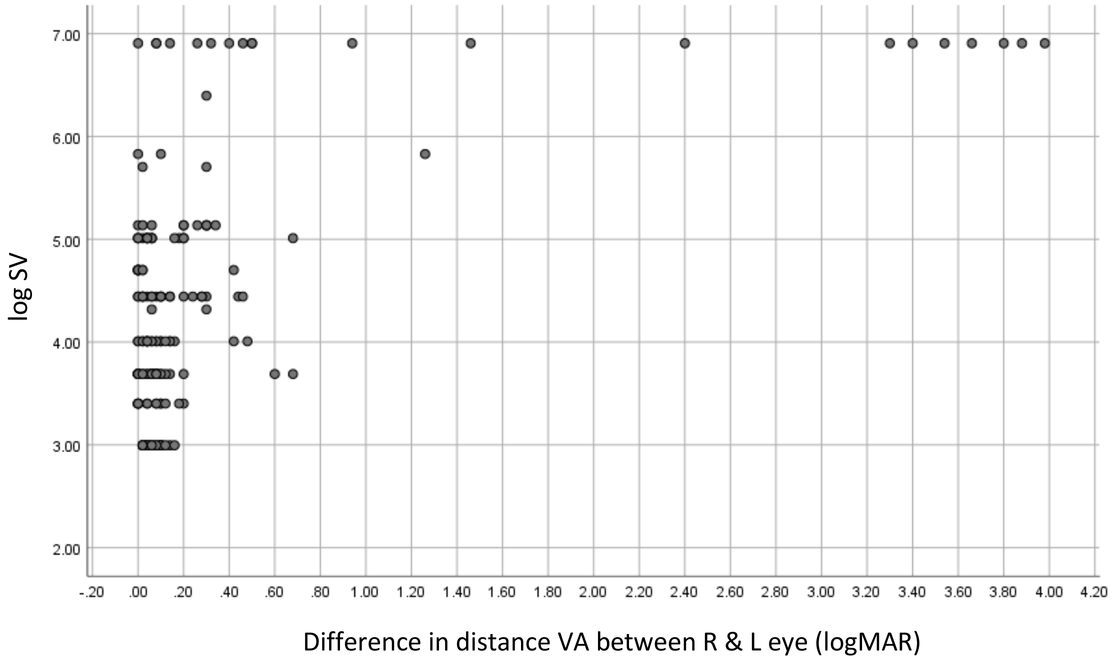


Figure 5.10: Scatterplot of stereoacuity vs difference in distance VA between either eye (logSV-Log of stereoacuity)



Of the total sample, 11 falls and 10 non-falls participants were unable to detect stereo with the Frisby. Therefore, these individuals were considered to be stereodeficient and were assigned an arbitrary value of '999' as the poorest measurable threshold on the Frisby test is 600" of arc. In the falls group, the main cause of being stereodeficient was poor monocular acuity either due to retinal disease (n=8), cataract (n=1), amblyopia (n=1) or poor binocular control (n=1). In the non-falls group, the causes for stereo-deficiency were similar although more individuals were amblyopic (n=5) (retinal disease, n=4 and ocular motility issue, n=1). As explained in Chapter 4 (Section 4.4.6) the value of 85" of arc was chosen as the cut-off for a normal threshold for stereoacuity. Fall participants had worse median stereoacuity compared to non-falls participants (Table 5.20, p=0.011, Wilcoxon signed-rank test) and a greater proportion had stereoacuity worse than 85" of arc (absolute difference 25%).

Table 5.20: Stereoacuity in falls participants (n=83) vs non-falls participants (n=83)

Stereoacuity (Frisby) (seconds of arc)	Falls participants	Non-falls participants	Significance
Median (quartiles)	85 (40, 170)	55 (30, 85)	P=0.011 Wilcoxon signed rank test
Participants achieving stereoacuity worse than 85" arc, n (%)	41 (49%)	20 (24%)	p=0.001 (Fisher's exact test)

5.3.5 Visual field

The Binocular Esterman visual field test was utilised to compare functional visual field loss between falls and non-falls participants. For analysis of the visual field, I used the DVLA standards to grade each participant's visual field as a 'fail' if they missed 4 or more adjoining points. I found no significant difference in the number of individuals who failed the Binocular Esterman visual field test (Table 5.21), hence suggesting that visual field deficits measured with the Esterman were not a risk factor associated with falls in this sample.

Table 5.21: Proportion of falls participants vs non-falls participants failing the Binocular Esterman visual field test

\`Binocular Estermann	Falls participants n (%)	Non-falls participants n (%)	Fisher's exact Test P-value
"Fail"- 4 or more adjoining points missed	14 (17%)	10 (12%)	0.51

5.3.6 Summary of the univariate analyses of visual function

Standard clinical tests were used to assess visual function to enhance the clinical applicability of these findings and to suggest clinical recommendations for the visual assessment of patients at risk of falls. In light of the evidence that the use of varifocals is associated with an increased risk of falls (Davies et al. 2001; Lord, Dayhew & Howland 2002), it was surprising that in my study the use of varifocals was not associated with falls and instead a greater proportion of the falls participants had single vision glasses.

The falls participants had statistically significant reduced visual function namely visual acuity, contrast sensitivity, stereoacuity and base-out prism fusion range for distance when compared to the non-falls participants. The difference in VA between the two groups was not clinically significant being less than 0.1 logMAR for distance and just over for near. However, there was a significant difference in the number of falls and non-falls participants who failed to achieve better than 0.3 logMAR in their better eye. Similarly, contrast sensitivity was impaired in falls participants at each spatial frequency but more clinically and statistically significant differences were found at the higher spatial frequencies (12 and 18 cpd). Almost half of the falls participants had stereoacuity worse than 85” of arc which is clinically significant based on the normative values for this population reported in Chapter 2. Stereoacuity levels became worse as the difference in logMAR VA between either eye for near and distance increased. Further work is needed to identify the level of reduction in stereoacuity at which locomotion and gait are affected. Whilst the distance BO prism fusion range was significantly reduced in falls participants, the clinical significance needs to be considered alongside a measurement of their ocular misalignment to draw any conclusions on the significance of this result.

In the next section, I will describe further analyses of these findings using univariate and multivariable logistic regression statistics. This will allow me to build logistic regression models to determine the best fitting model which is biologically plausible. The models will describe the relationship between a fall or non-fall outcome and all the explanatory variables measured in this study and allow for the adjustment of confounding factors.

5.4 Multivariable adjusted analysis of the risk of falling with respect to visual function

The previous sections focused on the univariate comparison of each single measured variable between the falls and non-falls participants. Here I will explore the association between the main visual function risk factors (Table 5.22) while adjusting for the significant demographic and non-visual function variables summarised in Table 5.23.

Table 5.22: Significant visual function variables when compared across falls participants and non-falls participants (p<0.05) (Univariate analysis)

Visual function variables	Falls participants (n=83)	Non-Falls Participants (n=83)	P value (statistical test)
Better eye logMAR VA - 6m (mean±SD)	0.16±0.23	0.07±0.14	0.004 (Paired samples t-test)
Better eye VA- 1/3m (mean±SD)	0.25±0.45	0.14±0.16	0.04 (Paired samples t-test)
Pelli-Robson contrast sensitivity-Both eyes median(quartiles)	1.65 (1.35, 1.80)	1.65 (1.35, 1.80)	0.006 (Wilcoxon signed-rank test)
CSV-1000E log units Both eyes 3 cpd median (quartiles)	1.63 (1.49, 1.78)	1.63 (1.56, 1.78)	0.009 (Wilcoxon signed-rank test)
CSV-1000E log units Both eyes 6 cpd median (quartiles)	1.70 (1.38, 1.84)	1.84 (1.7, 1.99)	<0.0001 (Wilcoxon signed-rank test)
CSV-1000E log units Both eyes 12 cpd median (quartiles)	1.08 (0.61, 1.40)	1.40 (1.25, 1.54)	<0.0001 (Wilcoxon signed-rank test)
CSV-1000E log units Both eyes 18 cpd median (quartiles)	0.64 (0.17, 0.81)	0.96 (0.47, 1.10)	<0.0001 (Wilcoxon signed-rank test)
Prism fusion range- 6m BO amplitude median (quartiles)	12 (8, 20)	20 (12,25)	0.012 (Wilcoxon signed-rank test)
Stereoacuity	85 (40, 170)	55 (30, 85)	0.011 Wilcoxon signed-rank test

Table 5.23: Significant demographic and non-visual variables when compared across falls participants and non-falls participants (p<0.05). All analyses were univariate.

Demographic variables	Falls participants (n=83)			Non-Falls participants (n=83)			P-value (statistical test)
Income deprivation affecting older people index (IDAOPI) decile median (quartiles)	2 (1, 4)			6 (2, 8)			<0.001 (Wilcoxon signed rank test)
Walking aid (%) (A-always, O-occasionally, N-never)	A	O	N	A	O	N	0.01 (Chi-square)
	16	27	58	4	12	84	
TUTG test (mean±SD)	10.8±4.9			7.2±2.1			<0.001 (paired samples t-test)
FES score (mean±SD)	33±14.1			21±6.7			<0.001 (paired samples t-test)
Number of pre-specified co-morbidities (% with ≥2)	59%			32.5%			0.011 (Wilcoxon signed rank test)
Hearing impairment	38.6%			13.2%			<0.001 (Chi-square)
Taking 4 or more medications	62.7%			33.7%			<0.001 Chi-square
Socialise out of the home no. of days Median (quartiles)	5 (3,6)			6 (5,7)			P<0.001 (Wilcoxon signed rank test)
RAPA Physical activity score median (quartiles)	4 (1,7)			6 (3,9)			P<0.001 (Wilcoxon signed rank test)
EQ-5D VAS score (mean±SD)	53±21			84±15.4			P<0.001 (paired samples t-test)

I initially performed a univariate logistic regression to demonstrate whether a fall is associated with each explanatory variable separately reported in this study (Sections 5.4.1 and 5.4.2). This then allowed me to construct a multivariable logistic regression model to describe the relationship between falls and the significant explanatory variables (Section 5.4.3). I took an epidemiological approach to the selection of the explanatory independent co-variates to enter into the model. Therefore, I used a directed acyclic graph (DAG) (Greenland, Pearl & Robins 1999) to select the biologically plausible covariates from this study to determine the relationship between reduced visual function and falls. I then determined the significant visual and non-visual risk factors associated with a fall in separate models before constructing the final model which contained the key visual and non-visual risk factors for falls. Further details of the statistical analysis are in the methods Chapter 4, Section 4.4.4.

5.4.1 Univariate logistic regression of non-visual variables associated with falls

First, I employed a univariate logistic regression analysis to independently consider the significant non-visual variables associated with falls (Table 5.24). All the non-visual covariates remained significant, though the odds ratio was > 1 for using a walking aid, FES-I, TUTG, hearing impairment, number of pre-specified co-morbidities and taking more than 4 medications indicating a greater risk of a fall when the individual has each of these variables. Whereas for IDAOPI, socialising out of the home, RAPA and EQ-5D VAS score all indicate that a 1 unit move to a positive outcome (e.g. moving to a less deprived area, socialising more, doing more physical activity and better quality of life) reduces the risk of falling by 24%, 28%, 30% and 9% respectively.

Table 5.24: Non-visual significant risk factors associated with falls from univariate logistic regression analyses, at the level of significance of 0.05
($Reference category for walking aid was 'Never') (β-coefficient of the constant, se-standard error, e^{β}-exponentiation of the B coefficient i.e. odds ratio, CI-confidence interval)

Variable		β	se(β)	e^{β} (odds ratio)	95% CI	P-value
Income affecting deprivation in older people (IDAOPI)		-0.28	0.06	0.76	0.67-0.85	<0.001
Walking$ aid use	Always	1.84	0.67	6.32	1.71-23.37	0.006
	Occasionally	1.17	0.43	3.21	1.40-7.38	0.006
FES-I		0.12	0.02	1.13	1.08-1.18	<0.001
TUTG		0.44	0.08	1.55	1.32-1.83	<0.001
Hearing impairment		1.41	0.40	4.11	1.90-8.90	<0.001
No. of pre-specified co-morbidities		0.35	0.14	1.42	1.08-1.88	0.012
Taking ≥ 4 medications		1.19	0.33	3.30	1.74-6.23	<0.001
Socialising out of the home		-0.32	0.09	0.72	0.60-0.87	<0.001
RAPA		-0.47	0.11	0.63	0.50-0.78	<0.001
EQ-5D VAS score		-0.09	0.01	0.91	0.89-0.94	<0.001

Next, I examined the most significant non-visual variables associated with falls when they are all considered together in the same model using multivariable logistic regression analysis. FES-I, TUTG and EQ-5D were not entered into the multivariable logistic regression model as all of these measures were recorded post-fall and therefore may have been affected by the fall. The remaining 7 co-variates were then entered into a multivariable logistic regression analysis model (Model 1, Table 5.25) to identify the combination of demographic variables that were associated with a fall. This model indicates that participants who come from an area of poor income deprivation, have a hearing impairment, participate less in social activity out the home and were less physically active are at a statistically significantly greater risk of having a fall ($p<0.05$, logistic regression). Specifically, if an individual moved up one decile i.e. to a less deprived area, socialised out of the home more by 1 day/week, and increased their physical activity score by 1, their risk of having a fall decreased by 24%, 22% and 25% respectively. Furthermore, they were 3.5 times more likely to have a fall if they had a hearing impairment. These results are consistent with the univariate analyses.

Table 5.25: Model 1-Significant non-visual risk factors regression model ($p<0.05$) (β-coefficient of the constant, se-standard error, e^{β}-exponentiation of the B coefficient i.e. odds ratio, CI-confidence interval)

Variable	β	se(β)	e^{β} (odds ratio)	95% CI	p-value
Income affecting deprivation in older people	-0.29	0.07	0.75	0.66-0.86	<0.001
Hearing impairment	1.26	0.43	3.51	1.50-8.22	0.004
Socialising out of the home	-0.23	0.12	0.78	0.63-0.99	0.04
RAPA	-0.41	0.14	0.66	0.51-0.87	0.003

5.4.2 Univariate logistic regression of visual function variables associated with falls

I entered all visual function variables into a univariate logistic regression analysis in their original measurement scale except the stereoacuity values (Table 5.26). I decided to log-transform these values as they were highly skewed with the stereodeficient individuals assigned an arbitrary value of '999' seconds of arc. Log transformation did reduce the skewness from 2.061 (original stereoacuity measures) to 0.887 (log-transformed stereoacuity) but it did not make the data normally distributed (Figure 5.11 and Figure 5.12).

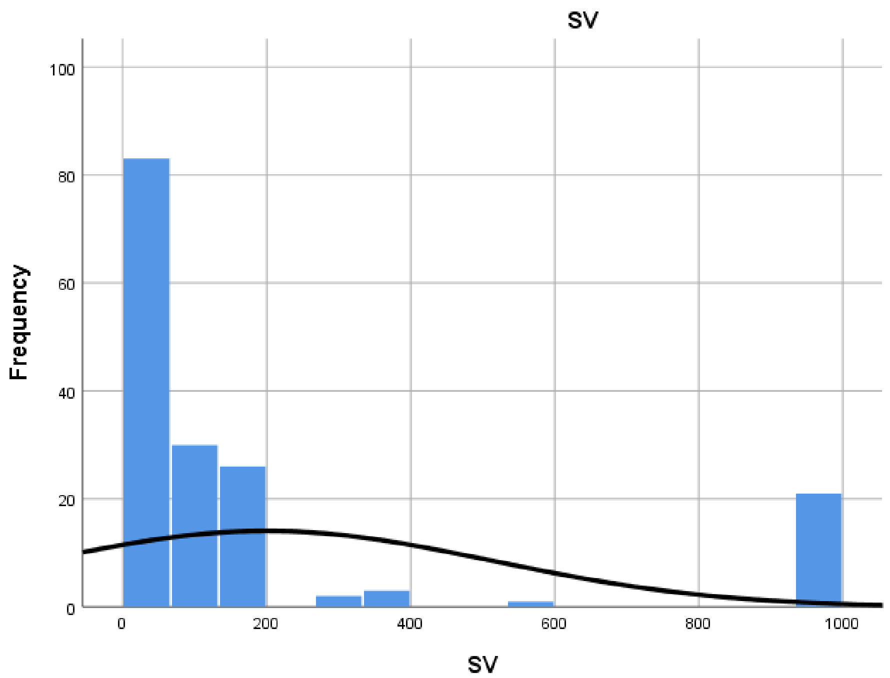


Figure 5.11: Histogram and distribution curve of stereoacuity measures

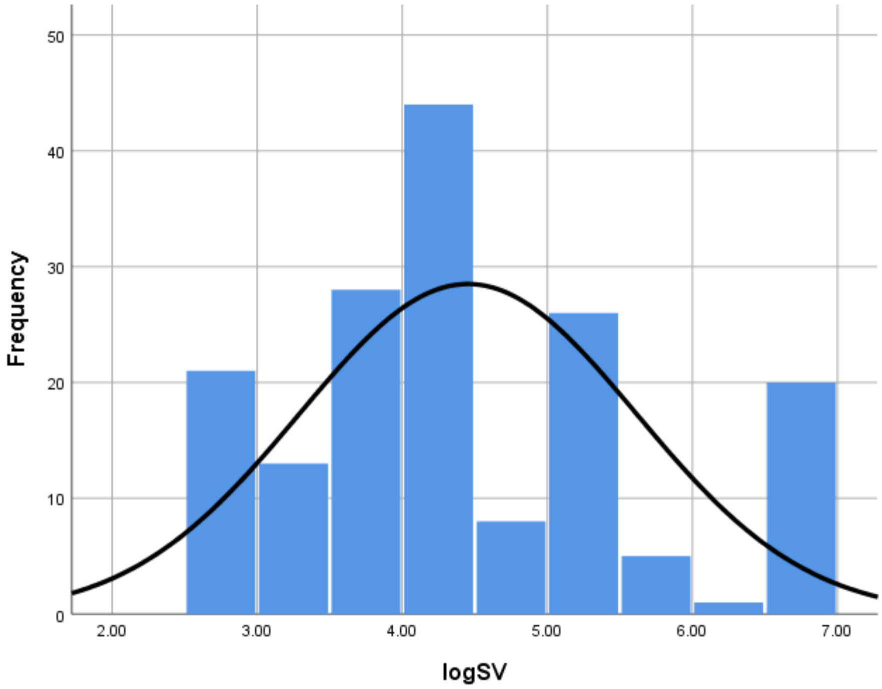


Figure 5.12: Histogram and distribution curve of log stereoacuity measures

I also ran the univariate logistic regression analysis of the stereoacuity data using the categories: no stereopsis demonstrable (=0), stereopsis outside normal limits (110-600"=1) and stereopsis within normal limits (85-20" =2). All visual function covariates remained significant, however, VA in the better eye for near and distance had very wide 95% confidence intervals albeit they were both significant.

Table 5.26: Significant visual function risk factors associated with falls from univariate logistic regression analysis

Variable	β	se(β)	e^{β} (odds ratio)	95% CI	p-value
Better eye VA- 6m	3.31	1.2	27.43	2.66-282.407	0.005
Better eye VA- 1/3m	2.62	1.08	13.78	1.66-114.43	0.02
Pelli-Robson contrast sensitivity Both eyes	-2.07	0.92	0.13	0.02-0.76	0.02
CSV-1000E Both eyes 3 cpd	-1.62	0.70	0.20	0.05-0.78	0.02
CSV-1000E Both eyes 6 cpd	-2.63	0.66	0.07	0.02-0.27	<0.001
CSV-1000E Both eyes 12 cpd	-2.39	0.52	0.09	0.03-0.26	<0.001
CSV-1000E Both eyes 18 cpd	-2.56	0.54	0.08	0.03-0.23	<0.001
Prism fusion range	-0.05	0.02	0.95	0.92-0.99	0.007

6m BO					
Log stereoacuity	0.410	0.145	1.51	1.13-2.00	0.005
Stereoacuity outside of normal limits (110”-600”)	1.50	0.42	4.5	1.99-10.17	<0.001

5.4.3 Multivariable model for the association between falls and vision while adjusting for confounders

The main aim of the quantitative component of my study was to investigate the association between reduced visual function and falls whilst adjusting for covariates that are potential risk factors for falls. To build the final model I used three principle strategic steps:

1. Since there were a number of variables, to avoid overfitting due to many significant visual function variables (visual acuity, contrast sensitivity, stereoacuity, prism fusion range), I introduced a new visual function variable -‘Reduced visual function’.
2. I used DAG (Directed Acyclic Graph) and an epidemiological approach in variable selection, which is preferable to arrive at interpretable clinically meaningful models.
3. used automated forward stepwise selection procedure to select the non-visual variables.

The ‘Reduced visual function’ variable was created whereby if the participant demonstrated an abnormal result in any of the associated visual functions they were deemed to have a visual function deficit. The criteria used for each visual function to be deemed ‘reduced’ was as follows:

- Visual acuity (6m) ≥ 0.3 logMAR
- Pelli-Robson with Both eyes open (BEO)< 1.65 log units
- CSV 1000E 3cpm (BEO)≤ 1.41 log units
- CSV 1000E 6cpd (BEO) ≤ 1.635 log units
- CSV 1000E 12cpd (BEO) ≤1.35 log units

- CSV 1000E 18cpd (BEO) ≤0.68 log units
- Stereoacuity > 85" of arc log units

To facilitate the choice of the appropriate covariates to enter into the logistic regression model with 'fall' as the outcome and 'Reduced visual function' as the exposure, I employed the use of a DAG to create a causal diagram (Greenland, Pearl & Robins 1999) (Figure 5.13). Fear of falling and TUTG were not entered into the model as deficits in both of these measures can be a consequence of the fall or a contributing risk factor and can be seen in the diagram as having a bi-directional arrow to illustrate the relationship.

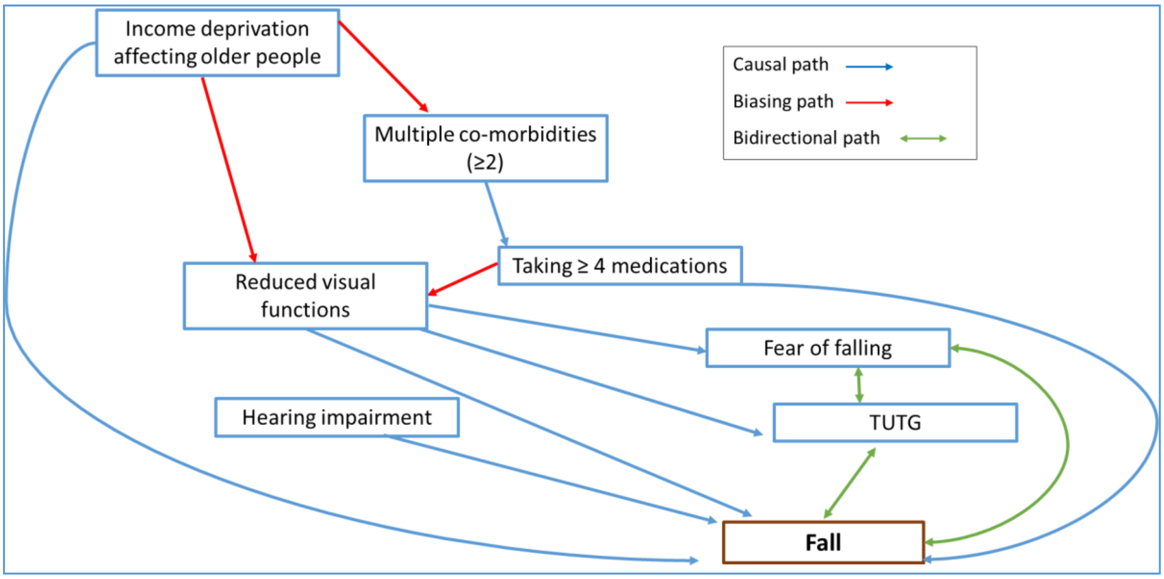


Figure 5.13: Directed acyclic graph (DAG) demonstrating the causal pathways of a fall using the covariates measured in this study

The covariates 'reduced visual function', 'IDAOPI', 'no. of pre-specified comorbidities', 'taking 4 or more medications' and 'hearing impairment' were entered using a 'forward stepwise selection' into a multivariable logistic regression model. Both sensory impairments, hearing and vision, were found to be significant predictors of a fall along with income affecting deprivation in older people (

Table 5.27).

Table 5.27: Multivariable logistic regression model illustrating significant risk factors for a fall Covariates entered into the model included: reduced visual function, income affecting deprivation in older people, no. of prespecified comorbidities, taking 4 or more medications and hearing impairment.

Variable	β	se(β)	e^{β} (odds ratio)	95% CI	p-value
Income affecting deprivation in older people	-0.25	0.06	0.78	0.69-0.88	<0.001
Hearing impairment	1.16	0.43	3.18	1.36-7.40	0.007
Reduced visual function (VA or CS or Stereo)	1.25	0.39	3.49	1.64-7.45	0.001

However, including 'Reduced visual function' as a covariate which includes deficits in VA, CS and stereoacuity, does not identify the specific visual function measures that are predictors of a fall. Hence, I used a 'forward stepwise' selection of all the significant covariates from Table 5.26 (significant visual risk factors) to build multivariable regression models of the visual function variables (Model 2, Table 5.28). Two visual function variables were found to be the strongest predictors for falls, contrast sensitivity measured at 18 cpd and stereoacuity outside of the normal limits i.e. >85" of arc (coded as a categorical variable).

Table 5.28: Model 2-Significant visual function risk factors regression model (p<0.05)

Variable	β	se(β)	e^{β} (odds ratio)	95% CI	P-value
CSV-1000E Both eyes 18 cpd	-2.81	0.66	0.06	0.02-0.22	<0.001
Stereoacuity outside of normal limits (110"-600")	0.90	0.45	2.47	1.02-5.98	0.045

Finally, a combined model (Model 3, Table 5.29) was built from the remaining significant covariates of model 1 and 2 to determine the association of specific visual functions after adjusting for other significant covariates. Impairments in contrast sensitivity, stereoacuity and hearing along with income deprivation and infrequent social activity outside of the home remained as significant predictors for falls in this sample.

Table 5.29: Model 3-Combined multivariable regression model of non-visual and visual function variables

Variable	β	se(β)	e^{β} (odds ratio)	95% CI	P-value
Income deprivation affecting older people index	-0.30	0.07	0.74	0.64-0.86	<0.001
Hearing impairment	1.24	0.46	3.44	1.39-8.54	0.008
Socialising out of the home	-0.29	0.11	0.75	0.60-0.93	0.01
CSV-1000E log units- Both eyes 18 cpd median	-2.23	0.76	0.11	0.02-0.48	0.003
Stereoacuity outside of normal limits (110"-600")	1.23	0.53	3.4	1.20-9.69	0.02

5.4.4 Summary of the logistic regression analyses

Univariate logistic regression of the visual and non-visual variables revealed all those that were statistically significant in univariate parametric and non-parametric analyses in Section 5.2 and 5.3. When I entered all the non-visual covariates into a multivariable logistic regression model (Model 1-Table 5.25), I found that there are increased odds a further fall in older adults (≥60 years) who come from lower areas of income deprivation, have a hearing impairment, are reluctant to socialise out of the home and take part in physical activity (Table 5.25, multivariable logistic regression). With the use of the DAG (Directed Acyclic Graph) (Figure 5.13), I was able to select (five) plausible explanatory covariates to enter into a model but was required to create a variable – 'Reduced visual function'. IDAOPI, hearing impairment and reduced visual functions were significant risk factors. However, of the reduced visual functions, the key predictors of a fall were reduced contrast sensitivity at 18cpd and stereoacuity worse than 85" of arc the normal threshold chosen for older adults (Model 2-Table 5.28). The combined model (Model 3-Table 5.29) of the significant visual and non-visual co-variates did not include the effect of reduced physical activity as other covariates explained the variability in the risk of a fall but it still remains a risk factor. Hence, there are key predictors of fall that are extrinsic and intrinsic to an individual: income deprivation affecting older people, socialising out of the home, reduced contrast sensitivity, impaired stereoacuity and hearing.

5.5 Discussion of quantitative analyses

In this observational individually age-matched case-control study falls participants had reduced measures of visual function: visual acuity, contrast sensitivity and stereoacuity compared to the non-falls participants. Visual and non-visual risk factors were significantly associated with the risk of a further fall in the multivariable logistic regression model after adjusting for confounding variates. Whilst VA was statistically significant at the univariate level, it was not significant when adjusted for in the multivariable regression model. A 4.5 letter difference in visual acuity between the falls and non-falls groups, although statistically significant is not clinically significant in terms of functional vision. However, the increased number of individuals with visual acuity equal to or worse than +0.30 logMAR in the better eye in the falls group is of clinical significance. This level of VA indicates a 3 line reduction (15 letters) from 0.00 logMAR. Legood, Scuffham and Cryer (2002) in their review of published studies reported that individuals with reduced VA were 1.7 times more likely to suffer a fall. Poor spatial contrast sensitivity (measured at 18 cpd) and impaired stereoacuity (worse than 85" of arc) remained as key visual risk factors for further falls. These are in agreement with the findings of a critical review of studies examining the association of visual risk factors and falls (Lord 2006).

Poor contrast sensitivity measured with the MET (Melbourne Edge Test) has been reported to be independently associated with postural instability (Lord, Clark & Webster 1991) slower walking velocity, increased step width and reduced stride length (Wood et al. 2009). There are fewer studies that have investigated contrast sensitivity at different spatial frequencies (de Boer et al. 2004; Ivers et al. 1998). Following adjustment for confounders, these studies found lower spatial frequencies at 3, 6 and 12 cpd (Ivers et al. 1998) and 1.5 and 3 cpd (de Boer et al. 2004) to be significant risk factors for falls. While the falls participants in this study had significantly reduced CS across all measures (Pelli-Robson and CSV-1000E), contrary to previous studies, only CS measured at 18cpd was a risk factor for falls after adjustment for confounders. CS at higher spatial frequencies relates to the individual's ability to see fine detail at lower contrast levels. Impaired contrast sensitivity impacts on functional vision particularly when negotiating an environment full of varying contrasts and detail. In the case of falls, individuals are required to negotiate outdoor pavements, steps and varying levels of walking surfaces which may alter in contrast if they are not uniform and flat. Similarly, stereoacuity or depth perception is utilised to judge distances and judging depth of kerbs and steps. The main cause of fall reported in this study was a 'trip' and stereoacuity was found to be a significant risk factor.

Stereoacuity has been measured using several different tests in falls studies and various measures have been reported as thresholds for being a significant risk factor (Chapter 2, Table 2.6). Lord and Dayhew (2001) reported stereoacuity levels ≥ 215" arc as a significant risk factor in their study. However, I selected ≥110" arc as the threshold for abnormal stereoacuity based on published normative data for older adults. Impaired stereoacuity has been reported to be associated with monocular blur (Odell et al. 2009a; Vale, Buckley & Elliott 2008). This suggestion is supported by the findings of my study where I have demonstrated a significant relationship between stereoacuity and difference in VA between either eye for near and distance. Appreciating depth relies on having good oculomotor control and is achieved by motor and sensory fusion. Prism fusion range (PFR), a measure of binocular vision, was significantly reduced for the base out range for the distance only in the falls participants. Yekta, Pickwell and Jenkins (1989) and Pickwell, Kaye and Jenkins (1991) found a higher prevalence of near exophoria in adults up to 65 years, so the base out range would be expected to be reduced for near rather than the distance. Reduced positive fusional amplitude could suggest that the participants in the falls group were using this to control their latent exo deviation in the distance.

Non-visual predictors for a further fall, included older adults who live in some of the more deprived areas of Liverpool, have a hearing impairment and take part in less social activity outside of the home. Limited studies have examined the impact of socioeconomic inequality specifically on falls (Ahmad Kiadaliri, Turkiewicz & Englund 2018; Gotsens et al. 2013), and none in England. Marmot (2010) highlighted the impact of an individual's social and economic status on health inequalities which can arise due to many interactional factors e.g. housing, income, education, social isolation and disability. In this study, older adults from more deprived areas was a key risk factor that remained in the model over multiple co-morbidities and polypharmacy which are variables that contribute to the health profile of individuals from more disadvantaged areas.

The association of hearing impairment and falls is consistent with other studies (Gopinath et al. 2016; Kamil et al. 2016; Lin & Ferrucci 2012). Although here I have relied on self-reported hearing loss, the likelihood is that it has been underestimated. When probable explanatory covariates were entered into a model, impaired hearing and reduced visual functions along with income deprivation were the key risk factors associated with falls. This finding is supported by a study (Gopinath et al. 2016) which investigated the association between dual sensory impairment and incidence of falls and found that those with co-existing mild hearing loss and best-corrected visual impairment had higher odds of incident falls. However, this association did not persist after they excluded individuals with cognitive impairment.

People with large social networks have better health (Berkman & Syme 1979) and it has been reported that loneliness is an independent risk factor for physical inactivity (Hawkley, Thisted & Cacioppo 2009). In Model 1, the level of physical activity was a significant risk factor but did not persist in the final model. However, physical activity can be related to socialising out of the home which was a significant risk factor in the final model.

The falls sample in this study had significantly more females which is corroborated by previous studies (Chang & Do 2015; Gale, Cooper & Aihie Sayer 2016; Stevens & Sogolow 2005). Curtis et al. (2016) examined fracture incidence stratified by age, sex, geographic region, ethnic group and socioeconomic status in the UK during 1988-2012. They found that the fracture rate reduced in men aged 50+ compared to those aged 18–49 years whereas the rate almost tripled in women 50+ years compare to the younger group. Gale et al. (2018) investigated whether different risk factors for falls differed in men and women and found that more depressive symptoms, incontinence and never being married were factors predictive of falls in women. In this study, I did not find any significant risk factors associated with the higher preponderance of females in the falls group.

The analyses in this chapter illustrate that the combination of social (income deprivation affecting older people), behavioural (socialising out of the home) and biological (reduced contrast sensitivity, stereoacuity and hearing) determinants are significant predictors of a fall. All of these predictors are amenable to intervention. Reducing health inequalities is a public health issue and Public Health England have published a resource for local government to implement specific interventions for different levels of risk, impact over time and across the life course to tackle health inequalities (Public Health England 2017). Encouraging physical activity and social prescribing should form part of every health professional's conversation with adults at risk of becoming sedentary and socially isolated (Public Health England 2019b). The biological risk factors, depending on the cause are also modifiable. For example, hearing aids to improve hearing and cataract surgery in both eyes has been reported to improve contrast sensitivity and stereoacuity (Elliott et al. 2000; Laidlaw et al. 1998). In Chapter 9 I will discuss the clinical implications of these findings for falls assessment and prevention strategies.

Chapter 6 Seeing sight

6.1 Introduction

In the following chapter, I aim to bridge the findings from the quantitative and qualitative phases of the study to add depth and an understanding of the visual findings as perceived and articulated by the participants. A phenomenological approach to the interviews allowed me to seek the opinion and personal accounts and interpretations of the participants (Gray 2004, p. 28). As highlighted in Chapter 4, the phenomenological theoretical perspective of Merleau-Ponty (1962) and van Manen (1997) has informed my thinking and analysis in the qualitative phase of this study. In line with Merleau-Ponty's view on phenomenology and the embodied experience (Merleau-Ponty 1962), the participant's in my study are perceiving, feeling and thinking within a meaningful context. Therefore, being sensitised to the phenomenology of perception (Merleau-Ponty 1962), I illustrate the participant's experiences of perceiving sight within the context of their lives and their perspective on the role of vision in falls. The phenomenological approach of van Manen (1997) was applied to each of the interviews whereby each transcript was read to gain an overall understanding of the participant's experience of their sight and the fall and then further explored specifically for the themes on sight.

The key features of qualitative research and implications for analysis is that it allows openness to new directions as new information emerges as well as the 'insider viewpoint and seeing things from the participant's perspective' (Bazeley 2013, p. 27). It has enabled me to gain additional insight into the lived experience of people living with age-related sight conditions alongside their clinical data. It is important to understand an individual's perception of their functional vision to develop appropriate information and strategies to limit the impact of their condition on everyday activities.

The clinical assessment of the participants in the quantitative phase of the study clearly demonstrated that visual function in the falls group was impaired compared to the non-falls group, but of particular significance was impaired depth perception in the falls group. Depth perception (otherwise known as stereovision) has been reported to be important for walking, stepping over obstacles and walking around objects (Hayhoe et al. 2009). Impaired stereoacuity has been demonstrated in patients with moderate to severe visual field defects due to glaucoma (Lakshmanan & George 2013) and also in patients with AMD and cataracts (Manoranjan, Shrestha & Shrestha 2013; Verghese et al. 2016). However, depth perception is not a test that is routinely tested in ophthalmological practice or addressed during a consultation (personal experience). Owing to the results of the quantitative phase I was sensitised to the importance of depth perception during the interviews when I asked the participants to describe their sight.

There are very few studies published on how individuals with ophthalmic conditions describe their own sight. Douglas et al. (2010) interviewed a large number of participants with registered visual impairment (n=1007) with two surveys over an 18-month period to gather information about their opinions of their visual impairment and experiences in eye clinics. Although this study was useful to gain an insight into the information and support that visually impaired people would find beneficial, it did not provide any description of the nature of sight impairment from the participant's perspective. Only two studies have been published to describe the patient's perspective of vision loss in dry AMD (Taylor et al. 2018) and visual field loss in glaucoma (Crabb et al. 2013). Therefore, in this chapter, I will initially introduce the participants enrolled in the qualitative phase of this study along with their VA of either eye and depth perception clinical data. I will follow this with qualitative evidence to support the contention that depth perception and difficulties with lighting are key visual correlates affecting participants in their daily living. In addition, I will discuss visual difficulties, colour, contrast and visual fields which also featured to a smaller extent in the participant's lived experience of living with an age-related sight condition. Throughout the chapter, I will draw on any similarities or differences of experiences between participants with cataracts, AMD and glaucoma.

Based on my thematic analyses of the lived embodied experiences of participants with age-related sight conditions, depth perception and difficulties with lighting were the main themes which emerged from the data. Therefore, I posit that owing to the quantitative and qualitative evidence particularly for depth perception and lighting that they are considered pivotal concepts associated with falls in older adults and considered in the falls preventions strategies.

6.2 Descriptive data of participants with sight loss

In order to understand the participant's experience of their sight, I will introduce each of them to give the reader a contextual understanding of their lived experience. Hence, in this section, I will present a short introduction for each of the participants and a table with their essential visual data (Table 6.1). Participants in the qualitative phase of the study where possible were recruited from the quantitative phase of the study (N=17) and the remaining participants were recruited from St. Paul's Eye Unit (N=13) (see Chapter 4). The majority of the interviews in the qualitative phase were conducted subsequent to the quantitative phase. Impaired depth perception was one of the key risk factors determined from the multivariable regression analysis in the quantitative phase (Chapter 5). Hence, before commencing the interview, I measured the depth perception of every participant who was not recruited from the quantitative phase. Each participant was given a unique code which consists of a number, the participants' initials, a letter G, C or M indicating whether they had glaucoma, cataract or AMD respectively and either 'F' for a falls participant or 'VI' for a non-falls participant who had been recently diagnosed with their sight condition. They have been given a pseudonym to protect their identity and will be referred to by this name throughout the remaining chapters. Table 6.1 illustrates the descriptive data of the participants in the qualitative phase of the study along with a diagnosis of their sight condition, visual acuity and depth perception results. More participants in the falls group had no depth perception (n=5) and either poor vision in both eyes or one compared to the recently diagnosed participants in this phase of the study. Two participants (Jacqui- 004JWMF and Tessa 009TJDRF) were registered blind.

Table 6.1: Visual data of participants in the qualitative phase of the study (RVA=Right Visual Acuity, LVA=Left Visual Acuity)

Falls participants with an age-related ophthalmic condition							Non-falls participants with a recently diagnosed age-related ophthalmic condition						
Participant code-Name	Age	Gender (F/M)	Age-related ophthalmic condition	RVA logMAR	LVA logMAR	Frisby (seconds of arc)	Participant code-Name	Age	Gender (F/M)	Age-related ophthalmic condition	RVA logMAR	LVA logMAR	Frisby (seconds of arc)
001MHCF-Marg	79	F	Cataract	0.40	0.90	Nil	001WBCVI-Wendy	79	F	Cataract	0.18	0.3	Missing
002MMGF-Mary	74	F	Glaucoma	0.28	0.30	150	002LHMVI-Lizzie	61	F	AMD	0.22	-0.08	Nil
003JHMF-Joan	74	F	AMD	0.80	0.80	Nil	003DKCVI-David	77	M	Cataract	0.18	0.00	40
004JWMF-Jacqui	85	F	AMD	1.60	PL	Nil	004ISMVI-Isaac	67	M	AMD	0.00	0.48	85
005BCMF-Betty	87	F	AMD	0.2	0.62	Missing	005JMMVI-Julian	71	M	AMD	0.00	0.48	340
006JKGF-Jenny	70	F	Glaucoma	0.00	0.20	170	006JCMVI-Jackie	71	F	AMD	0.48	0.10	Nil
007JACF-Joanne	74	F	Cataract	0.20	0.50	170	007JSGVI-Jenny	65	F	Glaucoma	0.14	-0.06	170
008GMacGF-Glenda	60	F	Glaucoma	0.02	0.14	55	008PWGVI-Paula	71	F	Glaucoma	0.00	0.48	Nil

009TJDRF-Tessa	67	F	Diabetic Retinopathy	1.00	1.78	Nil	009KHCVI-Kevin	74	M	Cataract	0.14	0.04	20
010STMF-Sally	62	F	AMD	0.00	0.30	170	010BKCVI-Bronwyn	79	F	Cataract	0.00	0.42	55
011PMGF-Peter	86	M	Glaucoma	0.30	0.48	Nil	011AOCVI-Alice	76	F	Cataract	0.24	0.66	110
012JO'BCF-Jack	72	M	Cataract	0.10	0.26	150	012JBGVI-Jean	75	F	Glaucoma	0.20	0.20	150
013RMcSCF-Robert	71	M	Cataract	0.50	0.30	150	013BWGVI-Bob	69	M	Glaucoma	0.04	0.04	85
014JBGF-Joy	69	F	Glaucoma	0.18	0.48	Nil	014JCGVI-Janet	53	F	Glaucoma	0.00	0.00	85
015SGCF-Susan	68	F	Cataract	0.12	0.04	40	015FTMVI-Fred	77	M	AMD	0.10	0.00	85

In the brief description of each participant, I have included a comment on their vision, depth perception and FES-I (Falls Efficacy Score) and any relevant information from the case record form (non-visual data) e.g. quality of life, physical activity, family support which was pertinent to the individual. The descriptive information will contextualise the participant's experience of the fall and/or having an age-related sight condition. The FES-I score gives a quantitative measure of the participant's concern for having a fall as described in the methods chapter. I have focussed on highlighting this score to the reader as the aim of this study was to explore the fear of falling in participants with age-related sight conditions who had fallen and those who had not fallen since their diagnosis.

6.2.1 Falls participants with age-related sight conditions

Marg (001MHCF)

This 79 year-old woman had lost 2 husbands and was living on her own. She was still in employment, doing shift work at a supermarket and stewarding work at the weekend. She had experienced three falls and was waiting for her cataract to be removed in her left second eye. She did not wear any glasses, had below driving standard vision in each eye and had no demonstrable depth perception. Her FES-I score was 32 indicating that she had a fear of falling following her last fall which was on her way to work.

Mary (002MMGF)

Mary, a 79 year-old woman, lived on her own and had experienced a fall in her back garden. She had hardly left the house for 3 months since the fall and had a high score of 34 on her FES-I. She was diagnosed with glaucoma over 10 years ago and her condition was stable with medication. Her vision was driving standard level in both eyes but she had impaired depth perception. Both of her children lived close by and were able to support her.

Joan (003JHMF)

This 74 year-old woman attended the Clinical Eye Research Centre (CERC) for her interview and had a walking frame with wheels. She had macular degeneration and poor vision in both eyes with no demonstrable depth perception. She had experienced more than five falls in the past two years and was very fearful of falling

(FES-I score 46). She lived alone and had multiple co-morbidities. She rated her own health as being less than average and was ‘extremely’ anxious about her health on the EQ-5D.

Jacqui (004JWMF)

Jacqui, an 85 year-old widow with age-related macular degeneration, lived on her own with family close by. She had very poor vision in both eyes and no depth perception. She had experienced multiple falls (>5) and had a high FES-I score (45). She also had Charles Bonnet syndrome and regularly experienced visual hallucinations.

Betty (005BCMF)

This 87 year-old woman lived on her own with no family support close by and was in a wheelchair when I interviewed her in her home. She had macular degeneration with poor vision in her left eye. The depth perception test was not available to measure with Betty but the difference in vision between her eyes would predict it would be impaired. Her last fall was in the house.

Jenny (006JKGF)

Jenny was a 70 year-old woman with glaucoma and had experienced multiple falls (>5) and had a high FES-I score (44). She lived on her own and was supported by family and carers. She had multiple co-morbidities including diabetes and had experienced ill-health for a long period of time. Her vision in each eye was within acceptable limits but her depth perception was impaired.

Joanne (007JACF)

Joanne, 74 years old, lived with her spouse and was waiting for her first cataract (left eye) to be removed. She had experienced multiple falls and had the highest FES-I score of all the interviewed participants (62). She reported that the bones in her feet were fused which she felt prevented her from walking normally and therefore attributed her falls to this condition. Her vision was reduced in her left eye to below driving standard level and she also had impaired depth perception.

Glenda (008GMacGF)

Glenda, 60 years old, lived with her son and grandchild and was diagnosed with glaucoma in the last two years. Her husband was in a care home who she visited daily. Her sight and depth perception were within normal limits. She had experienced multiple falls (>5) and had a high FES-I score (45).

Tessa (009TJDRF*)*

Tessa, a 67 year-old female, gave up work through ill health 7 years ago. During the interview she informed me of her regular visits to the hospital for kidney dialysis. She had diabetic retinopathy in both eyes which affected her sight. Her vision was very poor in both eyes with no demonstrable depth perception. She lived on her own and had moved to assisted living accommodation. She had experienced 3 falls and had a high FES-I score (44).

Sally (010STMF)

This 62 year-old female had recently retired. She had been diagnosed with AMD and had a fall 15 months before I interviewed her. She was recruited from the CERC and not from the quantitative sample. She lived with her adult daughter. She scored 26 on the FES-I indicating a moderate concern for having a fall. Although the vision in both eyes was within acceptable limits, her left vision was worse than the right and she had impaired depth perception.

Peter (011PMGF)

Peter, 86 years old, lived at home with his spouse and had family close by. He had glaucoma and experienced a single fall approximately 2 years before I interviewed him. He had normal vision up until the age of 70 years. The vision in his better eye was driving standard but he was unable to appreciate depth perception. He scored 36 on the FES-I, which was completed with his wife, and had self-rated his health as above average on the EQ-5D.

Jack (012JO'BCF)

This 72 year-old man lived at home with his wife and was a keen cyclist. He had epilepsy and took more than 4 medications. He had the start of cataracts in both eyes and his vision was within driving standard limits although his depth perception was outside the normal range. Jack had the lowest possible FES-I score (16), indicating no fear of falling.

Robert (013RMcSCF)

Robert, aged 71 years, was still married but lived on his own, with family close by. He had the start of cataracts and had always had poor vision in his right eye from when he was young which potentially led to his impaired depth perception. He had experienced three falls and after his last fall had a score of 41 on the FES-I indicating a high concern for falls. He had recently reverted back to single vision glasses from varifocals as he felt they were the cause of his falls.

Joy (014JBGF)

This 69 year-old female lived with her spouse and adult child. She had glaucoma for approximately 23 years and poor vision in her left eye with no demonstrable depth perception. She had fallen multiple times and had a high FES-I score (34). Joy was recruited from St. Paul’s Eye Unit and not the quantitative sample.

Susan (015SGCF)

Susan, a 68 year-old female, had experienced a single fall in the last five years. She had the start of cataracts in both eyes but had experienced retinal tears in the past which were treated with laser. Her sight in both eyes and depth perception were within normal limits. She had a low score on the FES-I (19) indicating a low concern for having a fall.

6.2.2 Non-falls participants with age-related sight conditions

Wendy (001WBCVI)

This 79 year old female lived on her own with her daughter close by. She was recruited from St. Paul's Eye Unit when she attended an outpatient appointment to discuss having her second eye cataract removed. She also had dry AMD in her left eye but her vision in her worst eye (left) was driving test standard. The depth perception test was unavailable to test Wendy. Despite having had no falls she had a high score on her FES-I (42).

Lizzie (02LHMVI)

Lizzie, a 61 year old female, lived with her spouse. She was diagnosed with AMD in her right eye and a retinal condition (central serous retinopathy) in her left eye. Though her sight in each eye was driving test standard level, it was unequal and she was unable to demonstrate depth perception. She had a moderate concern for falls on the FES-I (27).

David (003DKCVI)

David, aged 77 years, lived with his wife in a bungalow. He had recently been diagnosed with the start of cataracts and at his outpatient appointment was also told that he had the start of dry AMD. His sight and depth perception were within normal limits. His FES-I score (18) indicated he was not concerned about having a fall.

Isaac (004ISMVI)

This 67 year old man lived with his wife. He had been diagnosed with dry AMD in his right eye and more recently with wet AMD in his left eye for which he was having injections. Isaac had cirrhosis of the liver and rated his health as being below average on the EQ-5D. His vision was below the driving standard in his left eye but was normal in his right eye. His depth perception was just within normal limits in this study. He had a moderate concern for falls on the FES-I (29).

Julian (005JMMVI)

Julian, a 71 year old man, lived with his spouse and family close by. He was having treatment for wet AMD in his left eye in the CERC. The vision in his right eye was normal and below driving test standard in his left eye and impaired depth perception. He had no concern for having a fall on the FES-I (16).

Jenny (006JCMVI)

This 71 year old female lived with her husband in an annexe attached to her son's house. She spent part of the year at her villa in Spain. She had AMD in her right eye and had no demonstrable depth perception. Despite not having had a fall since the diagnosis of her sight condition, she did have a high FES-I score (33). During the interview she recalled a fall she had many years ago prior to the onset of her sight condition which damaged her knees.

Julia (007JSGVI)

Julia was a 65 year old female and lived on her own. She had glaucoma and her right eye was affected but the sight was within normal standards for driving but she had impaired depth perception. She had very little concern for having a fall (FES-17) despite having experienced a fall prior to her diagnosis.

Paula (008PWGVI)

This 71 year old female lived with her second husband. She had glaucoma in her left eye, a long-standing history of poor vision in her left eye and had worn glasses since she was 3 years of age. Hence, she had never been able to appreciate depth. She was not concerned about having a fall on the FES-I (17).

Kevin (009KHCVI)

Kevin, a 74 year old male, lived with his wife and dog. He had the start of cataracts but had also been told by the optician that he had the start of macular degeneration in his right eye.   His sight in each eye was within normal limits and he achieved the best possible result on depth perception. He continues to work part time. He had very little concern for having a fall on the FES-I (18).

Bronwyn (010BKCVI)

This 79 year old female lived on her own in a single storey residential development for over 55s managed by a resident's association. She had the right eye cataract removed and was waiting to have her left removed. Her sight was reduced in her left eye but her depth perception was within normal limits. She had a slight concern for having a fall on the FES-I (21).

Alice (011AOCVI)

Alice, a 76 year old widow, lived on her own. She had the left cataract removed 2-3 years ago and was waiting for the right to be removed. She did not have a straight forward experience with her left cataract extraction and consequently her sight and depth perception were impaired. She had a fall prior to the onset of her sight condition many years ago and was not concerned about having a fall FES-I (18).

Jean (012JBGVI)

This 75 year old female lived with her husband in the ground floor apartment of a residential development. She had a history of a detached and torn retina and had both cataracts extracted. The sight in each eye was within normal limits but her depth perception was impaired. She had experienced a fall prior to the onset of her sight condition on a loose pavement. Jean had very little concern for having a fall on the FES-I (18).

Bob (013BWGVI)

Bob was a 69 year old male who lived on his own in a single storey bungalow and worked part-time. He had glaucoma, with a possible visual defect but normal vision and depth perception. He had experienced a fall but many years before the onset of his glaucoma. He had a very slight concern for having a fall on the FES-I (22)

Janet (014JCGVI)

Janet was the youngest participant in the study (53 years) and lived with her husband and her young son (<18 years). She had glaucoma and a cataract in her RE but normal sight in either eye. Depth perception was within normal limits but she spoke about a visual field loss in either eye (greater loss in the left eye than the right). She was slightly concerned about having a fall on the FES-I (22).

Fred (015FTMVI)

This 77 year old male lived with his spouse. As well as having AMD, he had diabetes and had a stomach bypass. He was being treated with injections for his AMD at the CERC. He had normal vision and acceptable depth perception. He had a mild concern for having a fall (FES-21).

6.3 Impaired depth perception

I have discussed the ability to perceive depth and the measurement of it in Chapter 2 (Section 2.4) along with the studies investigating the association of impaired depth perception and falls. Impaired depth perception has been shown to be associated with falls (Ivers et al. 2000; Lord & Dayhew 2001; Nevitt et al. 1989). Depth perception is a function rarely tested in older adults presenting with age-related ophthalmological conditions. It is usually assessed in conditions where binocular vision is affected due to problems with the extraocular muscles. However, Essock et al. (1996) suggest some benefit of binocular testing in the routine assessment of glaucoma patients after they found that the binocular mechanism that mediates stereoacuity was heavily disrupted in glaucoma patients who had equal good acuity in both eyes.

Impaired depth perception can also be caused by monocular blur (Vale, Buckley & Elliott 2008) or having a difference in acuity between both eyes (Felson et al. 1989). A difference in acuity can occur during the variable time period between the extraction of the first and second eye cataracts. A reduction in stereoacuity has also been shown to be associated with optical blur (Costa et al. 2010) which may pose a problem for individuals who struggle to use varifocals. Therefore, individuals with any ophthalmological condition affecting their vision should be assessed or at least consulted regarding the problems they could potentially face with judging depth and distances. One of the participants (Lizzie-002LHMVI) alluded to the importance of clinicians communicating the effect of sight conditions on functional vision. Despite having driving standard vision, she had not driven since her diagnosis due to experiencing double vision and during the interview specifically mentioned having lost '3D' vision:

And of course now I don't drive because I have double vision, and I don't really think that clinicians probably do understand it's not just about eye tests, and a lot of reliance is placed upon the eye tests. You see when you're sitting static, when you're having an eye test, it's very different when you're moving. Because you've lost the 3D part of your eyesight.

(Lizzie, 61yrs old with AMD, non-falls participant)

There were several participants with either no or impaired depth perception following the development of cataract, glaucoma or AMD who described problems with judging depth and 'missing the step'. However, a difference in objective and subjective absence of depth was dependent on whether an individual had pre-existing binocular vision prior to the onset of their ophthalmic condition. Notably, one participant (Paula -008PWGVI), who had never had demonstrable depth perception due to the childhood condition of amblyopia , was unaware of any issues to do with judging depth. On the other hand, Joy, a 69 year old female with no childhood ocular problems, was aware of her loss of depth perception following the onset of glaucoma. She described experiencing problems with judging the depth of steps on a bus and feeling unsteady:

I'm not quite sure which step I'm getting on. So I have to keep hold of whatever. If there's, if I'm getting a bus, I've got to keep hold and then work my legs up, you know, to see which way I'm going.

(Joy, 69 years old with glaucoma, falls participant)

Whilst not all participants explicitly spoke about misjudging steps or depth, some of the falls were described as trips on uneven pavements. For example, Marg (001MHCF) had no demonstrable depth perception and did not express any problems with judging depth during the interview but she did describe her fall as a trip whilst negotiating uneven pavements at night on her way to work.

Robert (013RMCSCF), had impaired depth perception and had three falls since wearing varifocals which he was keen to explain was the cause of his falls. He described his last fall to me and how he struggled to judge the depth of the grid on the ground he was walking on when he fell:

No, I'd just got off the bus to return to my home, I tripped over it was like a grid, a manhole, it was raised, I just tripped on it, I didn't see it, tripped on it, went face down. But basically what it was, I think it was, it shouldn't have tripped me up this because it wasn't high enough, basically it was because I'm looking down, I'm looking through my varifocals. And I think that give me a misguide when I was walking. Because it's happened before when I've come down my stairs from my flat and missed the last one because I'm looking down, and I'm having the varifocal showing me, instead of my distance, you know my television glasses, the reading one.

(Robert, 71 years old with cataracts, falls participant)

In this case impaired depth perception may have been due to his cataract or the varifocal glasses causing small amounts of blur. This has been reported to alter gait when negotiating a raised surface due to the inability to judge the height of the step (Vale, Buckley & Elliott 2008). In addition, varifocal glasses have been linked to increase risk of falls and in particular trips (Davies et al. 2001; Lord, Dayhew & Howland 2002) compared to when wearing distance single vision spectacles (Johnson et al. 2007). Haran et al. (2010) also found that older adults who took part in regular outdoor activity experienced less falls when wearing single vision glasses. However, I found that more falls participants reported wearing single vision glasses (Chapter 5, Figure 5.5). Hence, it cannot be concluded whether varifocals or cataracts contribute to blur and consequently impaired depth perception.

Despite having reasonable stereoacuity, a few of the participants (Glenda-008GMacGF, Janet -014JCGVI and Isaac- 005ISMVI) were aware of their increasing difficulty at judging depth and particularly kerbs and steps. Isaac adopts a more cautious approach to steps, looking twice as he's aware of his eyes not adjusting to the different levels as they used to:

You know I mean obviously stepping off or on to something is always an issue isn't it?

… it is because you're not, you know … whereas normally you know you'd see a gap and you would just automatically step over it.

Well now you'd have to think twice before you done that, you know, you'd really give a good closer look at it.

You know you step off a kerb, you just do it automatically, don't you? Now, there has been times, there has been times when … you know you can get a slight difference in levels in buildings, and where normally your eyes would *just pick up on it, you'd just carry on walking, your eyes would au … now, I've been known to … stumble kind of thing, because you've pre … or you haven't judged it properly kind of thing.*

(Isaac, 67 years old with AMD, non-falls participant)

Janet, however, when speaking to me, was uncertain about why she was missing steps and only during our interview she felt that her reason for missing steps was due to not being able to judge depth.

Yeah, because I just seem to always miss the steps. If I'm not looking to see if there's a step there, I'll always fly in. I do notice that is like, I'm … you know and even my fella said that to me, you know why do you … and I go, is that a step, you know, is it there? And then I'm thinking, why did I not notice that? They're so … and it is, it must be depth mustn't it, you know, because I don't notice them.

(Janet, 53 years old with glaucoma, non-falls participant)

Each of these participants had stereoacuity within normal limits when measured and particularly Glenda but she mentioned that lighting, which will be discussed later, may have played a role in her judgement of the kerb.

I'm looking to see where the kerb is because I can't make out whether it's a flat, on the road, you know like a wheelchair access thing? Or if it's raised. I can't distinguish the length of it kind of thing. Yeah, I'm finding that difficult, more difficult now than what I did previously, yeah. Not unless it's because it's the lighting, the street lighting, I don't know, but yeah, I'm very wary now of … pavements, you know getting up and down kind of thing.

(Glenda, 60 years old with glaucoma, falls participant)

Participants from each of the age-related sight conditions described problems with depth perception in this study. Reduced stereopsis in glaucoma patients has been reported in previous studies (Bassi & Galanis 1991; Essock et al. 1996) and also in glaucoma suspects where they have normal visual fields (Gupta et al. 2006). In a review of the benefits of second eye cataract surgery, there was moderate evidence that stereoacuity improved following extraction of the second eye cataract (Ishikawa et al. 2013). Laidlaw et al. (1998) suggested from the results of their study that the self-reported problems with vision may relate to defective binocularity.

The authors reported a dramatic difference in stereoacuity between the expedited and control group for second eye cataract surgery. There has been very little published on the effect of AMD on depth perception but owing to unequal sight loss it is highly likely that it would be impaired. Negotiating the environment with impaired depth perception was apparent in these narratives from the participants when describing their lived experience of living with an age-related sight condition.

6.4 Difficulties with lighting

Individuals with vestibular or somatosensory deficits rely more on the visual system to maintain balance (Paulus, Straube & Brandt 1984). Hence, if visual information about the environment is compromised due to lighting, it potentially could increase an individual's risk of falls. Kesler et al. (2005) suggested that older adults with an increased risk of falls may predispose themselves to falls by having reduced vision or walking in near darkness. Impaired visual function combined with dim lighting have been shown to have a negative effect on gait in older adults (Helbostad et al. 2009). During the interview, participants were as equally concerned with issues of lighting as they were with judging depth. Concerns were raised about the level of lighting both being too bright or dim and also adapting to different lighting levels. Whilst there were more participants with glaucoma who had difficulties with lighting, it was highlighted by participants with each of the age-related sight conditions. A pilot study by Nelson, Aspinall and O'Brien (1999) to identify the most commonly perceived disabilities in the daily life of glaucoma patients found a high percentage of their patients experienced problems with glare (70%) and adaptation to different levels of lighting (54%).

Peter (011PMGF) had glaucoma and he and his wife both described his struggles with lighting and not being able to tolerate either very bright sunlight or dim rooms.

> *Well if I go out from the light, when I had no lights on the back, the place is dull, I'm quite concerned. I find it hard to see against the sun … So I want something in between!*
>
> *(Peter, 86 years old with glaucoma, falls participant)*

A few of the participants with glaucoma (Glenda, Julia and Jean) had difficulties with lighting. Glenda specifically identified that her eyes were unable to adjust to the light quickly when going from one level of illumination to another.

> *And coming out of the Asda, the street was dimly lit anyway, and I found myself, I couldn't see, it was just like a great big black space. And I'd think, oh God, what's going on here? So it's like my eyes didn't adjust quick enough and come from the light to the dark.*
>
> *(Glenda, 60 years old with glaucoma, falls participant)*

Julia was aware of needing more light in her environment when asked about any changes she has noticed in her sight since the onset of her glaucoma:

> *Apart from the fact you know I think I need more light. I need light, proper light to read, and as I say in gloomy places I'm aware now I put lights on.*
>
> *(Julia, 65 years old with glaucoma, non-falls participant)*

Similarly, Jean mentioned that the biggest change in her sight that she had noticed since the onset of glaucoma was the uncomfortable lighting levels in shops and occasionally her home environment when her husband was responsible for putting on the lights:

> *Lighting is a real issue and when I go in the stores, I just, I can't, it affects my eyes and I don't like shopping in the best of times, but …! I don't know, it just has an effect on me that it's … can't see properly, can I not see … I don't know, it's hard to explain, just has an effect on me, not a good effect. I go mad with my husband, he never switches lights off and he's … he comes to bed and he puts all the lights on and I can't bear it.*
>
> *(Jean, 75 years old with glaucoma, non-falls participant)*

Janet (014JCGVI), recently diagnosed with glaucoma, had normal stereoacuity and good visual acuity in either eye but felt very nervous about coming down the stairs in the dark and having a fall as she struggled to adjust her focus. She also talked about her fear of going out in the dark due to her sight:

> *I don't know how many times I nearly broke my neck when I come down the stairs or something, it was like, God, I can't see anything, like you know … like looking for the light switches and everything. And I could never seem to*

focus in the dark either, you know where normally after a bit you can focus but … I just couldn't focus at all.

No, it's just like the dark is more than anything, it's a bit more … it's a bit weird like, but it is a bit scary, that's why I feel more scared …I will, I'll go out if I've got someone with me and all that, but I don't, it's just, I don't know it's … if I get somewhere where it's really dark, it's just not nice, not a nice feeling. I just feel like I'm blind basically.

(Janet, 53 years old with glaucoma, non-falls participant)

One of the earliest studies published on falls reported that one third of accidental falls at home were stair-related (Sheldon 1960). However, it has been reported that whilst low lighting on stairs resulted in lower speed and cadence of older adults with visual impairments, it did not affect their foot clearance whilst ascending and descending stairs (Shaheen et al. 2018). A few participants spoke about how they negotiated stairs and their associated fear on stairs which I will discuss in Chapter 7.

Whilst there were more participants with glaucoma who described having difficulties with lighting, cataracts can also pose problems with lighting or more specifically 'glare'. This is where individuals may experience reduced visibility of a target in the presence of a bright light source. Superstein et al. (1997) demonstrated that although brightness induced glare did not affect visual acuity, it reduced spatial contrast sensitivity. A recent pilot study of individuals with simulated cataracts has shown that oncoming headlight glare affected their ability to detect pedestrians (Hwang et al. 2018). Here Marg (001MHCF) recounts experiencing glare when looking at car lights but felt that her fall was due to the environment rather than her cataracts:

I think it was environmental really, more so than anything else, I really do. I mean obviously as I told you the last time we were here, my, my … with being like, waiting for this cataract to be removed, you know, it … when I look at lights, especially cars, it's like a big Christmas light, you know. So I mean that could have obviously impacted on … but of course I wasn't looking at cars, I was looking at (the pavement)… you know what I'm saying?!

(Marg, 79 years old with cataracts, falls participant)

Similarly, Susan (015SGCF) a falls participant with cataract described her difficulties with seeing clearly when adjusting to different types of lighting and although she did not attribute her fall to her sight she did mention the lack of road lighting where she fell:

> *But as I say, it is poorly lit around there. Yeah I mean it is sort of a dark-ish end of the road. There aren't any sort of street lights for a little bit. I tell you what I do notice sometimes when we go shopping, we go into Asda, when we come out, my husband normally hands me the bill, and sometimes you can't see it … you know sort of clearly. And then when I get in the car and I look at it, I can see it perfectly clearly. So it's obviously the lighting isn't it?*
>
> *(Susan, 68 years old with cataracts, falls participant)*

Changes in ambient light affecting the ability to negotiate a curb while walking has been studied in participants with AMD and found that attenuated lighting impacts curb ascent and descent irrespective of the eye disease (Alexander et al. 2014). Participants with AMD in this study needed to have good light to read (Isaac-004ISMVI and Jenny- 006JCMVI). Sally (010STMF) who has driving standard level of vision in her weaker eye with AMD hadn't noticed any changes in vision apart from difficulties with adjusting to the light:

> *Yeah, no, I did say to the optician, the only thing I had noticed that was … say if you were in a shop and you went out into the, you know into the outside, my eyes were sort of … took a while to adjust, and I'm … to the point where I'd be thinking, do you know what, I should bring my driving glasses with me and put them on and see if that makes a difference. But that was the only thing, it was not that I couldn't see anything, it was just like it would take a couple of…[missing] to adapt to the different light.*
>
> *More so than actually seeing things, it was the light side of it. And that was the only thing that I noticed.*
>
> *(Sally, 62 years old with AMD, falls participant)*

Health professionals need to communicate the functional difficulties that accompany age-related sight conditions when seeing older adults so that these patients can adjust and manage their sight expectations. Individuals are usually aware of their clarity of vision, as I will present in the next section, but functional aspects like depth perception and lighting are important for daily tasks.

6.5 Visual difficulties

Binocular visual acuity of older adults can be inferred by the measures of monocular acuity (Rubin et al. 2000) and therefore the authors go on to suggest that the influence of visual acuity on the performance of everyday tasks can be accounted for by the better seeing eye. This would explain why a few of the participants were unaware that they had unequal or impaired clarity of vision due to an age-related pathology until they visited their optician (001WBCVI, 009KHCVI, 010BKCVI, 010STMF, 011PMGF, 011AOCVI, 015SGCF). Sally was completely unaware that she had AMD in her left eye and was sent to St. Paul's eye unit immediately by her optician after revealing that her left vision was very poor compared to her right:

> *And to be fair, before I went to the opticians, I didn't even know that I had anything wrong with that, with my eyes …It was only when I went to the opticians in July and she covered my right eye and went … oh! (laughs) And you know my left eye was quite blurry and I was quite shocked, and I went ooh, you know but …*
>
> *(Sally, 62 years old with AMD, falls participant)*

Whereas Alice (011AOCVI), described to me how she thought her sight loss was due to her age and that she needed stronger glasses before she was referred to have her right eye cataract removed:

> *I just thought I was getting old! You know it's just age-related! I mean I knew it was, I was having to get stronger, a bit stronger glasses, I couldn't read, you know the index on a map? So I used to just use a magnifying glass! So I … yes, I did notice it was getting worse, but I didn't, it never crossed my mind about cataracts!*
>
> *(Alice, 76 years old with cataracts, non-falls participant)*

There are very few qualitative studies published on how individuals with age-related sight conditions describe their sight. Crabb et al. (2013) interviewed participants with glaucoma who were asked to describe their visual field loss in their own words and found that they did not describe the typical depiction of the end of a black tunnel but used descriptors such as 'missing' and 'blurred' vision. Similarly, participants with dry AMD rejected the realism of images portraying the visual symptoms of AMD and instead used descriptors such as 'blur', 'missing' and 'distortion' when asked to describe their symptoms. McAlinden, Pesudovs and Moore (2010) developed an instrument to measure the subjective quality of vision in patients with cataracts from focus groups, interviews and past literature. They identified 10 symptoms associated with cataracts that were included in the questionnaire (glare, haloes, starbursts, hazy vision, blurred vision, distortion, double vision, fluctuation, focussing difficulties and depth perception).

The participants in this study did articulate some of these symptoms described in previous studies when asked to describe their sight and differences in vision between the two eyes. The most common symptoms or sensations experienced by the participants when asked to describe their sight and any differences in vision between the two eyes was 'blurry' vision:

> *Seeing the distance there, it's fine, slightly blurred with the right eye, not so bad at all with the left eye.*
>
> *(David, 77 years old with cataract, non-falls participant)*

> *I noticed, I had good sight, and then I noticed, especially in the supermarket, everything was all blurred, like as if it was smoke.*
>
> *(Joanne, 74 years old with cataracts, falls participant)*

As expected, participants with AMD described their loss of central vision. Isaac described to me the unexpected replacement of central vision with a 'cloud' when he was diagnosed with AMD:

> *You think everything's OK, and then all of a sudden macular degeneration starts coming, with this cloud in the middle.*
>
> *(Isaac, 67 years old with AMD, non-falls participant)*

However, for Joan not being able to see clearly in the centre of her vision had a negative impact on social interaction as she was unable to recognise their faces when speaking to them:

> *Now I'm looking at you, right, I can't see your face you know. I can't, I can see you, I can see you as a person, and I can see, you know it's your nose there, but I can't see any details of your face. And it's horrible that, because people talk to me and I'm supposed to know who they are, but I don't because I can't see them.*
>
> *(Joan, 74 years old with AMD, falls participant)*

Metamorphopsia is a common visual symptom of AMD where individuals report objects appearing curved, wavy, distorted or discontinuous. Although no specific studies to my knowledge have examined the effect of metamorphopsia on balance or depth perception, postural instability has been reported to be greater in individuals with AMD (Elliott et al. 1995). Theoretically, depth perception could be impaired in individuals with metamorphopsia due to the unequal visual input from either eye. Betty, an 87 year old female with dry and wet AMD, was not concerned about her vision and hadn't noticed any changes until she was referred to St. Paul's eye unit by her optician, but she did remark on seeing lines as not being straight once she was treated:

> *But I don't really notice it, except that … straight lines go funny, go zig-zaggy, and they did that when I started treatment, but they don't now, so I mean … … they definitely improved!*
>
> *(Betty, 87 years old with AMD, falls participant)*

Julian (005JMMVI), a man with early AMD, told me he was not hampered by his sight and that he continued with his daily routine but occasionally did experience metamorphopsia which he monitored for progression of the disease:

> *Yeah, no, it doesn't stop me doing anything, no, not at all, no. All as I do every now and again, I say, I make … I check by, I take my glasses off and I'm looking at the lines you know …… make sure that … And as I say, the horizontal line is practically straight compared to the way it was. And now, when I close my eye, it's the vertical line that I can see just a little judder in it.*
>
> *(Julian, 71 years old with AMD, non-falls participant)*

Another visual symptom of AMD that is not routinely assessed in clinical history taking is visual hallucination or otherwise known as Charles Bonnet syndrome. Khan et al. (2008) reported a high prevalence of Charles Bonnet syndrome in late AMD with hallucinations of people as being the most commonly experienced. Jacqui, an 85 year old female with late AMD and poor visual acuity in both eyes described to me the visual hallucinations she had been experiencing over the years. During the interview she did not seem perturbed by them as she seemed to have previous knowledge about the disorder:

> *I've also got the Charles Bonnet disorder. See things that they're not there. I've seen, when I first got that disorder, there was terrible load of horrible things you could see. Rats …… going back years, centuries to, you know when the men used to wear the big top hats and the collars? Starched … I was seeing them. And I could see … animals that weren't there.*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

The visual difficulties described by the participants when asked to describe their sight were consistent with the characteristics of their condition. The main symptom of blurred vision is common across all the age-related sight conditions the participants had in this study. The following section will explore the additional aspects of visual function that can be affected in age-related sight conditions that are beyond the standard test of visual acuity.

6.6 Visual field, colour and contrast deficits

Visual fields are routinely assessed in individuals with glaucoma to monitor the progression of the condition and rarely performed in AMD. Contrast sensitivity maybe tested in patients with AMD in specialist clinics (personal experience). Colour vision tests are rarely used in older adults as they provide little information to the clinician about progression and management of the condition. One of the characteristic symptoms of glaucoma is a gradual loss of visual field. The onset of glaucoma can be gradual, leading to the individual not noticing any visual symptoms until the late stages of the condition. Most of the participants in this study were unaware of any symptoms specific to glaucoma. Very few participants spoke about the impact of visual field loss which may be due to them not having a significant visual field loss. This finding is supported by Boodhna and Crabb (2015) who studied the severity of vision loss in newly diagnosed glaucoma patients from 1999-2011. The authors reported that glaucoma detection was modestly improving over time with the percentage of patients with advanced VF loss in at least one eye changing from 30% to 21%. Individuals with AMD lose their central visual field with some peripheral vision remaining intact. I found participants with glaucoma articulated their field loss to me rather than those with AMD. For example, Julia (007JSGVI), who had glaucoma but good vision in either eye, was aware of field loss in the lower part of one eye. She was therefore more cautious about tripping over obstacles in her lower field of gaze:

> *I think I'm more aware that sort of lower down my sight isn't great. I have to put my head down, but again that's … partly the fact that I know I've got low vision in one eye, the bottom half. Yeah, anything sort of below the knee, you're sort of careful about tripping over.*
>
> *(Julia, 65 years old with glaucoma, non-falls participant)*

Joy (014JBGF), who has poor vision in her left eye compared to her right and had field loss to her left side, described to me how this made her feel nervous about going to unfamiliar places:

> *So if someone was at the side of me, I can't, I can't see them. I'm alright in the house and I'm alright when I get in the gym because I know where I'm going. But if I go somewhere strange, which I wouldn't do at the moment, I don't know.*
>
> *(Joy, 69 years old with glaucoma, falls participant)*

Unequal visual field loss in either eye may not impact on individuals as their binocular visual field may not appear constricted. For example, Janet (014JCGVI) has a 75% visual field loss in her left eye and 25% in her right eye but did not notice a constriction in her visual field with both eyes open. However, she was aware of the damage to her peripheral vision:

> *With the left eye, if I put my hand over my right eye, you know there's a … it's 75% peripheral vision in the left eye that's damaged. So it's the whole of the top and like the bit at the bottom on there (describing left side in the inferior field).*
>
> *(Janet, 53 years old with glaucoma, non-falls participant)*

When Janet was asked about whether it affected her ambulation and avoiding obstacles in her periphery she did report 'bumping into things' on her left side. Black, Wood and Lovie-Kitchin (2011) found that an extensive visual field loss in the inferior visual field region was associated with higher rate of falls. Although these participants with field loss (Julia, Joy and Janet) had not experienced any falls since their glaucoma diagnosis, it may be beneficial to patients if clinicians communicated the potential implications of their specific field loss to the patient during their consultation.

Colour and contrast have been shown to diminish with age (Owsley, Sekuler & Siemsen 1983; Wuerger 2013) but can also be impaired by any disease of the ocular media, yet these visual functions do not form part of a routine standard ophthalmic examination. Studies have reported colour and contrast defects in patients with cataracts (Ao et al. 2019; Chua, Mitchell & Cumming 2004; Fristrom & Lundh 2000), AMD (Applegate et al. 1987) and glaucoma (Bambo et al. 2016; Poinoosawmy, Nagasubramanian & Gloster 1980). Early grade cataract has been shown to affect contrast sensitivity at intermediate and high spatial frequencies (Chua, Mitchell & Cumming 2004). No participants in this study reported seeing a difference in contrast specifically, apart from Alice (011AOCVI) mentioning that colours seem more subdued.

Lizzie (002LHMVI) was the only participant to spontaneously describe her eyesight as "colour wise, wishy washy" and unable to see some colours. Very few participants mentioned difficulties with colour even when asked. Lens with cataracts block shorter wavelengths, acting like a yellow filter (Fristrom & Lundh 2000). This was described by a couple of the participants (Joanne and Alice) with cataracts who commented on the yellow appearance of colours:

> *Just that when we were in the shops, I was thinking, well what is it, why is it like that? But it must have been in the house the same, as I say, because the furniture now, if I cover that eye up it's so bright, but that one, everything's dark. It's like a yellow-y brown tint.*
>
> *(Joanne, 74 years old with cataracts, falls participant)*

> *I mean when they did it (first eye cataract operation), you can look and everything, white looks white with that, my left eye… right one now it's*

cream. White's creamy you know, you can see the difference in the colours. The colours are more subdued.

(Alice, 76 years old with cataracts, non-falls participant)

Visual function measures of visual field, colour and contrast determine the functional vision of individuals with age-related sight loss. Information about their functional vision could empower people with knowledge to assess and manage their own risk in their daily life activities and prevention of falls.

6.7 Summary

The personal descriptions and experiences of the participants' sight provide an additional contextual understanding into how they experienced their environment whilst supporting findings from the quantitative phase. The inability to judge depth was the main and common impairment experienced by participants with age-related sight conditions. Impaired depth perception has been identified as a risk factor for falls in the literature (Lord & Dayhew 2001; Nevitt et al. 1989) and was also found to be a key predictor of falls in the quantitative phase of this study (Chapter 5). However, the participants' narratives of missing steps or inability to judge depth were not always congruent with their objective clinical data. Hence, older adults with age-related ophthalmic conditions despite having a normal stereoacuity clinical measurement may benefit from being advised regarding the effect of their condition on depth perception.

Similarly, the difficulties with lighting that have been raised by the participants in this study indicate that the functional significance of their ophthalmic condition should also form part of the consultation with the clinician. Clinicians may focus on the clinical visual status of the patient to monitor the progression of their eye disease. However, advice and information on the functional impact of their sight condition would allow individuals to risk assess their situation to facilitate daily living whilst maintaining quality of life. Also, difficulties with lighting experienced by the falls and non-falls participants raises some strategic issues around effective lighting in the home and the outside environment. Bhorade et al. (2013) demonstrated that lighting was the most significant factor associated with reduced visual acuity and contrast sensitivity tested at home compared to the clinic. The authors recommended that owing to this knowledge, clinician-patient discussions should take place to optimize lighting specific to the patient that would enhance their vision in their own homes.

Other visual difficulties and visual field deficits were described to a lesser extent by the participants. Very few participants who described visual field deficits reported this factor as being an impediment to their ambulation and as potential risk for having falls.

Impaired depth perception and difficulties with lighting were the main symptoms described by the participants with age-related ophthalmic conditions. In Chapter 5, impaired depth and reduced contrast at the higher spatial frequencies were two aspects of clinical visual function that were found to be risk factors for further falls in older adults. Therefore, the clinical consultation with patients should include a tailored discussion about the effects of their condition on their daily functional vision. This clinician-patient exchange may affect their risk perception of falls and consequently fear of falling which I will explore in the following chapter.

Chapter 7 The 'fall' and the FOF

7.1 Introduction

Experiencing a fall is a disruption to one's life and where the body may become strange and be relearned (Becker 1999). The fall was transformative for the participants I interviewed since they variously experienced some physical, emotional and social consequences; albeit these observations were made in the acute phase following the fall. As discussed in Chapter 3, a previous history of a fall is a significant risk factor for Fear of Falling (FOF) (Denkinger et al. 2015; Scheffer et al. 2008) but there are very few qualitative studies published to explore this FOF in individuals who have experienced a fall. Tischler and Hobson (2005), in a qualitative study, found that the FOF experienced by older adults was related to the negative emotions and feeling of pain that they experienced when they had a fall. This was evident also in the narratives of the falls participants I interviewed compared to those who had not suffered a fall. Instead, many of those who had been diagnosed with an age-related ophthalmic condition but had not experienced a fall since, spoke about taking more care and being cautious.

Oh-Park et al. (2011) reported that a fall history was a predictor not of transient but of persistent fear of falling (FOF). In the present study, the consequences of FOF may have been transient for some individuals, but have a longer-lasting impact on others following the fall. Due to the timing of the interview and the duration of this study, my focus was not to explore the long-term impact of falls and FOF. I recruited participants shortly after their fall for a vision assessment and an interview thereafter if they had an age-related sight condition (see Chapter 4 for methods and timing of the interview). All except two participants shared their narrative within a year of their fall to capture the nature and depth of FOF in the post-acute time period following the fall. Two falls participants (010STMF and 011PMGF) who were not recruited from the quantitative phase had suffered a fall within the last two years of the interview. Hence, my observations of their experiences and consequences are specific to that time point in their lives. I also explored the FOF in participants with an age-related ophthalmic condition who had not experienced a fall since their diagnosis. In this group, I recruited individuals who had been diagnosed with their ophthalmic condition within the last two years. This would allow me to explore any changes in their experiences of daily living with a focus on the fear of falling since the onset of their condition.

The phenomenological approach of the lifeworld existentials (lived body, lived space and lived time) described by (van Manen 1997) allowed me to draw out the experience of the fall in the context of each participant's life. Similar to how I applied the phenomenology of Merleau-Ponty (1962) to the participants' perception and senses of sight in chapter 6, I was informed by this philosophy in contextualising the embodied experience of the fall and focussing on the emotions and sensations experienced by the participants.

In this chapter, I initially present the lived experiences of the fifteen falls participants with age-related sight conditions including their view on the cause and the consequences of the fall. The causes were contextual in terms of the life-world of each participant but I have grouped them broadly into behavioural, physical and environmental. The perceptions and sensations (consequences) experienced by the falls participants were commonly either physical, social or emotional and were mainly described as the immediate consequence of the fall. The embodiment of having a fall and an age-related ophthalmic condition with respect to the emotional consequences, specifically, fear of falling is discussed in Section 5.7. The narratives around fear of falling between falls and non-falls participants are compared and contrasted. Participants who had not had a fall since their ophthalmic diagnosis described being more cautious rather than fearful. Throughout this chapter, I explore the participants' view on the role of their sight in the fall and fear of falling.

7.2 The 'fall'

During the interviews with the falls participants with age-related sight conditions in addition to exploring the FOF, I needed to acknowledge and contextualise the participant's experience of the fall, that is, the cause, surroundings/context and consequences. The falls participants recruited to this study suffered minor injuries and none were hospitalised as a consequence of their fall (see Chapter 4 for methods) and therefore the lived experienced of FOF described in this study will be specific to older adults experiencing minor falls-related injuries. Most participants attended A&E with a physical injury from their fall and there was a temporal sense to the emotional and social consequences experienced by the participants linked with the timing of their fall. In Chapter 6, I presented the participant's perceptions of their sight and here I will weave in the impact of their sight as described by the participants themselves.

7.2.1 Causes

A qualitative study (Brundle et al. 2015) explored the views of individuals with visual impairment as to what they believed the causes of falls to be using focus groups and interviews. They reported five main themes: (i) health issues and changes in balance caused by ageing; (ii) cognitive and behavioural factors; (iii) the impact of sight impairment on getting around the home; (iv) the impact of sight impairment on negotiating the environment away from home; and (v) unexplained falls. I found that the participants in this study described similar causes. However, the environment was described as one of the common causes of a fall followed by a physical cause which generally related to a mechanical condition of either the leg, knee, or feet rather than a sensory impairment such as sight or hearing. Similar to the behavioural factors described by the older adults in the study by Brundle et al (2005), a few of the participants blamed themselves for 'rushing around' or 'being silly' when I interviewed them. Some were unaware of how they had fallen and had lost the moment of the fall. Whilst each of the participants were asked about their sight, very few of them mentioned the role of their sight in the fall. One man, Robert, was the only participant who explicitly blamed his sight for the fall. He blamed the new varifocal glasses prescribed by his optician. During the interview he described struggling to judge the depth when looking down and therefore tripped:

> *But basically what it was, I think it was, it shouldn't have tripped me up this because it wasn't high enough, basically it was because I'm looking down, I'm looking through my varifocals.*
>
> *(Robert, 71 years old with cataracts, falls participant)*

The clinical evidence regarding the association of varifocal glasses and falls is inconclusive. A RCT study reported that single lens glasses were protective for varifocal wearers who took part in regular outdoor activity but harmful in those with low levels of outdoor activity (Haran et al. 2010). Yet, varifocal glasses have been shown to impair depth perception and edge contrast sensitivity (Lord, Dayhew & Howland 2002). This illustrates the difficulties with advocating single vision lenses across all older adults and the life-world of the older adults needs to be considered.

Generally, the causes of falls described by the participants were not as specific as Robert's, therefore by interpreting their lived experience of the fall I have grouped them into three broad themes: behavioural, physical and environmental.

Behavioural

Some of the participants blamed themselves for the fall. 'Rushing' or 'needing to slow down' were some of the common phrases used by individuals when describing the fall. Jacqui, now 85 years old, described how she was always rushing and tripping when younger and had experienced many falls:

> *Oh I was always tripping over. Yeah, when I was rushing, running! I've had quite a few falls, doing something stupid. Why do we rush from A to B? Like running for a bus when we don't need to because there's another one behind it? And doing things like that. Silly. Not taking my time.*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

The last fall that Jacqui experienced she describes as having done a 'stupid thing' when falling off the stair-lift coming down the stairs. In a study examining gender and the risk of falling using a sociological approach, women were found to blame falls on their own carelessness indicating a sense of 'self-blame' (Horton 2007). There were only 3 male fallers in the qualitative phase of my study, so it is difficult to discuss any gender differences in the causes of falls. However, a few women did blame themselves for the fall. Joan had poor vision (0.8 logMAR in either eye) and described a couple of her falls. During the interview she considered the circumstances on two occasions and blamed herself. However, on further reflection in the interview, she did consider the role of her sight in the fall:

It was my own fault this one, I tell you now, my own fault, coming downstairs with washing, the sheets and the pillow cases, and instead of throwing them from the top to the bottom, I carried them, I got my foot stuck in the sheet and ended up going down the last five stairs.

…..that was another fall, thinking about it, but again it was my own fault because I missed the step and fell up the bus! Which was silly of me because I should have looked. But then again, I blame my eyesight, so … [unfinished]

(Joan, 74 years old with AMD, falls participant)

However, when Joan was specifically asked about whether she linked her sight with the falls she had been experiencing she continued to blame herself rather than her sight:

No, I think I'm just clumsy

(Joan, 74 years old with AMD, falls participant)

Joan has low vision and whilst her fall cannot be categorically ascribed to her vision, there is a strong possibility that her impaired sight poses a significant risk factor for falls. A few of the participants did not know why or how they had fallen. Joy, who had glaucoma and could not appreciate depth, had experienced multiple falls and could accurately describe the location and time of day of the fall but was completely unaware of why she had fallen on each occasion:

I don't know how any of them happened.

(Joy, 69 years old with glaucoma, falls participant)

Susan was baffled and had lost the moment of her fall when she experienced her first fall in recent history when walking home. She had the start of cataracts in both eyes and her vision was unequal but her vision during binocular viewing was within normal limits. However, as demonstrated in Chapter 6, the objective measurement of visual function is not always congruent with the subjective perception. She had fallen outside on the pavement and it was dark but not knowing how she ended up on the ground made her feel slightly anxious:

But yet, when we say 'tripped', it's a puzzle really because I wasn't aware of falling.

Because after this fall happened, my husband went out the next day, you know to check the pavement and there weren't any flagstones up or anything.

So … But nobody seemed to know why … but it was just the fact that something must have stopped because otherwise I would have put my hand out, wouldn't I? And I would have felt a finger or the fact if I'd … I mean I did hit my face, so I would have felt that. So at least with … you know I didn't have any pain. Which made you wonder what had happened.

(Susan, 68 years old with cataracts, falls participant)

In contrast to Joy (who had never had a falls assessment), Susan had a full "MOT" check following her first fall as she was referred from A&E. She was very impressed by the comprehensive examination she received, although when asked if her vision was assessed as part of her falls assessment she said, "no and it didn't enter my mind to be honest". This contrasting experience highlights not only that cases of falls remain undetected like in the case of Joy but also that sight was not privileged in her falls assessment. Participants were more likely to attribute their falls to a physical cause.

Physical cause

In Chapter 5, I demonstrated that generally, the falls participants had poorer self-reported health than the non-falls participants. Older adults with poor baseline health characteristics such as poor balance, poor leg strength, slow gait speed, difficulties with activities of daily living, multiple comorbidities and medications have been shown to have an increased rate of indoor falls (Kelsey et al. 2012). In Table 7.1, I present the vision and physical characteristics data for the falls participants I interviewed in the qualitative phase of the study. I performed the Timed Up To Go (TUTG) test on all participants who attended the hospital for their clinical assessment and were able to stand up from a chair and walk 3 metres and back. Three participants who were not recruited from the quantitative phase and did not attend the hospital, do not have this data (Sally=010STMF, Peter-011PMGF and Joy-014JBGF). The majority of participants had impaired balance (N=10) which may have been either a cause or consequence of the fall.

Participants were asked about their level of physical activity before the fall and six of the participants indicated that they were doing at least 30 minutes of moderate physical activities, 5 or more days a week. In terms of their physical health, all except one participant (Marg-001MHCF) had multi-morbidities and the majority of participants were taking more than 4 medications (N=9). Participants also reflected on their mobility when I asked the EQ-5D mobility question: “Did they have no, slight, moderate, severe problems in walking about’ or were unable to walk about?”. Using the EQ-5D visual analogue scale each participant rated their own health (0- “worst health” and 100- “best health”). The majority of participants indicated that their mobility was moderately or worse affected (N=9) and only two participants rated their health above average (Sally-010STMF and Peter-011PMGF). The EQ-5D questions were also asked post-fall to determine self-rated health on the day I saw them. Hence, the physical effects of the falls may have diminished in Sally and Peter who had both experienced a fall more than a year before I interviewed them. Six of the fifteen falls participants in this study had an indoor fall and in line with the study by Kelsey et al. (2012) had poor health characteristics: impaired balance, reduced physical activity, mobility issues and multi-morbidities. However, they also had impaired visual function which has been shown to affect balance control (Chen et al. 2012; Kotecha et al. 2012)

Table 7.1: Vision and physical characteristics for falls sample (N=15)
TUTG (Timed up to go)>10 indicates impaired balance (W-Wheelchair), RAPA (Rapid assessment of physical activity) <6 indicates suboptimal physical activity, EQ-5D VAS(Euroqol-5 dimension visual analogue scale), # denotes missing data

Falls participants with an age-related ophthalmic condition													
Participant code-Name	Age	Gender (F/M)	Age-related ophthalmic condition	Fall Indoor or outdoor	RVA logMAR	LVA logMAR	Frisby (seconds of arc)	TUTG (secs)	RAPA (score)	No. of co-morbidities	≥ 4 medications	EQ-5D Mobility	EQ-5D VAS
001MHCF-Marg	79	F	Cataract	Outdoor	0.40	0.90	Nil	9	6	1	No	Moderate	50
002MMGF-Mary	74	F	Glaucoma	Outdoor	0.28	0.30	150	15	3	3	Yes	Moderate	50
003JHMF-Joan	74	F	AMD	Indoor	0.80	0.80	Nil	W	1	4	Yes	Unable	20
004JWMF-Jaqui	85	F	AMD	Indoor	1.60	PL	Nil	16	3	3	Yes	Moderate	50
005BCMF-Betty	87	F	AMD	Indoor	0.2	0.62	#	W	1	3	Yes	#	#
006JKGF-Jenny	70	F	Glaucoma	Outdoor	0.00	0.20	170	18	3	5	Yes	Moderate	35
007JACF-Joanne	74	F	Cataract	Indoor	0.20	0.50	170	16	2	2	Yes	Slight	50
008GMacGF-Glenda	60	F	Glaucoma	Outdoor	0.02	0.14	55	9	6	2	No	Severe	30

009TJDRF-Tessa	67	F	Diabetic Retinopathy	Indoor	1.00	1.78	Nil	W	2	5	Yes	#	#
010STMF-Sally	62	F	AMD	Outdoor	0.00	0.30	170	#	6	3	Yes	No problem	65
011PMGF-Peter	86	M	Glaucoma	Outdoor	0.30	0.48	Nil	#	3	5	Yes	Moderate	60
012JO'BCF-Jack	72	M	Cataract	Indoor	0.10	0.26	150	7	7	2	Yes	Unable	40
013RMcSCF-Robert	71	M	Cataract	Outdoor	0.50	0.30	150	9	6	2	Yes	Severe	10
014JBGF-Joy	69	F	Glaucoma	Outdoor	0.18	0.48	Nil	#	6	2	No	No problem	50
015SGCF-Susan	68	F	Cataract	Outdoor	0.12	0.04	40	6	4	2	No	No problem	50

The participants I spoke with rarely focussed on ‘poor general health’ as a cause of their fall and instead attributed the fall to a mechanical or physical cause rather than a sensory one. An exception was Jenny (006JKGF) who did associate the start of her falls history with being ill from a collapsed lung and having to spend a long period of time immobilised in hospital:

> *And it was from then that I’ve deteriorated, because … I had a collapsed lung as well, and I was so long in … intensive care, that all my muscles here, because my chest was opened quite a few times, my muscle went, wasted really. And I didn’t have the strength afterwards to build that up. So that’s then how I started having little falls because my legs were so swollen and tight.*
>
> *(Jenny, 70 years old with glaucoma, falls participant)*

Functional decline has been reported in older adults following hospital admission for a medical illness (Covinsky et al, 2003). Jenny felt that she started to experience more falls since being admitted to hospital and having to use a walking aid to help her mobilise and maintain balance. Jenny also had glaucoma and whilst the visual acuity was not impaired, she has reduced depth perception leading to a suboptimal visual input necessary for postural stability (Paulus, Straube & Brandt 1984).

Several falls participants reported having osteoarthritis and described their legs or knees giving way when describing the fall. Each of these participants also had either poor vision, impaired depth perception or both (Table 7.1). Betty (005BCMF) who had AMD, had two indoor falls that she described. She was very definite that her falls were to due to either her knee or the neuropathy she had in her foot:

> *And (laughs) it wasn’t bad really, it’s just, it’s this knee that collapses. Yes, they said the knee was … oh they took an x-ray the first time of the knee and the hip, and they said the hip was worse than the knee, but I didn’t know that. But … it … I’ve got neuropathy as well in that foot, which means I can’t sort of turn it, so … I can’t twiddle my toes, and it’s like a solid block, which doesn’t help!*
>
> *(Betty, 87 years old with AMD, falls participant)*

Joan who also had AMD had experienced multiple falls (>5) in the past five years, was able to recall each one. As well as blaming herself for some of her falls, she also describes how she thought arthritis was the cause of her falls and that on one occasion her 'legs just went':

> *And I'd had little ones now and again, but I just thought it was because of my legs, because I had like what you call heavy legs, and I thought it was all to do with the arthritis because I've got some in my right foot and my knees were bad, as I say, and of course I had put some weight on. Fall number four was again standing up and my leg just went.*
>
> *(Joan, 74 years old with AMD, falls participant)*

A couple of the participants talked about problems with their feet leading to falls:

> *But I don't know what it is with my feet, I always feel as if I'm tripping all the time.*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

> *And my foot just went … splat on the ground, and that's what caused it.*
>
> *(Tessa, 67 years old with diabetic retinopathy, falls participant)*

Falls are multi-factorial and quite often can be due to intrinsic, extrinsic and behavioural factors. Joanne (007JACF) had problems with her feet but was also conscious that she rushed around. She also acknowledged that going 'slower' could help her from falling:

> *I think because I walk on my heels, I should walk a lot slower, but you know I'm inclined to rush a bit.*
>
> *(Joanne, 74 years old with cataracts, falls participant)*

The participants I interviewed had a complex combination of multiple factors, for example, poor health, impaired sight, polypharmacy, poor balance and mobility. The risk of a fall has been shown to increase proportionally with the number of risk factors (Tinetti, Speechley & Ginter 1988) that are associated with falls. Physical causes of falls can include the presence of chronic conditions such as diabetes, arthritis, and age-related sight conditions but also other conditions which result in multiple medications for an individual. Polypharmacy is a known risk factor for falls (Deandrea et al. 2010), and whilst many of the participants in this study were on more than four medications, very few considered ill health as a cause of their fall.

Instead, issues to do with gait and mobility were raised which also can be associated with how the environment is negotiated by older adults.

Environmental

Nine of the fifteen falls participants experienced outdoor falls in the qualitative phase of this study. The frequency of outdoor falls has been reported to be higher than indoor falls in middle aged and older adults (Li et al, 2006). The same study reported that 73% of the falls were caused by environmental factors. A qualitative study exploring the experiences of older adults in their neighbourhood found that the participants described several structural factors of the built environment such as uneven walking surfaces, curbs, street design, traffic patterns and lighting that contributed to perceived risk and fear of falling (Chippendale and Boltz, 2014). Specifically, fear of outdoor falling in middle-aged and older adults has been linked to broken pavements (Lee et al, 2018). The physical condition of the environment was raised by a number of the participants in this study and included the state of disrepair of the pavements and/or lighting. Difficulties with lighting were raised by a number of participants in Chapter 6 when they were asked to describe their sight and changes since the onset of their ophthalmic condition. Hence, the interaction of personal sensory factors and the external environment need to be considered when exploring the causes of falls.

Marg describes the lighting and uneven pavements where she had her last fall on her way to work:

> *It was extremely dim. And of course, as I say, I'm just walking along there, and you know trying to avoid people who are coming towards me, as I'm going towards them, you know, the next thing I was on the floor. And to be quite honest with you, that … all the pavements, as you're probably aware, in Liverpool, are a disgrace, aren't they?*
>
> *(Marg, 79 years old with cataracts, falls participant)*

Uneven pavements was an issue for the falls participants but also a major concern for the participants who had not had a fall. Jacqui and Glenda report the cause of their fall to be raised flags but Glenda suggests that she may have 'misjudged' the pavement suggesting a visual element to ambulating her physical environment:

So maybe … I don't know, whether maybe I'd misjudged the pavement or the flags sticking up kind of thing, that I fell over.

(Glenda, 60 years old with glaucoma, falls participant)

Whereas for Jacqui, even though she points to the uneven pavements as a cause of her fall, she is visually impaired and therefore more likely that she was unable to see that it was not a flat surface:

But as I say, I fell … when I fell …, from church going into Belle Vale because one of the flags was up.

(Jacqui, 85 years old with AMD, falls participant)

Joy, who had fallen on uneven flags in her neighbourhood, suggested to the council she would have to take legal action if the flags in her neighbourhood were not fixed:

Yeah, the pavements are bad. They come out to a lady at the back of me, because I fell there once, and … they come out, they fixed the flag, a week later the flag was back up. So I e-mailed them again, I said the flag's back up, and I said, I don't want another fall because I am going the solicitors next time. And they were there within a couple of days, done it, and it come back up again! (laughs) So they've tarmacked it now.

(Joy, 69 years with Glaucoma, falls participant)

Tessa, who is registered blind had not experienced any falls on the pavement, however she expressed her fear of negotiating the environment with her impaired sight:

And as I say the, going out, if there are cracks in the pavement, I can't see them. Depths of kerbs, I can't see them. And the slopes, I can't see them. So that is a bit of an anxious time for me, when I go out. And particularly when I go to somewhere new.

(Tessa, 67 years old with diabetic retinopathy, falls participant)

Whilst more participants talked about the outdoor environment, Jack (012JO'BCF) and Joanne (007JACF) both had indoor falls and spoke about the flooring in their home. Jack slipped on a "steep flight of stairs" with a bannister that started halfway down to get to the downstairs toilet. During the interview, he also described his difficulty with maintaining balance on the spongy carpet under his foot. Jack has a cataract in one of his eyes and has impaired depth perception which may affect his balance:

> *It's the, the carpet itself has got an underlay underneath it, and the underlay is like a heavy underlay. If you know what I mean. So it's sort of … it is, it's a bit spongy, I don't particularly like it. I find it harder to maintain my balance on, yeah.*
>
> *(Jack, 72 years old with cataracts, falls participant)*

Similarly, Joanne has marble flooring in the kitchen where she has slipped many times. She is conscious of it being hazardous particularly in light of the gait she adopts when she is walking and her behavioural tendency to rush:

> *Lots of falls in the kitchen, I think I need to change the floor! It's like marble. That's it, it was just a little bit of water. I think because I walk on my heels, I should walk a lot slower, but you know I'm inclined to rush a bit, yeah.*
>
> *(Joanne, 74 years old with cataracts, falls participant)*

The qualitative data in this study has allowed me to gather the lived experience of the fall from each of the participants with age related sight conditions adding a 'human element' to the quantitative data collected earlier in the study. The narratives about their fall informs us of the context and complex interaction of the factors related to them. The participants in this study generally ascribed their fall to either a behavioural, physical or environmental cause. However, the presence of an ophthalmic condition which affected their sight may be a hidden factor in some of the falls experienced by the participants. Sight impairment was rarely identified as an explicit cause of the fall but appeared implicitly in some of the participant's description of the fall. Hence, adding further support for the role of sight in the multi-factorial assessment of falls. Also, individuals living with an ophthalmic condition affecting their sight may benefit from tailored advice during the clinician-patient discussion to highlight the importance of sight in avoiding falls. Allowing individuals to describe and contextualise the fall during their falls assessment may allow health care professionals to develop a personalised approach to preventing further falls in the future and manage the consequences effectively.

7.2.2 Consequences of the fall

The consequences of a fall may be immediate but transient, or gradual and long-lasting. I have grouped the consequences experienced by the falls participants in this study into three domains: physical, social and emotional. These consequences were not necessarily experienced in isolation or a linear fashion, but there appears to be a cascade effect to the consequences felt by the individuals. Having a 'fear' of falling is a widely reported emotional or psychosocial consequence of having a fall (Tinetti and Powell, 1993, Legter, 2002) (Chapter 3). However, I will discuss this as a separate concept in Section 7.3 as it was explored with respect to their sight in both groups of participants. In this section, I will present the experiences and consequences of the falls shared by the falls participants.

Physical

All falls participants suffered physical injuries from their fall although none were hospitalised for major hip fractures. Most had experienced either soft-tissue injuries, fractures of the ribs, hand or wrist, head injuries or lacerations. The physical consequences of a fall can be the acute loss of physical function or altered physical appearance. In the group of falls participants I interviewed, two females had experienced injuries to their face (Marg-001MHCF and Susan-015SGCF) and Mary had a large laceration to her leg (Mary 002MMGF). For Mary, it served as a physical reminder of the trauma she suffered and to be more cautious:

> *But I'm left with an ugly scar there to remind myself …But that's, it's not bothering me, but it's just when you look at it, you think what you went through. And what it did. And so in a way that can make you say, be careful, yeah.*
>
> *(Mary, 74 years old with glaucoma, falls participant)*

Marg and Susan, both sustained facial injuries following their fall. For Marg (001MHCF), this physical injury evoked an emotional response due to having had previous experiences of these types of injuries that she did not elaborate on during the interview. The facial injury prevented her from going out for fear of other people's perception and judgement of the injury but not for fear of having a further fall:

I mean obviously I couldn't go out, because as I say, my face was out here, and of course all this then started to go, you know, right down my neck and then …So I didn't, I didn't go out, as I say, just sort of like there's a shop over the road, so if I wanted anything, bread, milk or whatever, just used to go in. But oh yeah, it's impacted on me quite a lot actually, yeah

(Marg, 79 years old with cataracts, falls participant)

Whereas Susan, despite feeling self-conscious continued with her daily routine:

But I suppose also I felt rather self-conscious if I happened to want to go say to the shops, you'd go out and you'd look as though you'd been battered! (laughs)

(Susan, 68 years old with cataracts, falls participant)

The physical consequences of a fall and in particular the first fall can set off a trajectory for an individual that can impact on their daily life. For example, Betty had her first fall while reaching for something high in the house and subsequently spent 3 weeks in hospital, followed by a fortnight in a rehab centre due to a back injury. The rehab team taught her to use a walking frame which she now relies on due to her weak knee and is terrified of falling again and ending up in hospital:

Yes. I dread falling again. I've got one of these things round my neck, which I've never used, but …… I mean if I press it, I might end up in hospital again! I'd rather call a neighbour to pick me up! (laughs)

Are you worried about going into hospital?

(J Mehta- interviewer)

Well I seem to be worse since then …[unfinished]

(Betty, 87 years old with AMD, falls participant)

For Betty, the physical consequences impacted her daily life in a transformative way as she became less mobile and subsequently at risk of becoming socially isolated. When asked about her life before the fall she described how she was able to go out a lot more by herself to Tesco or Church:

Yes, I used to go out a lot in taxis but I don't now. Well I used to go to Tescos myself. And I'd go to church.

(Betty, 87 years old with AMD, falls participant)

Similarly, Joanne (007JACF) spoke about a 'bad' fall many years ago which resulted in having a fused toe. This physical consequence she described was impacting on her ability to walk and consequently felt that it has led to further falls. The compounded physical consequences of each fall she described affected her daily activities and dependence on others:

> *Yeah, because every time I fall, it's either, I've had joints put in the hands and my hands are weak, so it does affect me, you know when … although I get over it, I couldn't lift things out the oven and things, I haven't got the strength at all in my hands. And I've had reconstructions on the shoulder. It's left me weak everywhere. Well it's just annoying that you know someone has to do them for you.*
>
> *(Joanne, 74 years old with cataracts, falls participant)*

Sally a 62 year old female had suffered a fall 15 months before I interviewed her. She injured her rotator cuff during the fall and had to take five months off work. On her return to work, her job role had changed and her knee had become inflamed so she decided to take early retirement:

> *And they (employers) weren't putting up options for me, they were putting up blocks, and it got to the point where it was really getting me down. So in the end, I decided after having speaking to the children, I might as well you know try and retire and you know have a few months off, if I want to do something else I can, the kids say go and work for the defence, but I don't think I've got that in me!*
>
> *(Sally, 62 years old with AMD, falls participant)*

Although, Sally did not attribute the physical consequences of her fall to taking early retirement. The fall was a disruption to her life that set off a series of other issues which led her to take early retirement from her workplace.

Hip fractures (37.9%) and undifferentiated bone fractures (27.5%) are the most referenced in the clinical literature followed by head bruises (10.3%) and soft tissue injuries (6.8%) (Terroso et al, 2014). In this study there were no hip fractures therefore I acknowledge that the lived experiences and consequences of the participants in this study provide a different narrative to those who have suffered more debilitating injurious falls which require long hospital stays. The long term impact of the physical consequences from having a fall in this study is variable and extends beyond the physical pain and limitations. The physical consequences can cause further falls, embarrassment, social isolation, change in social circumstances through employment. Hence, physical consequences can be accompanied with social and emotional outcomes.

Social

The social consequences of having a fall can be social withdrawal due to fear of falling or limited physical capacity (Faes et al. 2010). Pin and Spini (2016) demonstrated that falls were negatively associated with social participation but increased social support. Trauma or a disruptive health event could potentially lead to altered social identity, personal relationships, loss of confidence and lack of engagement in social routine and activity (Becker 1999). However, it has been suggested that positive consequences could also result from a disruptive health event, for example forming new relationships or engaging in support networks (Bury 1982). However, there is little knowledge on the temporality of the development of these positive social consequences. I interviewed over half of the participants within 6 months of them experiencing their fall so some had not fully recovered physically from their fall. This may have impacted on their social interactions. It would be prudent to acknowledge at this point though that social and physical effects can occur as a result of changing relationships with ageing bodies over time or the fall or both. I interviewed Mary, three months following her fall and she spoke about her loss of confidence and consequently had not felt like 'herself'. During the interview she was very conscious of her age and turning eighty which she felt was psychologically affecting her. Her fall may have been the epiphany moment which triggered a transient loss of self as she became aware of her changing body and mind. Nonetheless, she was determined to be herself again but perhaps an altered self by being 'extra careful' and being aware of losing her memory:

> *So that (the fall) was the 21st of October 17, and I am only just about getting back to myself again. But no, it's just I've got to get out there and be me again. And to be extra careful and do the best I can to keep my bones going. I am beginning to lose a little bit, I am aware of that (talking about memory)…*

(Mary, 74 years old with glaucoma, falls participant)

Mary had enjoyed a social life with her husband who died twenty three years ago and whilst there was a sense of loss in her narrative, she accepted the shift in her social circumstances which occur with life course events:

> *But that was it, and we made a lot of friends there, and we used to … go off to various dances that were being held round about, that anybody knew about sort of thing. And so there was a little bit of social life involved. But that's sort of all gone now sort of thing, but it was nice while it lasted.*

(Mary, 74 years old with glaucoma, falls participant)

This example illustrates the complexity of understanding the changing shift in identity and social circumstances that can be brought about by age, life course events (Hutchison 2005) or like in this case a disruptive event like a fall.

Life course events such as retirement can have an impact on social connectedness in older adults (Cornwell, Laumann & Schumm 2008). Contextual factors such as age, health, economic resources may influence this transition and affect how an individual adapts to their new routine or role/identity(Kim & Moen 2002). Joan, a 74 year old female, expressed how much she enjoyed being a licensee for a pub and the social interaction that accompanied the job. Owing to ill health she had to take early retirement but continued to maintain the social relationships she built during her time at the pub although in a different role:

> *Because I've al … I was always … I mean I was a licensee for forty odd years, you know, so I was on the go all the time, and then …I retired in, well, took early ret … well redundancy really, in 2001. Because that, my health, my health had just started to deteriorate. But, oh I loved it, I loved it, really did. I mean I still keep in touch with quite a few of my customers.*

(Joan, 74 years old with AMD, falls participant)

Following retirement, Joan continued to enjoy a social life with her friends and taking care of her grandchildren. She expressed determination to continue with her social activities, for example, going out with her sister or the darts with her friends, despite having experienced a few falls. However, following her last fall, she had not participated in any of her usual social activities and was gripped by the fear of having a further fall:

> *But since this last fall, I haven't been to Crewe or darts, because I am too frightened I'm going to fall again.*
>
> *(Joan, 74 years old with AMD, falls participant)*

This example illustrates the negative impact of the fall on Joan's social life. Despite poor health, Joan maintained her social connections until she experienced another fall. Her narrative suggests that she is at risk of being socially isolated due to her fear of having a further fall.

Many of the falls participants spoke about their loss of confidence following the fall, yet they did not specifically refer to it as having a fear of falling. More female than male falls participants verbalised their loss of confidence due to the fall. This in part may be due to the gender distribution of the sample (3 males and 12 females). However, I interviewed Robert eight months after his fall and although at the time he had social contact and support from his family, he described the loss of confidence and feeling of isolation he felt after the fall:

> *I wouldn't go out. My daughter would come, she'd do the shopping. All my grandkids know my bank card number, they go and get my pension out. I got that way whereas you know … and then I'd wait for four o'clock to come, Flog It, I was living round the television, Flog It, Bargain Hunt, you know quarter past twelve, Antiques Roadshow. I lost it, I lost the confidence, you know, I wasn't confident on my own, you know what I mean? I wouldn't even go round the corner and get the paper.*
>
> *(Robert, 71 years old with cataracts, falls participant)*

I assessed Robert in the quantitative phase of the study and suggested that he may be struggling to adapt to his varifocal glasses and to try single vision glasses. He returned for his interview 7 months later and had changed his glasses. During the interview, he described how the fear and loss of confidence was transient. He told me, "he was back to where he was before the fall" and regained his confidence.

Loss of confidence to engage in the usual social routines was also evident in Mary's narrative. She had a routine for her week, going to a church club on two nights and shopping in town on Saturdays, but when I spoke to her 3 months following the fall she told me she had not been out due to lack of confidence:

But it has left me quite nervous. In fact I haven't really gone out on my own as yet, just sort of went out on Thursday on my own, a couple of days ago, but I didn't go too far, because I didn't have the confidence, and I came back. I do try my best, but … you can't do anything about it, but you just have a simple fall like I did, and it knocks you for six.

(Mary, 74 years old with glaucoma, falls participant)

The differences we can see between these two individuals is that I interviewed Robert eight months after the trauma and he made sense of his fall after having a visual assessment with me. Through history taking, visual assessment and talking about the context of the fall we were able to identify that Robert needed to revert back to single vision lenses. Once, he was able to address the tangible cause of his fall he regained his confidence. Whereas for Mary, the fall was more recent, she lived on her own with intermittent contact with her family, did not know the exact cause of the fall and consequently was unable to address any factors that could prevent falls in the future. This appeared to affect her confidence as she was unable to make sense of the fall.

Loss of confidence leading to a curtailment of social activities shortly after a fall was described by some participants. However, a few participants were determined to regain confidence and continue with social activities. The fall was the catalyst to other life events like retirement in the case of Sally (010STMF) and Joan (003JHMF) changing the social landscape of their life, perhaps prematurely for them. I have shown how the fall can prompt a series of consequences starting with the physical which in turn impacts on the social and emotional consequences which I present next.

Emotional

Emotional responses to the fall can occur at the time of the fall or as a consequence of the physical and social consequences. In this section, I present some of the emotional responses to the fall that the participants expressed during their interviews.

'Embarrassment' was one of the main emotional response expressed by the participants when asked to describe their fall, although Jacqui described it as being 'ashamed' when she tripped on one of the flags outside:

> *I fell in the, coming from church going into Belle Vale because one of the flags was up. And struggling to get up, feeling ashamed!*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

Jacqui who blamed herself for the falls and being clumsy went on to explain that it is 'embarrassment' from falling outside, not being able to stand up by herself, and the potential for people to misjudge her that concerned her the most:

> *Do you know what I think it is, you know when you fall outside? Embarrassment. Because you can't get up, so someone's got to come along and …And sometimes people could walk past and say, she's been drinking!*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

When speaking about the fall many of the participants spoke about their embarrassment at the time of their fall. Jenny described the embarrassment or shame she felt when fell on a tram. She was trying to get to her seat and she lost her balance and missed the pole to grab when the tram jerked forward:

> *And everyone is looking and oh. It's like if you trip and … you … you don't want everyone, did anyone see me? And I just got up and I … and I wouldn't go near the seat, and Jean said, sit down, and I said, no, no, I'm alright, just leave me, we're getting off soon. And I just, and I … pulled my hat further down and pulled my hood up when we got off*
>
> *(Jenny, 70 years old with glaucoma, falls participant)*

Similarly, Sally and Mary expressed their feelings of embarrassment when they fell. Sally fell in the Tesco car park and was helped up by a passer-by so felt embarrassed:

> *And I said, Paul, I said, I've just fallen over in Tesco! I mean it's shock, embarrassment, everything that goes with it!*
>
> *(Sally, 62 years old with AMD, falls participant)*

However, despite Mary being alone at the time of her fall in her garden, still felt ashamed that she had fallen:

> *I felt a bit silly! Falling flat on my face and my knee.*
>
> *(Mary, 74 years old with glaucoma and a falls participant)*

As discussed earlier Marg and Susan (001MHCF, 015SGCF) experienced physical injuries that affected their facial appearance. Marg felt embarrassed by her appearance due to her previous history of facial injuries she was alluding to during the interview. Susan although feeling self-conscious did not appear to have any emotional fall-out from the injury. Hence, emotional responses may be mediated by an individual's history and context.

In a slightly different context, Joan who had fallen multiple times was very emotional during her interview as it was the first time she had a chance to speak about her falls. She felt a sense of shame to speak with her family and friends as she felt they would blame her for being overweight:

> *Oh God, do you know what, I've really enjoyed talking to you …It's nice, well I can't talk to people, family, I'm too embarrassed, I really am. I feel … I know I'm overweight and I know everything … I feel as though they're going to say, you know, well you're too … you're too fat? And yet they don't, I know they wouldn't, but I just feel that, oh God, what am I talking about?! I'm talking rubbish!*
>
> *(Joan, 74 years old with AMD, falls participant)*

Joan's story illustrates the value of giving individuals who experience a fall the opportunity to fully explore the emotional effect of their fall either at the time of their falls assessment or thereafter with their GP to enable them to regain their confidence. The GP may be the first point of contact for individuals who have experienced a fall and therefore should be given time to explore with them, the social and emotional consequences of the fall.

I will explore fear in relation to having a fall in the next section, however, anxiety, an emotion similar to fear, can be a more generalised emotion in response to a negative event occurring in an unfamiliar environment. For example, Tessa a 67 year old falls participant with diabetic retinopathy described her anxiety when visiting an unfamiliar place but was able to have social support to reassure her in this situation:

> *Like when Mary and John were up, was it last year, and … they took me to Ormskirk, and John parked the car in a different car park to the one I used to park my car when I was driving. And so I didn't know the layout of the ground, and it was very … potholed and uneven and … a mess really. Now that was an anxious time for me because Mary, fortunately, Mary got hold of me when she realised I couldn't manage really.*
>
> *(Tessa, 67 years old with diabetic retinopathy, falls participant)*

Tessa was not gripped by the fear of falling FOF but felt anxious. Falls and fear of falling as discussed in Chapter 3 have a bidirectional relationship (Friedman et al. 2002; Lavedán et al. 2018). A systematic review by Payette et al. (2016) demonstrated that anxiety is significantly associated with falls related psychological concerns and holds a similar relationship with fear of falling. Having a fear of falling or being anxious can increase the risk of having a fall and potentially lead to the emotional, physical and social consequences discussed. Hence, the cycle of falls and fear of falling needs to be broken by offering a comprehensive personalised approach to each individual's falls history. In the following section I will examine the narratives in relation to the fear of falling of both groups of participants with age-related sight conditions who have and haven't experienced a fall.

7.3 Fearful or cautious of falling

In this chapter, I have illustrated the physical, social and emotional consequences the participants experienced as a result of their fall. This is supported by studies in which participants have described physical injuries, fear of falling, changes in autonomy/independence and social withdrawal as consequence of falls (Faes et al. 2010; Mackenzie, Byles & Higginbotham 2002). Lee, Mackenzie and James (2008) in their qualitative study found that most participants did not fear falling until they had had experienced a fall themselves. Similarly, other studies have found that participants have a greater fear of falling if they have experience one or more previous falls (Denkinger et al. 2015; Scheffer et al. 2008) and falls with injuries (Lach 2005). Hence, whilst fear of falling has been reported in individuals who have not experienced a fall (Lach 2005; Liu 2015), based on the literature my initial assumptions were that falls participants in this study may experience a greater fear of falling compared to those who have not suffered a fall.

Many of the participants spoke of different emotions during their interview, relating to either their fall, vision or from the time of diagnosis of their visual condition. Fear is a common and potentially limiting emotion associated with falls. I have discussed the literature of fear of falling in Chapter 3 and acknowledge that 'fear' is a concept that is often linked with 'risk', particularly in the sociological literature. Finucane and Holup (2006), in a paper on emotion, affect and risk communication in older adults, suggested that the influence of emotion and affect on risk management potentially increases with age. They suggest this influence may be used as a source of information or to facilitate information integration to manage risks and decisions. Therefore, although I set out to explore the FOF in two groups of individuals with age-related visual conditions, those who had and hadn't experience a fall since their ophthalmic diagnosis, I did not explicitly talk about 'fear' during the interview. Instead I asked about their concern and lifestyle since their fall and/or onset of their sight condition.

However, each participant did complete the 'Falls Efficacy Scale' (FES-I) which gives a measure of the participant's concern or fear for having a fall when doing various activities (see Chapter 4 for methods). The scores for each of the participants in the qualitative phase of the study along with the number of falls the participants had experienced in the last 5 years are illustrated in Table 7.2. We can broadly see that the falls participants have a higher FES-I score indicating a greater concern for having a fall than the non-falls participants which is expected and supported by previous literature (Denkinger et al. 2015; Lach 2005; Scheffer et al. 2008). In this section I will present the narrative evidence to support the FES-I data and the assertion that participants who have experienced a fall are more likely to be fearful whereas those who have not are more likely to be cautious.

A non-falls participant, Isaac, recently diagnosed with AMD, and had not experienced a fall since, perfectly articulated this expected finding when asked if he was worried about having a fall due to his sight:

> *Not yet because I haven't had one! (laughs)*
>
> *(Isaac, 67 years old with AMD, non-falls participant)*

During each interview, as well as asking the participants about their concern for having a fall, I also asked whether their concern was due to their sight as I set out to explore the fear of falling in participants with different age-related sight conditions (AMD, cataracts and glaucoma). Contrary to my initial assumptions, there were no obvious differences in how participants described their fear of falling across the different age-related sight conditions. A small number of participants considered their sight as cause for concern for having a fall describing their inability to judge distances or depths of kerbs (Chapter 6) as the common cause. This is illustrated here in two participants, Tessa (T009TJDRF) and Joy (014JBGF). Both of whom had experienced a fall and had no depth perception when clinically assessed. Tessa, whom I described earlier as having anxiety when going to unfamiliar places, described her experience and fear in more detail. She had difficulty with depths of kerbs and she had not been out as much since the fall suggesting that the fear is rendering her to become more socially isolated. When Joy was asked to describe the cause of her fear of falling, she acknowledged her falls history but was also fearful due to the deteriorating sight in her eye and not being able to judge where she is going:

> *Well …… because I had falls at the beginning, but now because of the way my eye's gone, you're more scared … bloody nuisance! It's just because the way my eye is, I can't judge anything now when I walk.*
>
> *(Joy, 69 years old with glaucoma, falls participant)*

Table 7.2: Participants in the qualitative phase (n=30) with age-related ophthalmic condition and FES-I score. (Low concern (16-19), Moderate concern (20-27) and High concern (28-64) (Delbaere et al. 2010a)

Group 1: Falls participants with an age-related ophthalmic condition							Group 2: Non-falls participants with a recently diagnosed age-related ophthalmic condition				
Participant code	**Age**	**Gender (F/M)**	**Age-related ophthalmic condition**	**FES-I score**	**No. of falls**	**Indoor or outdoor**	**Participant code**	**Age**	**Gender (F/M)**	**Age-related ophthalmic condition**	**FES-I score**
001MHCF-Marg	79	F	Cataract	32	3	Outdoor	**001WBCVI-Wendy**	79	F	Cataract	42
002MMGF-Mary	74	F	Glaucoma	34	3	Outdoor	**002LHMVI-Lizzie**	61	F	AMD	27
003JHMF-Joan	74	F	AMD	46	>5	Indoor	**003DKCVI-David**	77	M	Cataract	18
004JWMF-Jacqui	85	F	AMD	45	>5	Indoor	**004ISMVI-Isaac**	67	M	AMD	29
005BCMF-Betty	87	F	AMD	57	2	Indoor	**005JMMVI-Julian**	71	M	AMD	16
006JKGF-Jenny	70	F	Glaucoma	44	>5	Outdoor	**006JCMVI-Jackie**	71	F	AMD	33
007JACF-Joanne	74	F	Cataract	62	>5	Indoor	**007JSGVI-Jenny**	65	F	Glaucoma	17
008GMacGF-Glenda	60	F	Glaucoma	45	>5	Outdoor	**008PWGVI-Paula**	71	F	Glaucoma	17
009TJDRF-Tessa	67	F	Diabetic Retinopathy	44	3	Indoor	**009KHCVI-Kevin**	74	M	Cataract	18
010STMF-Sally	62	F	AMD	26	1	Outdoor	**010BKCVI-Bronwyn**	79	F	Cataract	21
011PMGF-Peter	86	M	Glaucoma	36	1	Outdoor	**011AOCVI-**	76	F	Cataract	18

							Alice				
012JO'BCF-Jack	72	M	Cataract	16	2	Indoor	**012JBGVI-Jean**	75	F	Glaucoma	18
013RMcSCF-Robert	71	M	Cataract	41	3	Outdoor	**013BWGVI-Bob**	69	M	Glaucoma	22
014JBGF-Joy	69	F	Glaucoma	34	>5	Outdoor	**014JCGVI-Janet**	53	F	Glaucoma	22
015SGCF-Susan	68	F	Cataract	19	1	Outdoor	**015FTMVI-Fred**	77	M	AMD	21

As highlighted in Chapter 6, after impaired depth perception, difficulties with adjusting to the light was the next major concern for a few of the participants. Peter was concerned about having a fall when moving from a brightly lit to dull place and his wife was equally worried as she added that “he goes blind very quickly”:

> *Well if I go out from the light, when I had no lights on the back, the place is dull, I’m quite concerned.*
>
> *(Peter, 86 years old with glaucoma, falls participant)*

Jack, who is a cyclist, described to me that although he did not have a fear of falling (FES score 16), he was fearful of cycling due to his sight, having double vision and not being able to judge distances:

> *I’m fearful of cycling now. Yeah, and that’s … mainly to do with my eyes, yeah. Judgement of distances … this business of … dual, you know who’s, how many’s [sic] there …Double vision.*
>
> *(Jack, 72 years old with cataracts, falls participant)*

Towards the end of the interview with Jack, I asked him specifically whether his sight concerned him for having a fall and he spoke about his concern for crossing the road as he struggled with judging the motion of the oncoming traffic:

> *Oh yes, a lot more than it ever did. Like I say, where you’d dance across a main road because you can see traffic both ways, now I can’t, I’m … well I won’t because I’m not sure what’s moving and what isn’t, you know.*
>
> *(Jack, 72 years old with cataracts, falls participant)*

In the previous chapter, a number of participants described specific difficulties with their sight but it was interesting to note that many of them did not consider their sight as a risk factor for falls. Apart from Lizzie, one of the younger participants who has AMD and struggling with processing visual images. She felt vulnerable due to her impaired vision and consequently described her fear of falling particularly in public spaces:

> *I have a fear of … I sometimes can’t find my way out of shops very easily. I am not so adventurous as I used to be, I am far more aware of vulnerabilities, I get dazzled very easily in the different flickering lights, which means I can’t see cars or anything very easily. Yeah, I do worry about*

falling, especially when I'm coming down stairs. It's like I'm going to London on, a week on Monday, and I'm going on my own, and that is a frightening prospect for me to go on my own really! I can't really tell you why it's a frightening prospect, but it is … It's because I can't see properly, I can't process the visual images, that's what it is.

(Lizzie, 61yrs old with AMD, non-falls participant)

Jackie (006JCMVI) a non-falls participant with AMD was more concerned about having a fall due to her knees rather than her sight which she did not realise was impaired until she had to go for the AMD treatment:

I don't think I'm really conscious of it, with the sight bit, it's … because it's always been there with my knees, yeah, I'm not conscious of falling …… due to sight.

(Jackie, 71 years old with AMD, non-falls participant)

Participants who had suffered many previous falls (>5) and had a high FES-I score spoke about being terrified or fearful. Joan, a 74 year old female with AMD, told me about the nightmares she had about falling and also how the fear was compounded every time she experienced a fall:

But I am, I am terrified now of falling again. It's gradually got worse as I've fell …[unfinished]

(Joan, 74 years old with AMD, falls participant)

Joan has very poor vision in both eyes due to AMD, but interestingly although she recognised this during the interview, she did not feel that her poor vision was the main concern for her having a fall but was more nervous of the fact she had fallen multiple times and the unknown cause of her falls was a bigger concern:

I think, yeah, I think the worst of it is I worry because I've already fell. I have a little bit of a thing about my sight because it's not the best as you …But I'm more worried the fact that I've fell and I don't know why I've fell. That's the worst bit, that is the crunch. If I knew why, I'd probably put my mind at ease a bit.

(Joan, 74 years old with AMD, falls participant)

Falls and fear of falling are interlinked and it has been demonstrated that falls and the fear of falling are both risk factors for each other (Friedman et al. 2002; Lavedán et al. 2018)(Chapter 2 and 3). Friedman et al. (2002) measured fear of falling over a 20 month period and demonstrated that fear of falling was not just an acute outcome following a fall. However, the questions to determine fear of falling in the study were dichotomous; yes/no rather than exploring how the fear manifests itself over time. For example, Joanne (007JACF) in this study had experienced multiple falls and was fearful of falling, however there was a temporality to her fear. She expressed that her fear was more acute following a fall which diminished with time and like many participants feared the consequences, for example, breaking bones or dying:

> *I'm just terrified in case you know I break things. You think, oh the next one could kill you or something, you know! Yeah … see I'm not fearful all the time, and then when I do fall, once I've fallen now again, I am fearful. But you know like once say you get over something and you think, well … I think I just … I've got to slow down I think, yeah.*
>
> *(Joanne, 74 years old with cataracts, falls participant)*

Liddle and Gilleard (1995) interviewed falls participants during hospital admission and one month after discharge and found no significant association between the patients' expressed fear of falling in the hospital and their subsequent adjustment after discharge. The authors did report significant association between patients expressing a fear of falling in hospital and similarly expressed fear at follow up. Nonetheless, they did report a reduction in the proportion of participants reporting a fear of falling from 25% to 19% in a month. As noted earlier in Chapter 4, I interviewed the majority of participants within a 6 week-11 month period following their fall with the exception of two participants who were interviewed within 2 years of their fall. Hence, the timing of the interview may have affected the 'fear' narrative as the participants may have conceivably transitioned from 'fear' to 'caution' or back to their pre-fall consciousness.

Indeed, I found some of the falls participants who had suffered less than five falls did not express fear when I spoke with them (Marg-001MHCF and Susan-015SGCF) but instead described with a temporal sense how since their fall they were exercising more caution:

I'm also now obviously cautious, you know cautious because of what's happened, I really am, it's, what three months now since I had this fall.

(Marg, 79 years old with cataracts, falls participant)

No, as I say for a while I was just a bit cautious about it going dark and going back, but I'm alright now.

(Susan, 68 years old with cataracts, falls participant)

Generally, the participants who had been diagnosed with an age-related visual condition and who had not suffered a fall since were more 'cautious' or 'careful' when asked about their fear of falling due to their sight. Jenny, a 65 year old female diagnosed with glaucoma and a loss of her lower field of vision spoke about being more cautious and was concerned about trips particularly when the lighting was not adequate and having to look down to avoid tripping:

I suppose I'm more aware and more cautious. I don't think it stops me doing anything. I do sort of think I need to be careful, tripping over things, because it's dark and it's gloomy and things on the floor…think I'm more aware that sort of lower down my sight is where I have to put my head down, but again that's … partly the fact that I know I've got low vision in one eye, the bottom half.

(Julia, 65 years old with glaucoma, non-falls participant)

Whereas, Bob acknowledged that his sight was not perfect, but felt he was more cautious owing to a fall he had many years ago and not due to the recent diagnosis of glaucoma:

No, no, definitely. I'm cautious, that's the word I'd use, because I know my eyesight isn't perfect and I wear glasses and bifocals, I'm cautious much more but it is linked to the accident, not because I've been told I've got glaucoma.

(Bob, 69 years old with glaucoma, non-falls participant)

A few of the participants like Joanne (007JACF) and Jean (012JBGVI) spoke about making behavioural adaptations and slowing down particularly on the stairs to be careful and cautious:

I am more careful because I'm always quick, quick, quick, quick, everything's got to be quick with me and I … I know I've slowed down a little bit, and I'm slowing down to be more careful. Because I can be quick and do

> *stupid things. So like going down steps, I'll hold on to be on the safe side. Because I don't want to fall*
>
> *(Jean, 75 years old with glaucoma, non-falls participant)*

Jackie, the youngest participant (53 years old) recognised that she is more careful but also because she is younger and more agile she would be able to prevent herself from having an injurious fall:

> *I … I am concerned, I do think about it, because as I said, I'm more careful, and it's like the depth thing, the steps, the tripping. But I think because I am more mobile, I'm quite fit, you know, even like the trip, I can prevent myself from the full fall, but I know that if I was older I wouldn't be able to, so you know I do sympathise with older people with this, because I know that I would be on the floor quite a bit!*
>
> *(Janet, 53 years old with glaucoma, non-falls participant)*

With age our bodies undergo a number of physiological changes for example the loss of being able to read at close distance; presbyopia (Greek meaning-'old vision'). Whilst some changes are considered 'normal' there also the changes brought about by pathological change. Individuals may make behavioural adaptations to accommodate these changes. Isaac, for example spoke about no longer having a pair of twenty five year old's eyes and having to double check and was exercising more caution:

> *But that, I mean … you're catering for a twenty five year old's eyes, you know and these aren't any more you know! I haven't missed anything yet (talking about steps), but I'm aware, I'm aware of it, I'm aware that you know … whereas you just do things for granted what years ago, now you tend to double up on yourself if you like, you know, you set it up, a bit more cautious*
>
> *(Isaac, 67 years old with AMD, non-falls participant)*

Participants in this study were not immobilised by fear, however the context of their narratives need to be considered, for example, the extent of their injuries and the time frame within which they were interviewed. The FES-I scale of the participants recruited from the quantitative phase of the study was completed in the falls unit shortly after their fall, however this may evolve to 'caution' over a period of time once they have recovered physically, socially and emotionally from the fall.

7.4 Summary

The causes of falls are multi-factorial and generally categorised as intrinsic, extrinsic and behavioural in nature. In this study, the participants broadly described similar factors in the cause of their falls, and more specifically identified physical and environmental causes. However, some participants were unaware of the specific nature of the cause. Although very few participants pointed to their impaired sight as a cause for their fall, their clinical data and description of the fall suggested an implicit role of sight in their fall. It was evident that there was a combination of factors involved in the experience of the fall. Hence, if healthcare professionals were able to offer more time to consider the narrative of the fall during the falls assessment, it may facilitate an individualised approach for the prevention of further falls.

An individual can experience multi-faceted consequences following a fall - physical, social and emotional; where each can manifest at different junctures following a fall. Owing to the timing of the interview, I suggest that there is an acute phase where negative consequences are experienced following the falls and that these possibly diminish with time. Whilst fear of falling has been associated with activity restriction (Deshpande et al. 2008a; Yardley & Smith 2002), there is a little research published on the temporal psychosocial effects of the fall itself. Changes in activities have been found not to be exclusively due to falls but also other factors such as altered health status of which sight deterioration was highlighted by participants in qualitative study of nine falls participants (Lee, Mackenzie & James 2008). Therefore, when exploring the consequences of falls like changes in activities, one has to be mindful of the stage at which the individual is post-fall and the impact of other health and life course factors. Austin et al. (2007), in a study to determine the persistence of FOF in older women over a 3-year period, reported 79% of women who had FOF at baseline had persistent FOF at 3 years. Similarly, Oh-Park et al. (2011) reported 60% of their participants had persistent FOF with female gender and a previous history of falls as significant predictors. The authors, therefore suggest the long lasting effect of falls on emotional function. Whilst, the short-term emotional consequences like embarrassment described to me by the participants can be addressed at the falls assessment, the persistence of FOF implies the need to address fall related emotional and social consequences in older adults at a later follow up stage.

Participants who had previous multiple falls did feel fearful of having further falls. Although previous literature has reported that a previous falls history was a risk factor for FOF (Denkinger et al. 2015; Howland et al. 1998; Scheffer et al. 2008), very few studies have reported 'multiple falls' as a risk factor for FOF. Zijlstra et al. (2007) reported multiple falls to be independently associated with FOF. Similar to the lack of value given to the role of sight in the cause of the falls, participants did not describe feeling more fearful of falling due to their sight. Instead, they spoke about being more 'careful' and 'cautious'. This finding does not support that of Howland et al. (1998) who reported that those who were afraid of falling were significantly more likely to have self-reported vision problems. However, it does support the findings from a qualitative study exploring the experiences of older adults with respect to falls and FOF and that there is a dynamic tension/balance between being cautious and striving for independence (Ward-Griffin et al. 2004). More recently, Cappleman and Thiamwong (2019) observed that their participants felt that FOF was not appropriate to describe their perceptions and instead identified with words like, 'concern' or 'awareness'. In the next chapter, I will explore why many of the participants described continuing with their social activities or daily life routines despite their concern for having a fall or being diagnosed with an age-related sight condition. Therefore, the next chapter will present the emerging themes behind people who were, "getting on with it".

Chapter 8 "Getting on with it"

8.1 Introduction

In Chapter 6, I discussed the participant's perception of their sight and their narratives on how it affected them in their daily living. Furthermore, in Chapter 7, I reported that participants who had experienced a fall were more likely to express a fear of falling than those who had not experienced a fall. Using a phenomenological approach I was able to explore the essence of the phenomenon: the fall and/or having a sight condition in the participant's lifeworlds, specifically their lived space and lived relationships (van Manen 1997). This approach enabled me to draw out the availability of resources in the participants' lifeworld in the context of managing the fear of falling.

Generally, participants in this study although being faced with a disruptive event, for example, the fall or the onset of an ophthalmic condition, did not explicitly describe being fearful or stymied in their daily routine. They instead talked about 'getting on with it':

> *You just get on with it, you just have to get on with it, you know, as I say, pick yourself and start all over again.*
>
> *(Marg, 79 years old with cataracts, falls participant)*

As discussed in Chapter 3, the management of risk and fear is individualized depending on their own life experiences, social structure and accessibility to knowledge. 'Getting on with it' could be interpreted as an acceptance of the adversity or a resilient response to the stressors in their life. Hildon et al. (2008) defined resilience as flourishing despite adversity. Resilience is often approached from a psychological or biological perspective with a neoliberal view that an individual suffering from illness is responsible for their own positive health outcome, however, a sociological approach examines the social and economic inequity that plays a role in resilience (Walker & Peterson 2018). Mills C. Wright (1959, p. 226) advocated using the *sociological imagination* to view the world by making a link between 'private troubles' and public issues. He described the sociological imagination as 'a quality of mind that seems most dramatically to promise an understanding of the intimate realities of ourselves in connection with larger social realities' (Mills C. Wright 1959, p. 15). People may blame themselves for their health troubles but this needs to be viewed within the social structure they live in and the inequalities they are faced with.

Whilst in this Chapter I am alluding to resilience, I will also use 'coping with' or 'managing' adversities to describe the experiences of individuals who continue to maintain their previous life prior to the disruption (the fall) or adversity (diagnosis of their sight condition). Having the capacity to 'get on with it' or cope was seen in individuals who were supported by key internal and external resources that I have broadly categorised into individual, social and environmental. These resources and consequently conditions of daily life are influenced by socio-economic status, distribution of power, gender equity, policy frameworks and values of society (Marmot et al. 2012).

Therefore, firstly I will briefly examine some of the participant's responses to their 'disruptive' or 'adverse' experience (Section 8.2) followed by the types of resources (individual, social and environmental) experienced by the participants (Section 8.3). Finally, I will present positive adaptations that some individuals described in this study which consequently facilitated a positive approach to well-being (Section 8.4).

8.2 'Disruptive' or 'Adverse' experience

All participants (n=30) in the qualitative phase of the study had been diagnosed with an age-related visual condition: cataracts, glaucoma or AMD i.e. a health-related adversity and half of the participants with these conditions had suffered a fall; a negative disruptive event. As discussed in Chapter 7, the experience of the fall was temporarily 'disruptive' or 'transformative' as the individuals lived through either physical, social or emotional consequences. Whilst many of the participants were not explicitly aware that they were coping or managing with the stressors, their narrative suggested that they were either unfazed or determined to continue with their normal life in the face of adversity (being diagnosed with an age-related visual condition or a fall). For example, David, a 77 year old man had previous knowledge of the sight-threatening condition AMD. Therefore, during his routine appointment for cataracts, due to this prior knowledge he was relatively untroubled by being unexpectedly told he had AMD:

> *I just didn't feel anything to be honest, I wasn't mortified or anything, I just said, oh yeah, well we have got some experience of it, because of Joan's father, so we do know what AMD is all about, as regards the effect it has, we don't know what it's all about as regards treatments!*
>
> *(David, 77 years old with cataract, non-falls participant)*

Some of the participants spoke to me about their determination to restore their daily routine or health. Jacqui, an 85 year old participant had a serious fall down the stairs and despite this negative adverse event, she was determined to 'carry on' and not let it prevent her from continuing with her daily activities and socialising out of the home:

> *Because if you don't go out and carry on … that fall what I had coming down the stairs, if I took it in my mind, I would never have gone out again.*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

Similarly, Joan (003JHMF) was determined not to have a fall again but she was in a liminal space while she recovered from her last fall:

> *Yeah, no but I'm slowly … I'm determined, don't want it to ever happen again. Eventually I'll get through it, it's just the getting through it at the moment, so it's really bugging me.*
>
> *(Joan, 74 years old with AMD, falls participant)*

Isaac was diagnosed with AMD and described he had good and bad days but when asked about any concerns about having AMD and going out, he was 'getting on with it' and determined that it was not going to ruin his life and was positive about resources that were available to him:

> *Not really, not really no. I'll get on with it, I'll … I'll just accommodate whatever's going on you know, I'll put up with it because I've got to and … unless, unless somebody knocks on my door and says, we can sort this for you I …… happy days. But until then, I'm stuck with it aren't I you know, so … I'm getting on with it. I'm not going to let it wreck my life if you know what I mean? You know it's not going to do that, I won't do that, no, and you know there are facilities there, out there, that will help you to get out there and do stuff …… you know I've got a bus pass now, so I can go and jump on the bus.*
>
> *(Isaac, 67 years old with AMD, non-falls participant)*

The nature and onset of the sight impairment vary with each of the age-related sight conditions. For example, sight impairment with cataracts may be slow and gradual, whereas an individual with wet AMD may experience sudden and alarming visual symptoms. Hence, not all participants may consider the diagnosis of a sight condition as an extraordinary adversity, for instance, older adults with cataracts may regard deteriorating sight part of the 'normal' ageing process or symbolise what Pickard (2010) refers to as a transition from one status (competent adult) to another (fourth age). Here an example of the embodied characteristic of ageing is illustrated by Susan, who had recently been diagnosed with cataracts and thought it was part of her ageing process:

> *I just thought, oh I'm getting older, you know, most people get them [talking about cataracts]!*
>
> *(Susan, 68 years old with cataracts, falls participant)*

This narrative resonates with Williams (2000) concept of 'chronic illness' being a central part of an individual's biography and the notion of 'normal illness' given the timing, context and circumstance of the event. Although cataracts are not seen as a chronic illness, the impairment in sight over a period of time could be viewed as a disruption. Hence, while all participants in this study had a disruption to their normal health either through a fall or diagnosis of a sight condition, their perception or strategy to cope may be influenced by their individual disposition or knowledge. Dispositions or 'habitus' described by Bourdieu (1984) are the way an individual behaves, acts or thinks that is accomplished unconsciously through socialisation, culture and society. Therefore, the position older adults may adopt in relation to their health is potentially influenced by the experiences they have encountered in their life. However, care must be taken not to imply that there is simply individual agency responsible i.e. a neoliberal response to negative events and that it is the combined effects of agency and structure which can contribute to the individual's response to adversity. In the following section I illustrate examples of structural and individual resources that have been identified and interpreted from the participant's narratives. These have potentially influenced the participants' response to the disruption they have experienced.

8.3 Individual, Social and Environmental resources

The participants in this study experienced consequences either related to their fall (Chapter 7, Section 7.2.2) or due to the diagnosis of their sight condition. Whilst the FES-I score was high in the falls participants in the acute phase following the fall (Chapter 7, Table 7.1), at the time of the interview very few participants (falls and non-falls participants with age-related ophthalmic conditions) described being fearful of falling and instead described being cautious. Hence, I propose that in the time period between the fall and the interview, participants had possibly transitioned from being 'fearful' to 'cautious'. Nonetheless, many participants were determined to not let the fall become a longer-lasting transformative event and were able to continue with their usual activities. Individual, social and environmental resources were apparent in the participant's lived experience of managing these adversities.

Bourdieu's concept of habitus and capital can be applied in how risk is perceived and managed in the context of dealing with adversities (Bourdieu 1977, 1984). He suggests that people will have varying forms of capital; economic, social and cultural depending on their social positions (Bourdieu 1984). These forms of capital can be considered a resource for living well (Pinxten & Lievens 2014). Economic capital can be understood as all material resources that are available to an individual. Higher income as an indicator of economic capital has been associated with better self-assessed health (Mackenbach et al. 2004). Social capital defined by Bourdieu is ‘the aggregate of the actual or potential resources which are linked to the possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition’ (Bourdieu 1986). The importance of social capital was highlighted by Putnam (2000) in his book ‘Bowling alone’. He describes the effect of a decline in social capital by way of civic disengagement on health and social isolation. Cultural capital has been described as three forms; embodied or incorporated (e.g. values, skills, knowledge), institutionalised (e.g. qualifications, degrees) and objectified (e.g. cultural goods, books) (Bourdieu 1986). The interaction of cultural capital with economic and social capital has been reported to influence people’s health chances and choices and therefore important in understanding health inequalities (Abel 2008; Abel & Frohlich 2012). In this section, each of these forms of capital are apparent in the participant’s narratives, and I will discuss them under the broad themes of individual, environmental and social resources. In order to contextualise the narratives from each of the participants and present their individual circumstances, I have illustrated the relevant non-visual data in Table 8.1.

Table 8.1: Socioeconomic status (IDAOPI decile 1=most deprived, 10=least deprived), EQ-5D Health status score, living arrangements for each of the participants in the qualitative phase of the study

Group 1: Falls participants with an age-related ophthalmic condition							**Group 2: Non-falls participants with a recently diagnosed age-related ophthalmic condition**						
Participant code-Name	Age	Gender (F/M)	IDAOPI decile	EQ-5D VAS score	Living arrangements	Support	**Participant code-Name**	Age	Gender (F/M)	IDAOPI decile	EQ-5D VAS score	Living arrangements	Support
001MHCF-Marg	79	F	1	50	Alone	Family	**001WBCVI-Wendy**	79	F	6	Missing	Alone	Missing
002MMGF-Mary	74	F	6	50	Alone	Family and friends	**002LHMVI-Lizzie**	61	F	9	80	Spouse	Family and friends
003JHMF-Joan	74	F	3	20	Alone	Family and friends	**003DKCVI-David**	77	M	8	90	Spouse	Family
004JWMF-Jacqui	85	F	4	50	Alone	Family and friends	**004ISMVI-Isaac**	67	M	5	40	Spouse	Family
005BCMF-Betty	87	F	3	Missing	Alone	Carers	**005JMMVI-Julian**	71	M	4	100	Spouse	Family
006JKGF-Jenny	70	F	3	35	Alone	Family and carers	**006JCMVI-Jackie**	71	F	6	60	Spouse	Family
007JACF-Joanne	74	F	7	50	Spouse and child (>18 yrs)	Family	**007JSGVI-Jenny**	65	F	9	90	Alone	Family

008GMacGF-Glenda	60	F	1	30	Child (>18 yrs) and grandchild (<18 years)	Friends	**008PWGVI-Paula**	71	F	1	80	Spouse	Family
009TJDRF-Tessa	67	F	1	Missing	Alone	Missing	**009KHCVI-Kevin**	74	M	3	85	Spouse	Family
010STMF-Sally	62	F	3	65	Child (>18 yrs)	Family	**010BKCVI-Bronwyn**	79	F	4	80	Alone	Family and friends
011PMGF-Peter	86	M	8	60	Spouse	Family	**011AOCVI-Alice**	76	F	8	90	Alone	Family and friends
012JO'BCF-Jack	72	M	1	40	Spouse	Family and friends	**012JBGVI-Jean**	75	F	8	90	Spouse	Friends
013RMcSCF-Robert	71	M	1	10	Alone	Family	**013BWGVI-Bob**	69	M	4	90	Alone	Family and friends
014JBGF-Joy	69	F	4	50	Spouse and child (>18 yrs)	Family and friends	**014JCGVI-Janet**	53	F	1	80	Partner and Child (<18 yrs)	Family
015SGCF-Susan	68	F	4	50	Spouse and child (>18 yrs)	Family and friends	**015FTMVI-Fred**	77	M	10	50	Spouse	Family and friends

8.3.1 Individual resources

Throughout this section I have presented evidence to support the influence of individual resources namely socioeconomic status, age, knowledge, physical health and previous life events that could be linked to the way participants responded to the disruptive event in their life and manage their risk.

Socio-economic status

The socio-economic status of participants was determined through the participant's postcode and in Chapter 5 (Section 5.1.1), I reported that a significant number of falls participants came from more deprived areas of Liverpool compared to participants who had not experienced a fall. The IDAOPI (Income deprivation affecting older people index) decile of the participants with age-related sight conditions is highlighted in Table 8.1 and twelve falls participants came from areas of deprivation lower than 5 compared to six non-falls participants. The index of deprivation comprises of seven domains and living environment deprivation and barriers to housing and services were two of the domains that could potentially affect falls. Environment resources will be explored later in Section 8.3.2.

Cosco et al. (2018) in a study examining socioeconomic position and resilience reported that adult socioeconomic advantage was associated with greater resilience. Participants in this study did not talk about their socio-economic status specifically during the interview but some individuals did allude to the economic implications of their health status and being able to live well. Betty, a falls participant with macular degeneration (005BCMF) had to move to a smaller home from a "huge house" due to her husband's ill health and economic situation. However, they kept all of their belongings and her husband had died 2 years previous to our interview. She was surrounded by books and had worked as a teacher and for the council before she had retired. Her past occupations and possessions hinted at the cultural capital Betty possessed which felt to me very much part of her identity. Betty had experienced two falls both of which were indoors. During the interview, I had noted the lack of space due to her possessions and the difficulty for her to move with the trolley and walking frame consequently posing a hazard for further falls:

We had a huge house in Aigburth, which we couldn't afford to keep up any longer, we moved here. And we were overcrowded really but … (laughs) and so there's all sorts of things I should get rid of but … [unfinished]

(Betty, 87 years old with AMD, falls participant)

A few participants talked about adaptations they had made like having extra home help (Jenny-006JKGF) or moving to assisted living accommodation (Tessa-009TJDRF) but were conscious of their individual financial resources:

But I can't do the pond like I used to do. So I'll have to get someone to come and do that. And it's money all the time. And you know you've got to watch your pension.

(Jenny, 70 years old with glaucoma, falls participant)

The only problem is it's expensive to live there, but …[unfinished] And obviously I have to pay for my care.

(Tessa, 67 years old with diabetic retinopathy, falls participant)

Participants with economic capital in this study were able to adapt and adjust their lifestyle to facilitate living well. As highlighted in the Marmot review (Marmot 2010):

"People with higher socioeconomic position in society have a greater array of life chances and more opportunities to lead a flourishing life. They also have better health".

Age

All participants except one (Janet-014JCGVI) were over the age of 60, and many of them spoke of their age during their narrative along with other challenging life events that potentially contributed to their notion of being able to 'cope'.

Positive or negative emotions from hardship have the potential to affect how adversities or disruptions are managed. However, these cannot be considered in isolation as other internal or individual considerations like 'age' may interact and impact on the response. This was negotiated in a positive or negative manner by some of the participants in this study. Two contrasting accounts of age can be seen here in two ladies (Mary-002MMGF and Marg-001MHCF) who spoke of past life events and both of whom were close to 80 years of age. The number change from seventy-nine to eighty for Mary was a big barrier (002MMGF) and told me how she had put herself on hold until her birthday had passed:

> *This one (fall) has (affected me) because … unless I suppose we're getting that little bit older, and psychologically … that change in number from seven to eight is affecting me.*
>
> *To be that old … I mean … I'm no different to anybody, everybody gets on with it and this and that and the other. But I don't know why it is having an effect on me. But it is.*
>
> *(Mary, 74 years old with glaucoma, falls participant)*

Whereas despite being a similar age, Marg (001MHCF) was continuing to work at Tesco and did not see that age would make any difference to her:

> *Absolutely, well I don't want to stop doing that [working] you know. But I mean I'll be eighty this year you know. I mean not that that makes any difference, you know but it's just that … I don't want to do anything different, you know. I'm quite happy going to work.*
>
> *(Marg, 79 years old with cataracts, falls participant)*

Tornstam (1997) developed a theory of gerotranscendence whereby he argues that well-being in older adults is based on the experiences of meaning and purpose in life and can potentially lead to an increase in life satisfaction. This can be seen for Marg, who continued to work at Tesco and described having a purpose in life which motivated her to bounce back from her adversity. However, the opportunity was offered from a structural point of view i.e. society and the organisation facilitated her returning back to work. Work as a health outcome is being promoted for good mental and physical health (Academy of Medical Royal Colleges 2019) but often in older adults, they have poor physical health which becomes a barrier to activities of daily life and potentially well-being.

Physical health

Barnett et al. (2012) demonstrated in a population of 1.7 million patients in Scotland that the proportion of adults with at least two chronic conditions rose from 30.4% in 45-64 year olds to 64.9% in adults aged 65 to 84 years. The co-morbidity pattern of the participants in this study have been reported in Chapter 5 (Table 5.7 and Table 5.8) where the non-falls participants had significantly fewer co-morbidities than the falls participants. Ong et al. (2014) in their study, report that living with multiple chronic conditions is a varied experience for individuals and their response is dependent on the social context within which they live. They found that social relationships change over the life course which can influence the health and well-being of the person with multiple morbidities. Tessa (009TJDRF), spoke to me about the multiple conditions she had endured: breast cancer, diabetes, diabetic retinopathy, arthritis and a blood clot and how she had adapted to her 'different life' with managing these conditions with support from family and friends and healthcare staff highlighting the importance of social and health service support in managing health in later life:

> *I'm alright now. Yeah, in spite of so many things going on (talking about multiple co-morbidities). I'm alright. Keep saying that to us! I'm alright! Life's different, yeah, but it's still liveable, and deep down I'm still happy. Yeah. And as I say, I've got good family and good friends, and here at the hospital they are absolutely fantastic.*
>
> *(Tessa, 67 years old with diabetic retinopathy, falls participant)*

Individuals who experience poor health throughout their life-course may see it as part of their identity and have had to adapt and cope with chronic illness and disruption. Jenny (006JKGF) described her embodied experience of poor health from the age of eleven and throughout her life as she had to contend with multiple hospital stays and illnesses. Here is her embodied response and acceptance of her illness to a friend who had been sympathising with her:

> *And I said, well you just … that's part of me [being ill], you know and I had to get on with it.*
>
> *(Jenny, 70 years old with glaucoma, falls participant)*

The manifestation of physical health conditions at different points in our life-course may impact on how we cope with ill health and adversities in later life. Charmaz and Paterniti (1999, p. 109) suggests that chronically ill people gain pride in knowing the journey that they have been through and their character, resourcefulness and will have been tested. Charmaz goes on to propose that chronically ill people through struggle and surrender grow more resolute in self as they adapt to the environment.

This strength of character and fearlessness was evident in Wendy's narrative (001WBCVI) who was due to have cataract surgery. She had experienced surgery as a young girl so her prior knowledge and experience of surgery and hospitals gave her the cultural capital to focus on a positive outcome of the cataract extraction and not be anxious about the surgery:

> *So needless to say, you know, we grew up with no fear of if you had to have things done, whether your tonsils … and by this time I'd had my tonsils out, my appendix out! I'd had two children by then, so … it's like this is only going to be good.*
>
> *(Wendy, 79 years old with cataracts, non-falls participant)*

Older adults are able to draw on a lifetime of experience and resources to deal with challenges (Wiles, 2019) and this can also be seen outside of the healthcare experience where participants spoke about previous life events and their effect on dealing with adversities.

Previous life events

Seery (2011) has suggested that some history of lifetime adversity can predict a better outcome in terms of mental health and well-being when faced with stressors. It can also be argued that risk perception and management could be influenced by previous events and the imaginability of the future (Slovic 2000). However, this needs to be contextualised in light of the current situation of each individual and their response. As Rutter (2012) contends exposure to adversities can have either a sensitising or a "steeling" effect whereby the individual is resistant to later stress. Marg and Mary, both aged 79 years of age (001MHCF and 002MMGF) described the hardships they had faced due to the death of their spouses and other life circumstances. Mary (002MMGF), however, reflected on the struggle of having to 'think just of herself' after all the hardships she had to contend with, for example, her spouse having haemophilia and receiving Hepatitis C infected blood in a transfusion, nursing her mother through a stroke and losing two of her sisters to Alzheimer's:

> *And I haven't had the easiest of lives, sort of thing, you know, and I … as I say, especially it was hard work with what we went through. But now I've just got, just me to think of really now.*
>
> *(Mary, 74 years old with glaucoma, falls participant)*

However, Marg (001MHCF) viewed her past adverse life events as stressors that she coped with and helped her manage future adversities:

> *Well, I'm just, as I say … I think … oh … how can I word it? The fact that I've lost two husbands, shall we say …[unfinished]. Well my husband, second husband who died last year, my … no my first … oh God, my first husband died last year, but my second husband died twenty six years ago, right? The thing is you just, you've just got to pick yourself up. You've just got to, you know … [unfinished].*
>
> *(Marg, 79 years old with cataracts, falls participant)*

When considering the contribution of previous life adversities to resilience, it must be noted that many other factors can impact on managing life stressors; the nature and time of previous adversities and the context in which these adversities are managed. Having capital, whether it be social, cultural or knowledge can also influence how each stressor is managed.

Knowledge

Having prior knowledge or experience of an adversity or event may equip an individual to cope and respond in a positive manner. Earlier, a quote from David (003DKCVI) the 77 year old man who spoke of being diagnosed with AMD when he attended St. Paul's eye unit for his cataract appointment, described that he was untroubled by being told that he had AMD. David had had prior knowledge of the visual effects of the condition as he had experienced caring for a family member with AMD. Nonetheless, he was not given any information about his treatment options and his own follow up care and so although having prior knowledge of the condition did not contribute to his initial anxiety, the lack of information about his care did make him reflect. His wife during the interview mentioned that David was "very down" for a few days following the diagnosis until he read up information himself:

> *But they didn't say if they were going to do anything about it (AMD), whether there was going to be any follow-up with it, or whether I'm going*

to be talking to people about it, it was just, well you've got AMD, there's no treatment for it, can't tell you what the timescale is, and it was left like that. I suppose I was getting a bit down …… very down, yeah, very down for two or three days last week, but the more I read about this, and I thought, well OK, it's like a cloud being lifted, there is a future here.

(David, 77 years old with cataract, non-falls participant)

Uncertainty due to lack of information and/or experience can impact on responses to stressors in a negative way and make an individual feel disempowered and anxious. This can be seen here in Paula, recounting her experience of having laser treatment for glaucoma and the anxiety associated with the uncertainty:

I was dead nervous. It was…it was OK! But you know it's the unknown isn't it? You don't know, you know. It's … they (clinicians) were very nice, don't get me wrong, it was just the unknown because I'd never had anything done to my eye before.

(Paula, 71 years old with glaucoma, non-falls participant)

Having knowledge and information was a key finding throughout the interviews and most participants spoke about their level of knowledge and the information given to them at the time of diagnosis of their eye condition. This will be further explored under healthcare service as an environmental resource available to individuals. However, the usefulness of healthcare knowledge in how we respond to adversity can be related to Bourdieu's concept of cultural capital (Bourdieu 1984).

Summary

An individual's capacity to manage or cope with health adversities extends beyond the neo-liberalist policies which expect individuals to be responsible for their own healthy ageing. Although individual resources have been identified in this section, they are shrouded in the economic circumstances that can impact on social and health opportunities and consequently affect and individual's response to stressors in later life.

8.3.2 Environmental resources

Wiles et al. (2012) used resilience as a useful concept to frame ways to 'age well' but highlighted the need to consider both the individual and environmental resources. It could be argued that 'ageing well' is akin to 'resilience', however there is potential to individualise the concept of resilience attributing personal characteristics to the success or failure of being resilient. However, 'ageing well' allows us to explore the concept in a multi-dimensional manner with the interconnectivity of personal, social and environmental resources. In the following section, I will explore the lack or availability of environmental resources that the participants reported during the interviews in this study. Neighbourhood characteristics will include the physical aspects of where they live, for example, the pavements or lighting as well as access to the social aspects of living in their area. I have also included participant's accounts of the hospital service as an environmental resource which is structural and one that all participants encountered in this study.

Neighbourhood

In a study examining the environmental characteristics related to fear of outdoor falling in middle-aged and older adults, low traffic speed on streets, drainage ditches and broken sidewalks were associated with the odds of having a fear of outdoor falling (Lee et al. 2018). A qualitative study exploring the experience of older adults in their neighbourhood in relation to perceived fall risk and fear of falling found that the participants felt the built environment contributed to falls risk (Chippendale & Boltz 2015). Specifically, sidewalk, street surfaces and lighting were raised by the individuals in the study.

Nine of my study participants experienced an outdoor fall (Chapter 7, Table 7.1). Some of the falls participants felt that the neighbourhood characteristics potentially may have caused their fall. Both the falls and non-falls participants spoke about the state of disrepair of the 'flags' or 'pavements' in their neighbourhood. Joy (014JBGF) mentioned earlier, complained to the local council after experiencing a number of outdoor falls and managed to get the paving fixed and tarmacked after threatening legal action. As well as pavements, participants often spoke about lighting issues either in the neighbourhood or within their home that they were conscious of impacting on how they negotiated their environment.

This was particularly evident in participants who had glaucoma and struggling to adjust between different lighting levels (see Chapter 6, section 6.4):

> *Not unless it's because it's the lighting, the street lighting, I don't know, but yeah, I'm very wary now of … pavements, you know getting up and down kind of thing.*
>
> *(Glenda, 60 years old with glaucoma, falls participant)*
>
> *Or the other day it was really dull when we went out, and he can't see when the weather's dull, he just can't see a thing when the weather's dull, can you? You're actually blind.*
>
> *(spouse of Peter, 86 years with glaucoma, falls participant)*

These findings support studies which have found that patients with early or moderate glaucoma reported needing more light, seeing glare (Hu et al. 2014) and described difficulty adapting to different levels of lighting (Ramulu 2009). The World Health Organization (2019) has recognised that an age-friendly environment reduces the risk of falls and prevents older people being neglected and made to feel vulnerable by building safe environments and consequently the security and protection of older people.

Many participants described environmental issues as the cause of their fall during the interview. For example, in Chapter 7, Marg, a 79 year old female with cataracts described how she tripped and fell on her way to work which was poorly lit with uneven pavements.

Isaac, a 67 year old man diagnosed with AMD felt anxious about negotiating flooring and steps that lacked contrast between different levels:

> *………they should always slope it as far as I'm concerned, but putting steps and having two carpets which are exactly the same colour can be confusing. So, and you can be walking along, either you trip … especially sometimes going, not just going up, but going down, and you consider yourself all on one … then all of a sudden you've gone and you think Christ, what happened there you know?*
>
> *(Isaac, 67 years old with AMD, non-falls participant)*

Sally remarked on the state of the pavements felt that there was a lack of effort put in to repair them:

> *But I suppose in this day and age as well, there's that many broken pavements and you know things aren't done that should be done.*
>
> *(Sally, 62 years old with AMD, falls participant)*

While Jean acknowledged that the pavements were 'so bad', she also blamed herself for not seeing 'something'. In her interview, she unintentionally privileged the worth of 'looking' and being careful but was keen to point out that this was not associated with age and being older:

> *Or … I don't know, maybe something that you've not seen, you know, I mean you walk along the pavements, and I basically walk down looking ahead and looking, because the roads are so bad, the pavements are so bad …… that it's quite … you don't have to be older to trip up, you know. So it's not an age thing, it's more just being careful … But I do try to be careful walking, because as I say, the pavements are so bad.*
>
> *(Jean, 75 years old with glaucoma, non-falls participant)*

Lee, Lee and Ory (2019) reported that subjects who had fallen were more likely to reside in areas of with higher environmental barriers (poor sidewalks and uneven walking surfaces) compared to the non-fallers. A systematic review of the evidence exploring the environmental influences on older adult health and activity participation reported a number of features including street lighting, traffic conditions and poor walking surfaces that impacted on activity participation (Annear et al. 2014). Hence, infrastructural changes to the environment, namely better pavements and lighting would potentially facilitate better physical well-being and healthy ageing in older adults.

Healthcare services

All of the participants in this study had experience of healthcare services in some guise, whether that was at the hospital or the high street opticians. The falls participants either attended the A&E department or the falls service at Broadgreen hospital. Question were not specifically asked about the healthcare service the participants received but a few of them described their experience as part of their narrative. A key theme that emerged from the interview transcripts was around the exchange between the healthcare professionals and the participant. Participants were generally complimentary about the staff in the hospital setting:

> *It's not that you're living on a knife edge because there's a lot of help out there, you know, the hospital have been brilliant, on both counts, with the eye and the cirrhosis.*
>
> *(Isaac, 67 years old with AMD, non-falls participant)*

> *The Royal were fantastic, how they did it I don't know, but they put me back together sort of thing, all strapped up …… and that was for weeks and weeks, re-dressing and that. And it was hard work, but I've got through it.*
>
> *(Mary, 74 years old with glaucoma, falls participant)*

However, not all participants had positive experiences. Marg (001MHCF) who had experienced a fall and was conscious of bright lights and glare, acknowledged the problem with waiting times in the NHS. However, she was frustrated at the delay in getting her cataract removed from her second eye:

> *And I feel, I mean I know there's a problem with the NHS and that, but it doesn't make you feel any better when you're waiting to have something done, does it, you know.*
>
> *(Marg, 79 years with cataracts, falls participant)*

Marg had been referred to a contracted service for NHS patients for her first eye cataract surgery where she was told that she did not need her second eye cataract removing and that she should return to the optician's for new glasses. She found this quite distressing and the optician sent a further referral letter for her second eye cataract. At the time of our interview, she was still waiting for her second eye cataract surgery and subsequently spoke about the inefficiency of the healthcare service and the impact of having a difference in vision in terms of judging traffic when crossing the road:

> *But I mean it has it has….impacted on me quite a lot, you know it's annoying because as I say, you know….I mean I suppose you know sometimes you'd cross the road when you think the road's clear. I mean now I got to traffic, you know where the traffic lights to make sure the lights are on red, and I'm extra cautious in that way, you know.*
>
> *(Marg, 79 years with cataracts, falls participant)*

Part of the healthcare service is also the interaction between the healthcare professional and the patient and includes the process of communicating relevant information to the patient about their condition, treatment and support.

Healthcare information provision

The Calman-Hine Report (Department of Health 1995) a policy framework for commissioning cancer services, recognised the importance of providing information to patients, families and carers in an understandable format about treatment options and outcomes available to them at all stages of the treatment from diagnosis onwards. Though not related to cancer here, a diagnosis of an eye condition that could potentially threaten a person's sight could have implications on how an individual manages and mitigates risk. Information or knowledge exchange between the healthcare professional and the participant was a theme that emerged from a few of the interviews in this study. As discussed in Chapter 3, increased accessibility to knowledge of risk could potentially allow individuals to make informed choices to mitigate risk (Beck 1992; Giddens 1991). Participants felt empowered and reassured if they were given sufficient information during their exchange with the healthcare professional.

Wendy, a 79 year old participant who was due to go for cataract surgery spoke about feeling reassured and perhaps a little surprised at the amount of information she received about her surgery from a public sector organisation:

> *Anyway, I had, went through with the procedure, and then, yeah, I was, I'm not saying I wasn't scared, but what I liked about it, from the Royal, came all the information and everything about what you were going to have. Now, I found that amazing because even though I'd been in the private sector, I'd never had the experience of opening the letter and everything is explained.*
>
> *(Wendy, 79 years old with cataracts, non-falls participant)*

Similarly, Jackie described how she had received an information pack and had the opportunity to read through it before having an injection in her eye to treat the AMD. A disc was also sent with the written information but lack of access to technology meant she was unable to listen to the audible information. Efforts were made in this instance to enable people with sight impairment to access information in other formats, but inequity in accessibility meant this was not available to Jackie. However, she was also reassured by the verbal information she received and compared it less positive healthcare experiences in the past:

> *They gave me an information pack, which I read through and a disc, which I didn't use because I haven't got a player! But (sighs) they were just … yeah, in fact every single one of them, right from, what do you call the outside bit when you go …? They were super, super people, and sort of you know really put my mind to rest.*
>
> *So every little detail … I can remember going to hospitals years ago when they wouldn't, they would have said, lay there, lay still … da da da you know. Wouldn't think of offering you a tissue or something like that. But it was all little things like that, that was … it was reassuring and they were.*
>
> *(Jackie, 71 years old with AMD, non-falls participant)*

For Fred, a 77 year old man, information about his condition was crucial for him to feel well informed and less anxious. He was keen to hear the information "as it is" but also acknowledged that not everyone would be ready or willing to know about their condition and prognosis:

> *I was a bit worried because I'd got used to my eyes being so good after the cataracts, and then for this to…. (talking about AMD in the eye) it was like a setback. So yeah it was worrying for a while. But the best thing of all is information! He's great Mr X (consultant ophthalmologist) he tells you exactly as it is, what it….I want to know that. I know some some people don't want to know. So information, critical to me. Absolutely critical you know.*
>
> *(Fred, 77 years old with AMD, non-falls participant)*

In this current age of information accessibility, individuals were keen to learn about their condition and find out how to manage it themselves. Jenny at her time of diagnosis did not want to ask too many questions and felt she would be better accessing information in her own time where she could retain the information but was also aware of looking up information from trustworthy websites:

So I knew I could … look it up because obviously you know you think about things afterwards, and it's a lot of questions to ask and I'd rather …You don't remember it all, I'd actually rather read …… as long as it's a proper site, so I look at the National Glaucoma Association and the NHS ones, because then I … avoid sites that aren't relevant to, well the country, as like America and Australia …

(Jenny, 65 years old with glaucoma, non-falls participant)

Participants who felt they had not been given enough information at their consultation were keen to access information about their condition, for example I illustrated the case of David (003DKCVI) earlier who had been diagnosed with AMD unexpectedly at his routine cataract appointment and he spoke about the lack of information given to him at the time. He felt despondent but after searching for information and finding that a case had been successfully treated at Moorfields, he felt more hopeful and was better able to cope with the diagnosis.

… I've been reading a hell of a lot about it, that's why I've got this file out. There's so many things about now, you know about AMD. In fact there was a case in the paper yesterday wasn't it, down at Moorfields.

(David, 77 years old with cataract, non-falls participant)

A lack of information or knowledge at the point of diagnosis was pointed out to be a "power knowledge" issue by Lizzie (002LHMVI) in this study. Lizzie had also been unexpectedly been diagnosed with AMD and wasn't entirely sure about her diagnosis until after she had three injections in her eye. At the time she felt that although the staff were very nice and treated her with dignity and respect, there was no time to relay any information about her condition:

It's the whole power knowledge thing isn't it? You know it felt to me like everybody else knew (!) and I was the last person to know about my condition.

(Lizzie, 61 years old with AMD, non-falls participant)

Lizzie spoke to me again about the uncertainty of her condition later on in the interview when the conversation turned to support services and accessing the ECLO (Eye Clinic Liaison Officer) and that she didn't' know what to look for on the internet as she had no diagnosis for a period of time:

I didn't know, I … I had macular degeneration probably until about the third eye injection, when we plucked up courage to ask a question, I didn't know, I didn't know what to look for on the internet with my one eye. I had no idea really. I didn't know how serious it was, I didn't know how many people had this condition. I did know that I was probably the youngest sitting in the waiting room most times, most times it was older people, you do get some younger people going through.

(Lizzie, 61yrs old with AMD, non-falls participant)

Whilst many of the participants did not appear concerned or explicitly talked about the degree of information they received either from the optician on the high street or the ophthalmologist at the hospital there was a sense of unknowing in their interviews about their condition and the trajectory of their sight loss. Here Kevin, a 74 year old male told me about his encounter with the optician when he was told that he had cataracts and his unconcern or acceptance of the condition:

They didn't … they said it was early days, they didn't see they needed to do anything I don't think, no. I think …I know basically what it is, I think I was told it's just one of those things you know, so …! Yeah, well I'm seventy four, you have … those things happen, so …!

(Kevin, 74 years old with cataracts, non-falls participant)

On the other hand, Sally who was diagnosed with AMD was concerned by the uncertainty created by the lack of information about her treatment plan:

But I still don't know like if … what's going to happen if I have my next injection … Well you know I think he said it's for twelve months, and then what happens after the twelve months, do I keep going back for them to keep … well I obviously will do, keep going back to keep an eye on it and will it come back, how soon will it come back? I don't … there's, these are the questions I don't know yet …

(Sally, 62 years old with AMD, falls participant)

These findings are supported by a multivariate research model study about information giving in medical care which revealed that doctors spent very little time informing their patients and also underestimated the patient's desire for information (Waitzkin 1985). If individuals are armed with the appropriate personalised information, it could potentially enable them to make informed rational decisions about how they manage their own risk.

Support services

Support services in this context is discussed as a formal source of support that was available to the participant in their environment that in turn potentially impacted the way in they were able to respond to their fall and/or visual condition. I have discussed the more informal sources of social support available to the participants (family and friend networks) in the earlier section of social resources (Section 8.3.2).

Betty (005BCMF) who was wheelchair bound out of the house was becoming isolated due to the lack of facilities for disabled people and imposed safeguarding policies. These barriers meant that she was unable to continue with her routine social commitments:

> *But now they've got this safeguarding thing, and they're not allowed to come in to fetch the, the chair! And I can't put the chair outside myself! It's all so stupid! I mean I've known these people for years. And I trust them, but no, they're not allowed to do it. And if anything happened, it would be their fault you know. So I used to be taken to Lunch Club that way, but I can't go now. So it's very difficult.*
>
> *(Betty, 87 years old with AMD, falls participant)*

Similarly, Bronwyn (010BKCVI) spoke of the lack of support available to her at a train station when she was visiting her son in London from Liverpool but unlike many others in the study she was in a financial position to make alternative arrangements like getting a taxi from Liverpool to London to continue with her social commitments:

> *I said to him last time, Russell [the son] I can't do this anymore, getting that taxi at Euston is just the nearest thing to hell on earth isn't it? It's just awful. Oh dreadful, and then if you ask … I asked for assistance and it never appeared and oh you know … I said, I can't do this anymore, definitely. Anyway, he's spoken to some taxi company about doing me a door to door, which is £230, which really when you add up how much I pay on the train with the two taxis is not that far out you know, so I'm doing that on the 23rd of December.*
>
> *(Bronwyn, 79 years old with cataracts, non-falls participant)*

Although private taxi services are not strictly considered as a formal support service, they play an important part in individuals maintaining their independence and continuing with their social activities. The individual's interaction with the driver can influence their experience as can be seen here with Joan who had AMD (003JHMF) and was not afraid of falling due to the driver supporting her. As a result, she continued going to her bridge club:

> *Do you know what, that taxi firm were absolutely unbelievable. The bloke come to pick us up, and he came to my door, and he said, you're not able to walk very far? I said, no, he said, he said, I've pulled up there, I only had like … say, what … twenty yards, and he held me, and he held me on my wheelie and walked me in. I knew I wasn't going to fall. Oh they were, they were so amazing! I said, I said to my sister about it, and she said, well we'll get taxis in future, we won't ask Elaine (daughter), so … whether we will or not, I don't know, see this week. But at least I know I can go to bridge, I can, you know.*
>
> *(Joan, 74 years old with AMD, falls participant)*

Physical, social and attitudinal environments can inhibit or disable people with impairments or foster their participation and inclusion (World Health Organization 2011). Tessa (009TJDRF) in this study continues to enjoy going to the Royal Court despite her visual impairment as they place her at the front of the stage during each visit. A further cultural resource offering support was evident in this account from Lizzie (002LHMVI) who visited the Walker Art gallery to see an exhibition by visually impaired ex-military people who were doing art as therapy. She felt supported and able to engage by sharing her experience with people who understood her condition:

> *You know, and I think that helped quite, you know, although I didn't realise at the time, that helped me quite significantly to plough on and you know do things when I felt the energy to do them really.*
>
> *(Lizzie, 61yrs old with AMD, non-falls participant)*

Summary

Poor environmental characteristics for example cracked, uneven pavements and poor lighting were raised by a number of individuals that made them wary about walking outdoors. Regardless of poor sight and disabilities in older adults, a good built environment should be regarded as an enabler for healthy ageing (Annear et al. 2014). Physical activity has been shown to have a positive impact on healthy ageing (Daskalopoulou et al. 2017). A review on built environment correlates of physical activity and sedentary behaviour in older adults found that walkability was positively associated with physical activity. The authors recommended that the built environment needed to be considered by policy makers in the complex concept of promoting healthy ageing (Cleland et al. 2019).

Health care services, provision of health information and formal sources of support were highlighted as issues that relate to environmental resources and enable individuals to manage their adversities. Brashers, Goldsmith and Hsieh (2006) highlighted that information management is an important aspect of coping with illness and illness-related uncertainty. If individuals were offered relevant individualised information about their condition and the management of it, they would potentially feel empowered to manage their own risks and make a positive adaptation to continue living well.

8.3.3 Social resources

In addition to individual resources, older adults may have access to support within their social sphere. An individual's social support network has been shown to play an important role in promoting healthy ageing (Seeman 2000; Wu & Sheng 2019). The participants indicated the type of support available to them on the case record form and are outlined in Table 8.1. This section will focus on the experiences of the participant's interpersonal relationships with their family and social networks and the potential impact it may have on their response to adverse events or stressors.

Family support

The amount of family support and the role they play in an older adult's care depends on economic resources, family structure, quality of relationships and other competing demands on family time and energy (Brody, Poulshock & Masciocchi 1978). Hence, whilst people may have family, it cannot always be assumed that they are available for support in a way that would meet the individual's needs. Marg (001MHCF) despite having many children described her lack of family support when she had a fall, but she continued to "get up and carry on":

> *You have a fall, you get up, you carry on don't you, you have to. And I live on my own anyway, so I have to, although I've got like lots of children, they*

don't come into the equation really because they've got their own lives, some of them live away.

I mean my youngest daughter, she works nine till … no seven till three, something like that, but I'll be quite honest with you, my kids don't put the way, themselves out for me, they really don't.

(Marg, 79 years old with cataracts, falls participant)

Marg did not rely on her family for support but as I described earlier, her previous life events and sense of purpose were resources that enabled her recovery from the fall and motivate her to resume her routine activities. The physical distance between family members can be a barrier for being supportive as suggested by Marg and many of the other participants I spoke with. However, some participants like Joan and Betty talked about feeling supported by simply hearing from their family over the phone:

My son, who lives in Aston-le-Walls, which is down by Daventry, we went to see him, just before Christmas, took the presents and stuff down, and he was asking about, you know, have you fell any … have you had any more falls and that, and I say, no. Now he rings me every night to make sure, is everything OK? I've got my daughter ringing me every now and then, got my granddaughter ringing me, I've got my grandson ringing me …

(Joan, 74 years old with AMD, falls participant)

In contrast to Joan who had a good social network of friends from the darts team who came to collect her and take her places, there was a sadness when speaking with Betty (005BCMF) who had four sons, lived by herself and was wheelchair bound:

Yes, so the youngest came yesterday with his wife. And the other two rang me and the fourth is in Australia anyway, and they have a different Mother's Day! (laugh) So, but he rings quite regularly. No, they're all scattered. Yesterday's [sic] lives in Hull. He came and went in the same day. But they both rang up yesterday of course [referring to mother's day]

(Betty, 87 years old with AMD, falls participant)

Betty spoke about the difficulty with getting in and out of the taxis, not having anybody to push her wheelchair and issues with safeguarding which prevent individuals coming from church to come and collect her. The challenges for Betty could potentially lead to social isolation as during the interview she became very sad as she told me that she only got out to go to medical appointments:

> *Well I don't have somebody to push me, no, not regularly. My youngest son came yesterday and we went out in the wheelchair for lunch. I've a friend who comes, she took me to the dentist last week or the week before, and … but otherwise I don't go out.*
>
> *(Betty, 87 years old with AMD, falls participant)*

During the interviews, many of the participants recognised the value of having family and social support to help them cope and quite often sympathised with people who did not have family or friends to either support them or encourage them to continue with their normal routine. For example, Lizzie who had been diagnosed with AMD and felt very downbeat about her condition at the time of the diagnosis acknowledged she had support from her husband:

> *But I did take quite a lot … took a lot of encouragement from John (spouse) to get me to go to places. You know, he did encourage me to do things, and he still does now. Mm, I don't know what I'd be like if I hadn't got family around and friends.*
>
> *(Lizzie, 61yrs old with AMD, non-falls participant)*

Jacqui, also with AMD talked about her good fortune of having family support when she compared herself to her friend Peggy who had no family support and relied on her to take her out for one day a week to a support centre for visually impaired individuals:

> *See, with Peggy, that's the only day she gets out. Because she's got no family now. And when you think how lucky I am, with the family I've got. And the likes of Peggy, got no one. It's hard isn't it?*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

However, from the following excerpt, I deliberated on whether support from family members could potentially be a negative influence by being over cautious and protective. Gallant, Spitze and Prohaska (2007) found more negative influences from family members than friends on self-management of chronic illness in older adults. Jacqui recognised this and through her own determination and willingness took control of her well-being. However, the confidence and security of having accessible family support enabled her to regain her independence:

> *Sally-Anne (daughter) was doing my messages and Stephanie (grand-daughter), and I was getting waited on hand and foot wasn't I? You can't do this and you can't do that. And I said, I can. Because she used to get all my shopping in, and Christopher (grandson) come and he used to get my shopping in. And I started to like that interlude. I thought, oh, I don't have to go out, do I? If it's raining I don't have to go out, if it's cold, because they'll do my shopping. And then I thought all of a sudden, no, no … you do your shopping yourself and get out.*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

As well as family support, many of the participants spoke about their social support or networks that contributed to their well-being.

Social support

Higher levels of resilience have been associated with good social networks (Lamond et al. 2008). Social support includes engaging with a network of friends, family and acquaintances for social activities but also are willing to be of assistance in times of need or adversity. Many of the participants in this study who continued to engage with routine activities and life despite being fearful of having further falls had strong social networks.

Social networks or support can develop and evolve throughout the life-course as can be seen here with Jacqui whose relationship with her employer, Edna had evolved to friendship over time:

> *Edna, my friend, she lives around the corner, she used to my boss [sic] from when I worked in the fire station, she took me, both of us went into town, used to go, I used to get my pension, she used to take me for that. And then we'd go into the little café and have cream team, that was our day out, wasn't it?*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

Being engaged in routine activities forms part of your identity and self. For example, Peter (011PMGF) who was from Ireland and had settled in Liverpool, maintained his identity through his weekly visits to the Irish centre. Peter was able to continue with this routine activity through the social support structures he had in place:

> *I go out every Friday night, I go down to the Irish Centre for a game of cards. Every Friday night one of my friends picks me up, he lives just three blocks down, he picks me up and takes me home. So we have a game of cards every Friday night.*
>
> *(Peter, 86 years old with glaucoma, falls participant)*

Jacqui (004JWMF) viewed her routine as a way of being physically active and preventing her from being trapped in a pattern of mundane life that could potentially lead to becoming isolated:

> *Yeah, I go … I told you I go out on a Sunday, I go to church. Monday I stay in. Tuesday I go to church. Wednesday, I go the … Bradbury Fields. Thursday, I go the slimming club. Friday I go to church, Saturday I do my shopping. I've got to get out because otherwise, if I don't … if you don't move, you're getting into a rut, don't you?*
>
> *(Jacqui, 85 years old with AMD, falls participant)*

Jacqui had a large family and social network that she regularly engages with. Social resources can be regarded as social beings or facilities available to individuals to promote well-being, and one may regard the social facilities or structures as environmental resources. However, in the context of this thesis, I have included structural support services highlighted by the participants as an environmental resource for well-being.

Summary

People with social ties and relationships have been shown to have better health than those without such ties (Berkman & Syme 1979). However, it is the quality of those relationships (Pinquart & Sörensen 2000) and the frequency of contact with others that has been shown to be associated with well-being and quality of life. In my sample of older adults, individuals identified the importance of having family and social support to enable them to either manage their adversities or encourage them to adapt and continue participating in social activities. Public health work in social prescribing acknowledges that people's health is determined by a range of social, economic and environmental factors (Public Health England 2019b). Social prescribing by health professionals offers the opportunity to support individuals make social connections particularly in groups where there are health inequalities or where there is a lack of social support within their own environment. However, the ability to engage with social support may also depend on the individual and environmental resources available to individuals, to facilitate this engagement.

8.4 Positive adaptations

There is potentially a two-way relationship between the accessibility to individual, social and environmental resources and making positive adaptations as being able to make changes or adjustments may require resources or those changes may also lead to a changing in the accessibility of resources to enable an individual to cope or contribute to well-being.

For instance, earlier I described the situation with Bronwyn who decided to get a taxi from Liverpool to London to see her family for Christmas. She had a made a positive adaptation or adjustment to her travel arrangements to enable her to continue seeing her family but she had the economic resources and family resource to support her in making that adjustment and sustain her well-being. Similarly, Mary (002MMGF) and Jenny (006JKGF) had made adaptations to their bathrooms as Mary described to me her fear of falling whilst getting in out of the bath and felt fortunate to have had a downstairs toilet put in before her last fall:

> *But luckily enough, about eighteen months ago, I had a downstairs loo put in.*
>
> *(Mary, 74 years old with glaucoma, falls participant)*
>
> *And I've had a shower put in, the taps I'd had altered as well, you know.*
>
> *(Jenny, 70 years old with glaucoma, falls participant)*

However, some adaptations are made with social support like Joan who felt she could not continue with her secretarial support to the darts league due to her sight and not being able to see the screen. Until a friend was able to assist her to so that she could continue with doing meaningful work:

> *The … the sight's the worst of my problems at the moment because, well you've seen I can't read or anything, but I love my computer, I really do, and I do a lot of work, I mean I'm … the league secretary for the darts, which entails doing a lot of … competition stuff and everything. And at the moment, I can't do it because I can't see … the screen very well. But now, somebody showed me a programme the other day, to make the … make the, what do you call it, the font size bigger.*

(Joan, 74 years old with AMD, falls participant)

Participants with sight conditions that severely impaired their vision, had made adjustments to continue living independently. For example, Jacqui (004JWMF) who lived on her own used the microwave to cook her dinner and rarely used the gas due to her poor sight. So far, I have highlighted physical adaptations participants had made to their environment. However, participants were conscious of making behavioural adjustments to continue living well. Isaac (004ISMVI) diagnosed with AMD was conscious of being more careful and slowing down as he was concerned about having a fall due to his sight:

> *I mean you're always conscious of it, so you act accordingly, you know, you're that little bit more careful, you don't go, you don't rush at things like a bull at a gate, you know, you've … because you've got this (referring to AMD) … OK, you've got one good eye, but when you've also got one dodgy eye. So it's just accommodating for it, you know, and that's what I tend to do, you know, I tend to think, well don't, don't rush into anything, don't do something that you might be sorry for after.*

(Isaac, 67 years old with AMD, non-falls participant)

Many of the participants in this study spoke about the need to slow down where they had always been rushing around before. Jack, who was a keen cyclist had developed double vision and also had cataracts. Due to the fear of having an accident on his bike outdoors and not being able to judge the traffic, he had set up a stationary bike at home and got a dog to walk every day. Nonetheless, he missed the level of fitness he got from cycling 120 miles/week:

> *I'm fearful of cycling now. Yeah, and that's … mainly to do with my eyes, yeah. Judgement of distances … this business of … Double vision. Overtaking people … All of that I think, no I'm not going to do this. So I have one (a bike) set up at home*

(Jack, 72 years old with cataracts, falls participant)

However, in Jack's case despite making some behavioural changes to maintain physical health, he felt that his sight could be improved by removing the cataracts:

> *Maybe if I got these cataracts sorted, that would improve a hell of a lot, you know?*

(Jack, 72 years old with cataracts, falls participant)

Bury (1982) in his work on biographical disruption in chronic illness contends that the experience of illness can disrupt the structures of everyday life and the knowledge underpinning it. The focus of his work early on was around how people adjusted to the long-term trajectory. In the cases of participants with long term sight loss due to AMD or glaucoma, they had reconstructed their life or narrative to adapt to the changes associated with these conditions. However, in the case of Jack with cataracts, his sight loss was reversible and therefore there was a sense of the adaptations being transient.

8.5 Summary

Individual, social and environmental resources were identified through many of the participant's lifeworlds and potentially played a role in their response to the stressors they encountered. However, every participant had different life experiences and consequently may have influenced their response to adversity. The personal experiences throughout the life course are not just a product of mental and physical toughness but also the social and economic opportunities and chances afforded to the individual throughout their life (Walker & Peterson 2018).

Windle (2011) defined resilience in terms of adversity and the resources available to an individual which determine their ability to manage the adversity:

> "Resilience is the process of effectively negotiating, adapting to, or managing significant sources of stress or trauma. Assets and resources within the individual, their life and environment facilitate this capacity for adaptation and 'bouncing back' in the face of adversity. Across the life course, the experience of resilience will vary" *(Windle, 2011).*

This definition takes into account personal characteristics but also recognises that people exist and live in a world influenced by physical, social and environmental factors. Thetford et al. (2015) examined the impact and interactions between the social, community and individual resources on visually impaired individual's capacity for resilience. They found that access to resources was not exclusively responsible for a positive outcome of resilience and that individuals needed to be motivated to use the resources. However, this relates to a neoliberal view of resilience, where in fact as Walker and Peterson (2018) contend resilience relates to the interplay between the socio-political and health systems and the individual.

Participants in this study felt empowered with information from the healthcare professionals about their condition, treatment and potentially prognosis and consequently were able to assess and manage their risk when continuing with routine daily activities. Individuals made physical or behavioural positive adaptations if they had economic resources but social resources also featured as a positive influence to facilitate making changes to improve well-being.

Chapter 9 Discussion

9.1 Introduction

The literature reviewed in this thesis has highlighted that there are a number of published clinical studies that have reported an association between impaired visual function and falls, although these vary in methodological quality and rigour (de Boer et al. 2004; Freeman et al. 2007; Klein et al. 2003; Lord, Clark & Webster 1991; Lord & Dayhew 2001; Nevitt et al. 1989; Tinetti, Speechley & Ginter 1988). Yet, whilst a few qualitative studies are exploring the fear of falling in older adults who have fallen (Bailey, Jones & Goodall 2014; Gardiner et al. 2017; Tischler & Hobson 2005; Ward-Griffin et al. 2004) there is a lack of qualitative research specifically exploring the lived experience of falls and fear of falling in older adults with visual impairment (Brundle et al. 2015). No qualitative studies have specifically explored the fear of falling in individuals with age-related ophthalmic conditions.

Therefore, I have conducted to my knowledge an original study, using a combination of quantitative and qualitative methods to investigate the association of impaired visual function with falls and fear of falling in older adults. My study objectives were to compare measures of visual function in falls and non-falls participants and explore the experiences of falls and fear of falling in older adults with age-related sight conditions. The individually age-matched, case-control study design of the quantitative phase enabled me to provide strong evidence to support the existing body of knowledge on visual risk factors for falls using robust statistical methods. This was followed by the qualitative phase informed by a phenomenological approach. The findings of the interviews conducted with individuals with age-related ophthalmic conditions integrated with the quantitative findings make a novel contribution to the knowledge on falls and fear of falling in older people with visual impairment.

The key visual predictors for a further fall in older adults was impaired depth perception (poorer than 85” of arc) and spatial contrast sensitivity (18cpd). Non-visual risk factors were also significant: impaired hearing, living in poorer areas of deprivation and reduced socialising out of the home. Therefore, social, behavioural and biological determinants were determined to be significant predictors of the falls in the quantitative phase of the study. These findings were then considered together with the qualitative findings from the interviews. The participant narratives allowed me to explore and integrate these findings in more depth to understand the fall they experienced and their fear of falling. Older adults did not consider 'sight or vision' per se to play a role in their fall or to contribute to their fear of falling but were aware of the difficulties with depth perception and lighting. Interestingly, in this study, contrary to my initial assumptions, there was a commonality in the experiences of falls and fear of falling across the age-related ophthalmic conditions. This suggests that the nature of vision loss was less important in how fear of falling was felt or managed by my study participants. Yet, there were some differences in how participants described their sight.

Throughout this chapter, I have assimilated the quantitative and qualitative findings and first discuss the importance of sight with the emphasis on depth perception, contrast sensitivity and lighting. This is followed by a discourse on managing risk and fear of falling drawing on the concept of resilience and Bourdieu's theory of capital.

9.2 Is sight important in falls?

Vision is often overlooked in the falls assessment of older adults. While the evidence in this thesis, suggests that impaired depth perception and contrast sensitivity are predictors for a further fall, in Chapter 7, very few falls participants attributed their fall or their fear of falling to their sight. There was no evidence in the literature or from my interviews to suggest that any discussion takes place with older adults about the risk of falls with impaired visual function in an ophthalmology setting or in a falls assessment. Therefore, an older adult has not been subjected to this narrative of the importance of vision in falls. This may explain why participants did not consider their sight as a concern for falls and fear of falling and instead talked about physical, behavioural and environmental causes. These findings are similar to those reported in a qualitative study by Brundle et al. (2015) that explored the views of visually impaired older people on the causes of falls. In their paper, they identified the impact of sight on negotiating home and environment but some of their interview data privileged environmental issues above sight. This supports the notion that sight and negotiating the environment are inextricably linked as we move within a three-dimensional environment with many contrasting features. In combining quantitative data around stereoacuity with narrative data from the interviews, I have made a link between the importance of depth perception as a function of sight and falls.

In the quantitative phase of my study, I demonstrated reduced measures of visual acuity, depth perception and contrast sensitivity when data from both falls and non-falls participants were compared. Depth perception and contrast sensitivity remained as statistically significant risk factors ($p<0.05$) after adjusting for other non-visual risk factors. Specifically, older adults with depth perception worse than 85" of arc are three times more likely to experience a further fall (95%CI: 1.20-9.69). Also, an improvement in spatial contrast sensitivity (18 cpd) by one contrast level on the CSV100E would reduce the risk of fall by 89% (95%CI, 0.02-0.48). These are also clinically significant as both measures fell below the normal clinical threshold. These findings are consistent with other cross-sectional studies (Ivers et al. 2000; Lord & Dayhew 2001; Nevitt et al. 1989). The published evidence for visual acuity as a risk factor for falls (Chapter 2) is inconsistent. Similarly, the VA findings in my data were inconclusive as VA was significant at a univariate level but not clinically significant. Visual acuity provides limited information about other types of visual function (Ginsburg 2003) such as how well an individual performs while interacting with the visual environment (Bennett et al. 2019). Whereas contrast sensitivity and stereoacuity are both measures of visual function that provide better information about vision in the real world.

Difficulties with depth perception were described by many participants when describing their sight. Whilst contrast sensitivity was not explicitly described as a problem in their narratives, participants spoke about issues with lighting levels and adapting to light. This issue of adapting to light has been reported to impact on contrast (Superstein et al. 1997; Zakerian et al. 2018). Therefore, in the following sections, I discuss the quantitative and qualitative data on depth perception and contrast sensitivity as the two main visual function findings associated with falls in older adults.

9.2.1 Judging depth

Few qualitative studies have explored the subjective depth percept (Railo et al. 2018; Vishwanath & Hibbard 2013) and none that I have found have explored the perceptions of people with either a lifelong absence of stereopsis or those who become stereodeficient later in life. The quantitative assessment of stereoacuity was not always congruent with the participants' description of their ability to appreciate depth. For example, the amblyopic participants with longstanding reduced/absent stereoacuity did not describe any problems with depth, unlike those who had impaired depth or loss of stereoacuity in adulthood and reported having difficulty with judging depth and missing steps.

Vishwanath and Hibbard (2013) suggested that the subjective qualitative appreciation of depth should be dissociated from its objective quantitative measurement when discussing stereopsis and argue that the subjective sensation of depth can occur without binocular disparity. Railo et al. (2018) investigated the effect of binocular disparity on the subjective and objective appreciation of stereopsis. They demonstrated that the functional advantage of stereovision did not require an enhanced conscious perception of depth. Similarly, I have demonstrated in this study that the measurement of stereoacuity did not always compare with the participants' narrative of depth perception. Further support for this difference between the depth percept and stereoacuity has been demonstrated in a study by Lindstrom, Davis and Frisby (2009) who reported substantial individual differences between perceived depth of the Wirt fly and stereoacuity measures using Randot circles and Frisby. The authors also confirmed reports of reduced stereoacuity due to monocular blur induced by plus lenses (Costa et al. 2010; Vale, Buckley & Elliott 2008) and Bangerter filters (Odell et al. 2009b).

Monocular blur has also been reported to impair stereoacuity and consequently associated with increased toe clearance when negotiating a raised surface (Vale, Buckley & Elliott 2008). The authors went on to conclude that participants under compromised visual conditions adopt a cautious gait. I did not have an opportunity to measure gait in this study but a number of participants (N=36) had experienced a trip and during the interviews some described difficulties with judging depth and being more ‘careful’ when negotiating different levels. Refractive blur potentially induced by multifocal lenses has also been reported to impair depth perception (Lord, Dayhew & Howland 2002) and negatively affect stepping accuracy in older adults (Black et al. 2016). The impact of the graded reduction in stereoacuity on gait in older adults would be an area worth exploring in future studies. Although I detected no significant association of varifocals and falls in the quantitative phase of my study (Chapter 5), a few participants reported difficulties adapting to varifocals especially when going downstairs. One participant, in particular, experienced multiple falls which he felt were due to his varifocal lenses making it difficult for him to judge the height of obstacles on the ground. Following a change to single vision glasses, he was able to regain his confidence to continue with his daily activities. This embodied change in his outlook demonstrates the impact of a temporary change to stereoacuity levels, on falls and fear of falling.

A change in stereoacuity can also occur with age, with declines reported to commence around the age of 50 years (Bohr & Read 2013; Costa et al. 2010; Garnham & Sloper 2006; Lee & Koo 2005; Norman et al. 2008; Wright & Wormald 1992; Zaroff, Knutelska & Frumkes 2003). Stereoacuity can be impaired in age-related ophthalmic conditions such as cataracts (Elliott et al. 2000; Manoranjan, Shrestha & Shrestha 2013), AMD (Suzuma et al. 2008) and glaucoma (Lakshmanan & George 2013). Yet, few studies have reported the functional effect of impairment of stereoacuity in later life. Elliott et al. (2000) did demonstrate an improvement in mobility orientation, walking speed and obstacle avoidance following second eye cataract surgery. This finding would be supported by the improvement of stereoacuity following second eye cataract surgery (Elliott et al. 2000; Ishikawa et al. 2013; Laidlaw et al. 1998). However, the question remains whether people who have had long term absence or impairment of stereoacuity have the same functional effect.

A common cause of long term absence or impairment of depth perception is amblyopia (Levi, Knill & Bavelier 2015). A few of the participants (Falls=1, Non-falls=5) were amblyopic and consequently stereodeficient. However, other participants who had age-related ophthalmic conditions were more likely to be stereodeficient due to having a mismatch of retinal images (Falls=9, Non-falls=5). Whilst the functional significance of stereopsis has been studied in terms of performing visuomotor tasks (O'Connor et al. 2010; Piano & O'Connor 2013), there is a lack of published data on comparing the functional significance of long term loss of stereopsis due to amblyopia and a recent loss or reduction due to reduced visual input in later life. A long term loss of stereoacuity has been demonstrated to impact on fine motor skill tasks (O'Connor et al. 2010) and gait (Buckley et al. 2010). O'Connor et al. (2010) reported evidence of adaptation to the long-term absence of stereoacuity where participants with nil stereoacuity performed better on fine motor skills tasks compared to those who were temporarily stereo blind (due to monocular occlusion) but their speed and accuracy on the visuomotor tasks was below that of the participants with high-grade stereoacuity.

Buckley et al. (2010) did not compare the effect of long term and temporary loss of stereoacuity on gait but did demonstrate that individuals with impaired stereovision due to amblyopia and/or associated conditions adopted a more cautious gait when negotiating higher obstacles. Their findings would suggest that stereodeficient individuals would be at greater risk of trips and falls. In addition to the effect on gait, stereoacuity equal to or worse than 150” of arc in older adults has been reported to be associated with poor balance (Althomali & Leat 2018). In Chapter 5, although I did not test the association of stereoacuity and TUTG as they were both measured following the fall, I demonstrated that participants who had stereoacuity worse than 85” of arc (a relatively low level of stereo function measured with Frisby) were three times more likely to be at risk of falls, further supporting the role of stereoacuity in everyday locomotion.

The quantitative and qualitative evidence that I have presented and those from others suggests that depth perception is a key risk factor for older adults in negotiating their environment in daily life. However, this measure of visual function is not currently assessed or spoken about during a falls or ophthalmic (non-orthoptic) assessment for older adults. Improvement of stereoacuity in amblyopes using perceptual learning techniques has been demonstrated in studies of varying methodological quality leading to inconclusive evidence (Levi, Knill & Bavelier 2015). Therefore, whilst future studies are conducted to improve stereoacuity in older adults, healthcare professionals in falls clinics and ophthalmology should be cognisant of the risks associated with impaired stereoacuity. This can then be effectively communicated and inform any potential home or environment adaptations to minimise falls risk.

9.2.2 Contrast sensitivity and lighting

Contrast sensitivity is a better measure of real-world vision compared to high contrast distance visual acuity, as the world is not comprised of uniform high contrast objects. Poor contrast sensitivity has been associated with falls (Chapter 2, Table 2.5) and postural instability (Lord & Menz 2000; Turano et al. 1994) in many cross-sectional studies. In Chapter 5 (Section 5.3.3) I reported that less than a third of the falls participants passed the age threshold of contrast sensitivity measured at 12 and 18 cpd. The multivariable regression analysis (Table 5.29) demonstrated that if contrast sensitivity at 18 cpd improved by one unit the participant's chance of having a fall decreased by 89%. Owing to the age demographics of the sample, it is conceivable that many of the participants would have some grade of cataract and, although their distance visual acuity may not be impaired, it may explain the decline in contrast sensitivity. This suggestion is supported by Chua, Mitchell and Cumming (2004) who reported reduced contrast sensitivity at spatial frequencies equal to or greater than 6 cpd in patients with early posterior subcapsular and cortical cataracts. In a study to determine the effects of simulated cataracts on how individuals negotiated a single step, Heasley et al. (2004), reported that subjects took longer to take the step to another level and adopted a more cautious gait.

Contrast related causative factors for falls have been described by participants in a previously published study (Boon et al. 2015). Contrary to this, none of my study participants with cataracts or other age-related ophthalmic conditions specifically articulated difficulties with contrast in their narratives. The participants did not highlight issues with contrast when describing their sight or in the cause of the fall. Instead, participants were more likely to point to physical causes of their falls, for example, poor health or mobility and/or environmental causes like poor pavements or lighting. The difficulties with lighting raised by several participants may also be related to their contrast function. This suggestion is supported by Sloane, Owsley and Alvarez (1988) who demonstrated in their study significant losses in spatial contrast sensitivity in older adults which were further impaired under low environment light levels. Furthermore, the participants I interviewed commonly reported visual difficulties under low environmental lighting. Increased light scatter in an ageing lens has been suggested as a possible explanation for this impairment under low luminance (Sloane, Owsley & Alvarez 1988).

Negotiating a real-world environment with impaired depth perception and/or contrast sensitivity is potentially further exacerbated under reduced luminance for older adults. This was confirmed by a study demonstrating a more cautious and unstable gait in individuals with visual function deficits such as blurred vision (caused by a 10% reduction in contrast) and impaired stereoacuity under dim lighting conditions (Helbostad et al. 2009). Whilst I did not assess gait in either phase of my study, some participants did describe being 'cautious', particularly in low lighting conditions (Chapter 7, Section 7.3). This was particularly evident in the narratives of participants with glaucoma. A study reported that ambient lighting <300 lux and exposed light bulbs were the most common fall-related hazards in individuals with glaucoma at home (Yonge et al. 2017). The same group in a later study to determine the location, circumstances and outcomes of falls in patients with glaucoma, demonstrated that the most common location for falls was in and around the home. The authors reported that an uneven floor and poor vision were cited by the participants as the third and fourth most common contributing factor to the fall (Sotimehin et al. 2018).

Stereoacuity and spatial contrast sensitivity are two key measures of visual functions that have been identified as an important part of sight. Based on these findings I would recommend the inclusion of these in the vision assessment of older adults at risk of falls. This would allow appropriate home and environment adaptations and potentially reduce the risk of further falls. Furthermore, there is also a role for healthcare professionals to advise individuals with age-related ophthalmic conditions of the falls risks associated with impaired stereoacuity and contrast sensitivity. This knowledge would empower them to manage their own risks. This will be further explored in the next section.

9.3 Managing the risk and fear of falls

One of the objectives of this study was to explore the impact of age-related sight threatening conditions on falls and fear of falling. Participants who had been diagnosed with an age-related ophthalmic condition in the last two years but had not experienced a fall were generally not ‘fearful’ but instead ‘cautious’. However, participants who had experienced multiple falls were more concerned about having a fall when doing particular activities (as per the FES-I). Also, some of these participants spoke about being ‘terrified’ of having a further fall. Very few participants were fearful of having a fall due to their sight and most cited having experienced a fall and that the consequences (for example, poor health and mobility) led them to be fearful (Chapter 7). Whilst this may be true for the participants in my study, it cannot be generalised to all falls participants or people who have just been diagnosed with either cataracts, AMD and/or glaucoma. Studying falls and fear of falling is complex with the number and interaction of risk factors, including the personal and social circumstances involved in the manifestation of these two outcomes.

In Chapter 7, I demonstrated that non-falls participants typically proceed with their daily activities and routines, but with caution. These findings are similar to those reported in a phenomenological study exploring the everyday experience of older adults with respect to fear of falling (Ward-Griffin et al. 2004). The authors suggested that there was a dynamic tension between exercising precaution and striving for independence. However, the authors reported that participants *restricted their activities* and *depended on help* as some of the strategies for ‘exercising precaution’. ‘Striving for independence’ included *minimising the impact of the fall* and *resisting confinement* as the strategies employed by the older adults.

However, I found that whilst participants may have been striving for independence or trying to maintain a status-quo, they were exercising precaution by being 'careful' rather than restricting activities (Chapter 7, Section 7.3).

Fear and risk are concepts that are often considered together as discussed in Chapter 3 (Furedi 2006; Lupton 1999; Tulloch & Lupton 2003). However, I propose that managing fear or risk is also related to resilience. The extent to which fear and risk were managed by participants to enable them to be resilient was influenced by the individual, social and environmental resources available to them (Chapter 8). Some of the participants I interviewed were 'getting on with it' despite the fall or the diagnosis of an age-related ophthalmic condition.

9.3.1 Resilience

The concept of resilience associated with successful ageing (Wagnild 2003) has been linked to personal agency (Rowe & Kahn 1997). However, the accounts of the individuals in this study suggest that resilience is not simply an individual responsibility but that there are broader social and structural issues contributing to how an individual may respond to a disruptive event. Some common themes emerged from the data in terms of resources that influenced the participant's response to a disruptive event like a fall or the onset of an ophthalmic condition: a potential risk factor for having a fall.

Broadly, I grouped the themes into individual, social and environmental resources that emerged from the interviews, exploring the life-world of the participants following the fall or diagnosis. Windle (2011) in her definition of resilience referred to assets and resources within the individual that contribute to the resilience process. This definition could be further developed to include the influence of broader social structures on resilience based on the evidence I have presented regarding the influence of socioeconomic status on available resources. Socio-economic status has been consistently demonstrated to have an impact on conditions of daily life and health inequalities (Marmot 2010; Marmot et al. 2012). This is further supported by an increased proportion of falls participants living in more deprived areas of Liverpool, compared to the non-falls participants (Chapter 5, Figure 5.2).

Abel and Frohlich (2012), in their paper, draw on Bourdieu's concept of capital and habitus to explain why individuals from a low socioeconomic position are less likely to be in good health. Similarly, I found the availability of resources in managing risk/fear or adversity in my study participants was related to Bourdieu's concept of habitus or capital (Bourdieu 1984). There was evidence of the contribution of either economic, social or cultural capital to resources throughout the participants' narratives.

Economic capital

Having economic capital enabled participants to make adaptations to their lifestyle and manage their risk to continue living well, for example, move to assisted living, or get a taxi from Liverpool to London. One of the domains to calculate the multiple deprivation index, an indicator of economic capital, is *living environment deprivation.* A dominant theme from the participants' interview data was the state of their outdoor living environment either as a cause of their fall (Chapter 7, Section 7.2.1.) or as an influence in being able to 'get on with it' (Chapter 8, Section 8.3.3- environmental resources). Many of the participants described poor pavements and lighting in their environment as hazards for falls. These participants also had poorer general health and were less physically active. This supports the finding of a systematic review of the environmental influences on physical activity which cited barriers for physical activity as living in high poverty areas, little or inappropriate infrastructure for such activity, poor quality footpaths and lack of street lighting (Annear et al. 2014). In Chapter 5, I reported the association of reduced physical activity with falls at a univariate level but it was not a confounder in the relationship between impaired visual function (stereoacuity and contrast sensitivity) and falls in the multivariable regression model. However, reduced socialising out of the home did remain in the regression model as a confounder and may account for physical activity no longer being significant as both covariates involve non-sedentary behaviour. The impact of the lack of economic capital is evident here but it also impacts on other forms of capital: cultural and social (Bourdieu 1986).

Cultural

Knowledge (cultural capital) about their condition was critical and reassuring for some participants I interviewed. However, it was evident that this was not consistently available to all participants I interviewed. This is an example of where it is the responsibility of the social structures (healthcare system) for the consistent dissemination of knowledge (cultural capital). Having knowledge could potentially allow individuals to appraise their risk in certain situations (Beck 1992; Giddens 1991) and make informed choices. Also, advising individuals on the functional impact of their impaired visual function could potentially reduce the risk of further falls. For example, if older adults were having difficulties with impaired depth perception or lighting, as well as making the necessary adaptations in the home, they could be advised to take a moment before moving between areas of different ground levels or luminance. Published evidence suggests that there is inadequate information provided by healthcare professionals (de Vries McClintock et al. 2016; Waitzkin 1985). However, it is difficult to ascertain the effect of information provision in terms of it being anxiety-inducing or empowering. Yardley et al. (2006), in a qualitative study, suggest that for some participants the discussion of falls risk may have been anxiety-provoking. Yet, a study specifically exploring the provision of information and support to AMD patients reported that participants required ongoing information to manage their fear and uncertainty (Burton, Shaw & Gibson 2013). The authors give a specific example of a participant with AMD who was "frightened of falling" and that this fear had motivated her to search for information. Hence, they recommended that individuals with AMD were offered a person-centred approach with adequate information provision that supports their self-efficacy and self-advocacy.

Social

Participants spoke about social resources (social capital), in the form of the social support/networks they had available to them. The evidence from the narratives suggests that social relations are important in managing health adversities. Furthermore, this was supported by the finding in my study, that 'socialising out of the home' was a confounder in the association of impaired visual function and falls.

Socialising out of the home by an additional day was found to reduce the risk of falls in the quantitative phase. Similarly, Pinxten and Lievens (2014) demonstrated that a low level of social support is negatively related to physical health. The ideology of social capital contributing to good health was proposed by Putnam (2000) where he asserts that a decline in social networks can potentially lead to poor health and social isolation. Putnam's idea of social capital is based on community social engagement rather than at an individual level. Therefore, there is a case for health care professionals to engage with social prescribing (Public Health England 2019b) for older adults to improve health and well-being and potentially reduce the risk of falls.

Hence, the clinical implications of the work in this thesis are outlined in the next section to prevent further falls in older adults.

9.4 Clinical implications

Based on the quantitative and qualitative evidence in this thesis, I propose that the following guidance is used for a vison assessment in the multifactorial falls assessment of older adults at risk of falls:

Falls assessment

- Brief ophthalmic history:
    - Last visit to an orthoptist/optician/ophthalmologist
    - Any previous history of ophthalmic conditions
- Visual acuity of either eye to measure clinical visual function and identify older adults who have reduced high contrast acuity due to uncorrected refractive errors or undetected ophthalmic conditions.
- Spatial contrast sensitivity at mid-high spatial frequencies
- Stereoacuity using the Frisby test.

Outcomes

- If an individual aged between 60-70 years has not visited the optician in the past 2 years, advise to make an appointment with the optician

- If individual is ≥70 years, they should attend an optician annually (Advise these are free eye tests)
- If no previous history of ophthalmic conditions (e.g. childhood or adult onset) and VA in either eye is worse than +0.30 logMAR, advise to make an appointment with the optician.
- If contrast sensitivity at 18cpd is worse than 0.68 log units with both eyes open, refer to the orthoptist.
- If stereoacuity is worse than 85" of arc and there is no previous ocular history (e.g. strabismus, amblyopia or ophthalmic condition) refer to the orthoptist /optician.

In addition, I recommend that eye care professionals empower older adults with knowledge and advice about their sight condition to manage falls risk. Therefore, risk must be communicated in the form of health education using appropriate health literacy (Gesme & Wiseman 2012) to avoid older adults becoming fearful and instead feel well-informed about their functional vision.

Advice from healthcare professionals to older adults at risk of falls

Any older adults with uncorrectable ophthalmic conditions, that potentially impair stereoacuity and contrast, should be advised of the possible impairments and their functional impact. However, this needs to be communicated in a manner that is understandable by older people considering their health literacy. Words like 'risk' should be avoided and instead older people should be informed of what to expect in terms of their vision so they are not afraid to be active and can continue with their daily living. For example, detecting contrast under low luminance conditions, variable flooring and taking care on steps. Also, to ensure that older adults with ophthalmic conditions take time to adapt to different levels of luminance when negotiating different environments.

Outcomes of the visual assessment should also be communicated to other members of the multi-disciplinary team to facilitate vision specific home adaptations. The Eye Clinic Liaison Officer (ECLO) would be an ideal person to advise an older adult of services to access to enable effective implementation of the home adaptations particularly for those with limited financial resources.

Social prescribing should also be considered for older adults at risk of falls and who do not participate in social activities outside of the home.

9.5 Strengths and limitations

The strengths of this study include the use of a robust statistical study augmented with qualitative interviews to explore in depth the impact of visual function on falls and fear of falling. Many studies have explored risk factors for falls and specifically the impact of visual functions on falls which have been discussed in Chapter 2. The main strength of the quantitative phase is that it is an observational individually age-matched case-control investigation. Participants were assessed within two months of their fall and therefore there was little recall bias of falls and no participants reported visual losses as a result of the fall. Also, I was able to appropriately adjust for demographic, general health, social and living arrangements and physical activity data using an appropriate selection of confounders and analysis. However, the cross-sectional design means that caution should be used in interpreting any causative effect of the variables on falls. I employed standard clinical tests to enable the findings to be translatable to clinical practice.

The use of interviews in this study allowed me to explore in depth the context of the fall and the role of sight from the participant's perspective and the impact of each of these disruptive events on their lifeworlds. Many of the falls participants in the qualitative phase were the same as those in the quantitative phase. Therefore, I was able to triangulate the findings from both of these phases providing rich clinical and narrative data, particularly when participants described their sight in relation to falls and fear of falling. However, for the non-falls group, only a third were recruited from the quantitative phase and the aim was to explore the impact of their sight on fear of falling and daily life. Hence, the criterion was no fall since their diagnosis and limited to two years to allow participants to access their memory of life before the onset of their sight condition.

Limitations of the quantitative phase include the lack of older adults ≥ aged 80 years who had experienced a fall and the potential for educated, active participants to volunteer to take part as non-falls participants, hence introducing sample selection bias. In future studies, best-corrected VA and a slit-lamp examination should be included in the design to identify individuals with uncorrected refractive errors and grade any ocular pathology respectively. The RAPA tool was quick to administer and easy for older adults to understand to determine their level of physical activity. However, it does not address the balance component of fitness which is a key risk factor for falls. The FES-I is a validated tool but is primarily concerned with falls efficacy. Future studies exploring fear of falling using mixed methods could also include the SAFFE tool if it was not too onerous for older participants in terms of the burden of time as it is a good predictor of activity level. Whilst the qualitative interviews allowed me to explore a range of issues in depth, and identify the themes outlined in Chapters 6, 7 and 8, the main limitation is that these findings cannot be generalised to larger populations.

9.6 Summary

Depth perception and contrast sensitivity are the main visual predictors of a further fall in this study of older adults. This finding was further supported by participants' (with age-related ophthalmic conditions) descriptions of their sight. However, very few participants explicitly cited the role of sight in their fall but did identify poor environmental attributes which require optimal visual function to successfully negotiate. For the context of this study, I found that managing falls risk and fear is related to resilience and is underpinned by individual, social and environmental resources. The narratives of the participants lead me to theorise that the availability of these resources is connected to Bourdieu's concept of habitus or capitals (economic, cultural and social) (Bourdieu 1984). Older adults living in the most deprived areas of Liverpool were at greater risk of having a fall and poor environments (poor pavement and lighting) were most commonly cited by the participants as a risk for falls. These findings and the desire for knowledge in the medical setting support the significance of social determinants of health in the context falls. Furthermore, the importance of maintaining social connection/networks was evident in the quantitative and qualitative analysis of the data.

Falls will continue to be a public health problem as the ageing population is set to increase, therefore I have outlined below some recommendations for future research:

- Evaluate the implementation of the guidance outlined in this study.
- A long-term study to explore the fear of falling in older adults at various time points.
- An exploration of the impact of long term vs recent loss of visual function.
- Development of a portable digital tool to measure stereoacuity and spatial contrast sensitivity in older adults at risk of falls.
- A longitudinal study to evaluate the effect of cataracts on stereoacuity, contrast sensitivity and falls, including 1st and 2nd cataract extraction.
- Effect of age-related ophthalmic conditions on gait in relation to measures of visual function.
- Explore people's perception of the provision of personalised healthcare information about their eye condition.

Conclusions

By using both qualitative and quantitative methods of inquiry, I have demonstrated the association of biological, social and behavioural factors with falls and fear of falling. The biological determinants of falls risk included impaired depth perception, contrast sensitivity and hearing. Older adults with stereoacuity worse than 85" of arc are over three times more likely to experience a further fall. A unit increase in spatial contrast sensitivity (18 cpd) would result in an 89% reduced risk of a fall. These effect sizes are clinically significant. The associations with visual function were also supported by the qualitative phase of the study, in which participants with age-related ophthalmic conditions described difficulties with depth perception and lighting.

Social factors were evident with falls and fear of falling in both the quantitative and qualitative phase of the study. Income deprivation affecting older people was a significant risk factor for falls. The effect of socio-economic status was evident throughout the narratives of the participants when describing the poorly maintained environment they lived in (uneven pavements and poor lighting) and also affecting the resources available to them to manage falls risk and fear.

Whilst socialising out of the home could be considered a social factor, I have interpreted it in the quantitative phase of the study as a behavioural factor which was associated with a reduced risk of falls. However, this could also relate to increased physical activity and warrants further exploration.

Very few participants considered the role of their sight as being directly important in the fall or were fearful of having a fall due to their sight. Fear of falling varied according to whether participants had a single fall or multiple falls. Many participants proceeded with caution, particularly those who had not experienced a fall since the diagnosis of their sight condition. Participants continued with their daily routines and managed their falls risk/fear that I have conceptualised as resilience with individual, environmental and social resources. Healthcare knowledge was important to participants I spoke with to help manage their risk. Having social support was also a key factor in managing falls risk. Therefore, healthcare professionals have a role to play in empowering older adults with knowledge and advice to potentially mitigate the risk of falls.

References

Abel, T. (2008) 'Cultural capital and social inequality in health', *Journal of Epidemiology and Community Health*, vol. 62, no. 7, p. e13.

Abel, T. & Frohlich, K.L. (2012) 'Capitals and capabilities: Linking structure and agency to reduce health inequalities', *Social Science & Medicine*, vol. 74, no. 2, pp. 236-244.

Academy of Medical Royal Colleges (2019) *Healthcare Professionals' Consensus Statementfor ActionStatement forHealth and Work* [Online], Available from: https://www.aomrc.org.uk/wp-content/uploads/2019/04/Health-Work_Consensus_Statement_090419.pdf (Accessed: 14/9/19).

Adachi, S., Yuki, K., Awano-Tanabe, S., Ono, T., Shiba, D., Murata, H., Asaoka, R. & Tsubota, K. (2018) 'Factors associated with developing a fear of falling in subjects with primary open-angle glaucoma', *BMC Ophthalmology*, vol. 18, p. 7.

Adolphs, R. (2013) 'The biology of fear', *Current biology : CB*, vol. 23, no. 2, pp. R79-R93.

Ahmad Kiadaliri, A., Turkiewicz, A. & Englund, M. (2018) 'Educational inequalities in falls mortality among older adults: population-based multiple cause of death data from Sweden', *Journal of Epidemiology and Community Health*, vol. 72, no. 1, pp. 68-70.

Alaszewski, A. & Coxon, K. (2009) 'Uncertainty in everyday life: Risk, worry and trust', *Health Risk & Society*, vol. 11, no. 3, pp. 201-207.

Alexander, M.S., Lajoie, K., Neima, D.R., Strath, R.A., Robinovitch, S.N. & Marigold, D.S. (2014) 'Effects of age-related macular degeneration and ambient light on curb negotiation', *Optom Vis Sci*, vol. 91, no. 8, pp. 975-989.

Almegbel, F.Y., Alotaibi, I.M., Alhusain, F.A., Masuadi, E.M., Al Sulami, S.L., Aloushan, A.F. & Almuqbil, B.I. (2018) 'Period prevalence, risk factors and consequent injuries of falling among the Saudi elderly living in Riyadh, Saudi Arabia: a cross-sectional study', *BMJ Open*, vol. 8, no. 1, p. e019063.

Althomali, M.M. & Leat, S.J. (2018) 'Binocular Vision Disorders and Visual Attention: Associations With Balance and Mobility in Older Adults', *Journal of Aging & Physical Activity*, vol. 26, no. 2, pp. 235-247.

Alvesson, M., Hardy, C. & Harley, B. (2008) 'Reflecting on Reflexivity: Reflexive Textual Practices in Organization and Management Theory', *Journal of Management Studies*, vol. 45, no. 3, pp. 480-501.

Alvesson, M. & Sköldberg, K. (2018) *Reflexive methodology : new vistas for qualitative research*, 3rd Edition edn, SAGE, Los Angeles.

Ambrose, A.F., Paul, G. & Hausdorff, J.M. (2013) 'Risk factors for falls among older adults: a review of the literature', *Maturitas*, vol. 75, no. 1, pp. 51-61.

Annear, M., Keeling, S., Wilkinson, T.I.M., Cushman, G., Gidlow, B.O.B. & Hopkins, H. (2014) 'Environmental influences on healthy and active ageing: a systematic review', *Ageing and Society*, vol. 34, no. 4, pp. 590-622.

Ansons, A.M. & Davis, H. (2014) *Diagnosis and management of ocular motility disorders*, 4th ed. edn, Wiley.

Antona, B., Barrio, A., Barra, F., Gonzalez, E. & Sanchez, I. (2008) 'Repeatability and agreement in the measurement of horizontal fusional vergences', *Ophthalmic & Physiological Optics*, vol. 28, no. 5, pp. 475-491.

Antonovsky, A. (1981) *Health, stress, and coping*, Jossey-Bass Publishers, San Francisco;.

Antonovsky, A. (1996) 'The salutogenic model as a theory to guide health promotion', *Health Promotion International*, vol. 11, no. 1, pp. 11-18.

Antonovsky, H. & Sagy, S. (1986) 'The development of a sense of coherence and its impact on responses to stress situations', *The Journal of Social Psychology*, vol. 126, no. 2, pp. 213-225.
Ao, M., Li, X., Qiu, W., Hou, Z., Su, J. & Wang, W. (2019) 'The impact of age-related cataracts on colour perception, postoperative recovery and related spectra derived from test of hue perception', *BMC Ophthalmology*, vol. 19, no. 1, p. 56.
Applegate, R.A., Adams, A.J., Cavender, J.C. & Zisman, F. (1987) 'Early color vision changes in age-related maculopathy', *Applied Optics*, vol. 26, no. 8, pp. 1458-1462.
Aspers, P. (2009) 'Empirical Phenomenology: A Qualitative Research Approach (The Cologne Seminars)', *Indo-Pacific Journal of Phenomenology*, vol. 9, no. 2, pp. 1-12.
Attebo, K., Mitchell, P. & Smith, W. (1996) 'Visual acuity and the causes of visual loss in Australia. The Blue Mountains Eye Study', *Ophthalmology*, vol. 103, no. 3, pp. 357-364.
Austin, N., Devine, A., Dick, I., Prince, R. & Bruce, D. (2007) 'Fear of Falling in Older Women: A Longitudinal Study of Incidence, Persistence, and Predictors', *Journal of the American Geriatrics Society*, vol. 55, no. 10, pp. 1598-1603.
Baig, S., Diniz-Filho, A., Wu, Z., Abe, R.Y., Gracitelli, C.P., Cabezas, E. & Medeiros, F.A. (2016) 'Association of Fast Visual Field Loss With Risk of Falling in Patients With Glaucoma', *JAMA Ophthalmololgy*, vol. 134, no. 8, pp. 880-886.
Bailey, C., Jones, D. & Goodall, D. (2014) 'What is the evidence of the experience of having a fall across the life course? A qualitative synthesis', *Disabil Health J*, vol. 7, no. 3, pp. 273-284.
Ballinger, C. & Payne, S. (2000) 'Falling from Grace or into Expert Hands? Alternative Accounts about Falling in Older People', *British Journal of Occupational Therapy*, vol. 63, no. 12, pp. 573-579.
Ballinger, C. & Payne, S. (2002) 'The construction of the risk of falling among and by older people', *Ageing and Society*, vol. 22, no. 3, pp. 305-324.
Bambo, M.P., Ferrandez, B., Guerri, N., Fuertes, I., Cameo, B., Polo, V., Larrosa, J.M. & Garcia-Martin, E. (2016) 'Evaluation of Contrast Sensitivity, Chromatic Vision, and Reading Ability in Patients with Primary Open Angle Glaucoma', *J Ophthalmol*, vol. 2016, p. 7074016.
Bandura, A. (1982) 'Self-efficacy mechanism in human agency', *American Psychologist*, vol. 37, no. 2, pp. 122-147.
Barnes, C.S. & Hall, C.D. (2019) 'Similarity In Rates Of Falls And Fear Of Falling (Fof) Between Groups Of Older Men And Women With Age-Related Macular Degeneration (AMD)', *Age and Ageing*, vol. 48, no. Supplement_2, pp. ii20-ii22.
Barnett, K., Mercer, S.W., Norbury, M., Watt, G., Wyke, S. & Guthrie, B. (2012) 'Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study', *Lancet*, vol. 380, no. 9836, pp. 37-43.
Bassi, C.J. & Galanis, J.C. (1991) 'Binocular visual impairment in glaucoma', *Ophthalmology*, vol. 98, no. 9, pp. 1406-1411.
Bazeley, P. (2013) *Qualitative data analysis : practical strategies*, SAGE.
Beck, U. (1992) *Risk Society: Towards a New Modernity*, SAGE, London.
Becker, G. (1999) *Disrupted Lives. How people create meaning in a chaotic world*, University of California Press.
Beddoe, L. (2014) *Risk and Vulnerability discourses in health.* , Routledge, London.
Bennett, C.R., Bex, P.J., Bauer, C.M. & Merabet, L.B. (2019) 'The Assessment of Visual Function and Functional Vision', *Seminars in Pediatric Neurology*, vol. 31, pp. 30-40.
Berger, R. (2015) *Now I see it, now I don't: researcher's position and reflexivity in qualitative research*, vol. 15, pp. 219-234.

Berkman, L.F. & Syme, S.L. (1979) 'Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents', *American Journal of Epidemiology*, vol. 109, no. 2, pp. 186-204.

Bertera, E.M. & Bertera, R.L. (2008) 'Fear of falling and activity avoidance in a national sample of older adults in the United States', *Health & Social Work*, vol. 33, no. 1, pp. 54-62.

Bevan, M.T. (2014) 'A Method of Phenomenological Interviewing', *Qualitative Health Research*, vol. 24, no. 1, pp. 136-144.

Bhala, R.P., O'Donnell, J. & Thoppil, E. (1982) 'Ptophobia. Phobic fear of falling and its clinical management', *Physical Therapy*, vol. 62, no. 2, pp. 187-190.

Bhorade, A.M., Perlmutter, M.S., Wilson, B., Kambarian, J., Chang, S., Pekmezci, M. & Gordon, M. (2013) 'Differences in Vision Between Clinic and Home and the Effect of Lighting in Older Adults With and Without Glaucoma', *JAMA Ophthalmology*, vol. 131, no. 12, pp. 1554-1562.

Bjerk, M., Brovold, T., Skelton, D.A. & Bergland, A. (2018) 'Associations between health-related quality of life, physical function and fear of falling in older fallers receiving home care', *BMC Geriatrics*, vol. 18, no. 1, pp. 253-253.

Black, A.A., Drager, D., Parker, L., Richardson, M., Urquhart, T. & Wood, J.M. (2016) 'Effect of Gaze Position and Blur on Stepping Accuracy in Older Adults', *Optometry and Vision Science*, vol. 93, no. 6, pp. 560-566.

Black, A.A., Wood, J.M. & Lovie-Kitchin, J.E. (2011) 'Inferior field loss increases rate of falls in older adults with glaucoma', *Optometry and Vision Science*, vol. 88, no. 11, pp. 1275-1282.

Blake, A.J., Morgan, K., Bendall, M.J., Dallosso, H., Ebrahim, S.B.J., Arie, T.H.D., Fentem, P.H. & Bassey, E.J. (1988) 'Falls by elderly people at home: Prevalence and associated factors', *Age and Ageing*, vol. 17, no. 6, pp. 365-372.

Bloch, F., Thibaud, M., Dugué, B., Brèque, C., Rigaud, A.-S. & Kemoun, G. (2011) 'Psychotropic Drugs and Falls in the Elderly People: Updated Literature Review and Meta-Analysis', *Journal of Aging and Health*, vol. 23, no. 2, pp. 329-346.

Bloch, F., Thibaud, M., Dugue, B., Breque, C., Rigaud, A.S. & Kemoun, G. (2010) 'Episodes of falling among elderly people: a systematic review and meta-analysis of social and demographic pre-disposing characteristics', *Clinics*, vol. 65, no. 9, pp. 895-903.

Bloch, F., Thibaud, M., Tournoux-Facon, C., Brèque, C., Rigaud, A.-S., Dugué, B. & Kemoun, G. (2013) 'Estimation of the risk factors for falls in the elderly: Can meta-analysis provide a valid answer?', *Geriatrics & Gerontology International*, vol. 13, no. 2, pp. 250-263.

Boffin, N., Moreels, S., Vanthomme, K. & Van Casteren, V. (2014) 'Falls among older general practice patients: a 2-year nationwide surveillance study', *Family Practice*, vol. 31, no. 3, pp. 281-289.

Bohannon, R.W. (2006) 'Reference values for the timed up and go test: a descriptive meta-analysis', *Journal of Geriatric Physical Therapy*, vol. 29, no. 2, pp. 64-68.

Bohr, I. & Read, J.C. (2013) 'Stereoacuity with Frisby and revised FD2 stereo tests', *PLoS One*, vol. 8, no. 12, p. e82999.

Bonanno, G.A. (2005) 'Clarifying and extending the construct of adult resilience', *American Psychologist*, vol. 60, no. 3, pp. 265-267.

Boodhna, T. & Crabb, D.P. (2015) 'Disease severity in newly diagnosed glaucoma patients with visual field loss: trends from more than a decade of data', *Ophthalmic and Physiological Optics*, vol. 35, no. 2, pp. 225-230.

Boon, M.Y., Chu, B.S., Lee, P.C., Chiang, T.J., Alshamli, N., Alghamdi, W., Lai, J., Yeung, W. & Bridge, C. (2015) 'Perceptions of Older People Regarding Their Vision and Incident Causation', *Optometry and Vision Science*, vol. 92, no. 10, pp. 995-1002.

Bornat, J. & Bytheway, B. (2010) 'Perceptions and presentations of living with everyday risk in later life', *British Journal of Social Work*, vol. 40, no. 4, pp. 1118-1134.
Bourdieu, P. (1977) *Outline of a Theory of Practice*, trans. R. Nice, Cambridge University Press, Cambridge.
Bourdieu, P. (1984) *Distinction : a social critique of the judgement of taste*, Harvard University Press.
Bourdieu, P. (1986) The Forms of Capital, in J.G. Richardson (ed.), *Handbook of theory and research for the sociology of education*, Greenwood Press.
Boyce, T. (2011) *Falls - costs, numbers and links with visual impairment.*, RNIB, RNIB
Boyd, R. & Stevens, J.A. (2009) 'Falls and fear of falling: burden, beliefs and behaviours', *Age & Ageing*, vol. 38, no. 4, pp. 423-428.
Boyé, N.D.A., Velde, N.v.d., De Vries, O.J., Lieshout, E.M.M.v., Hartholt, K.A., Mattace-Raso, F.U.S., Lips, P., Patka, P., Van Beeck, E.F., Cammen, T.J.M.v.d., van der Cammen, T.J.M., Patka, P., Beeck, E.F.v., van der Velde, N., Polinder, S., Mattace Raso, F.U.S., Hartholt, K.A., Boyé, N.D.A., Looman, C.W.N., Lips, P., Vries, O.J.d. & Kerver, A.J.H. (2017) 'Effectiveness of medication withdrawal in older fallers: Results from the improving medication prescribing to reduce risk of falls (IMPROveFALL) trial'.
Bradbury-Jones, C. (2007) 'Enhancing rigour in qualitative health research: Exploring subjectivity through Peshkin's I's', *Journal of Advanced Nursing*, vol. 59, no. 3, pp. 290-298.
Brashers, D.E., Goldsmith, D.J. & Hsieh, E. (2006) 'Information Seeking and Avoiding in Health Contexts', *Human Communication Research*, vol. 28, no. 2, pp. 258-271.
Bridge, H. (2016) 'Effects of cortical damage on binocular depth perception', *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, vol. 371, no. 1697, p. 20150254.
Britten, N. (1995) 'Qualitative interviews in medical research', *British Medical Journal* vol. 311, no. 6999, pp. 251-253.
Brody, S.J., Poulshock, S.W. & Masciocchi, C.F. (1978) 'The Family Caring Unit: A Major Consideration in the Long-term Support System1', *Gerontologist*, vol. 18, no. 6, p. 556.
Brundle, C., Waterman, H.A., Ballinger, C., Olleveant, N., Skelton, D.A., Stanford, P. & Todd, C. (2015) 'The causes of falls: views of older people with visual impairment', *Health Expectations : An International Journal of Public Participation in Health Care and Health Policy*, vol. 18, no. 6, pp. 2021-2031.
Buckley, J.G., Panesar, G.K., MacLellan, M.J., Pacey, I.E. & Barrett, B.T. (2010) 'Changes to Control of Adaptive Gait in Individuals with Long-standing Reduced Stereoacuity', *Investigative Ophthalmology & Visual Science*, vol. 51, no. 5, pp. 2487-2495.
Bueno-Cavanillas, A., Padilla-Ruiz, F., Jiménez-Moleón, J.J., Peinado-Alonso, C.A. & Gálvez-Vargas, R. (2000) 'Risk factors in falls among the elderly according to extrinsic and intrinsic precipitating causes', *European Journal of Epidemiology*, vol. 16, no. 9, p. 849.
Burns, E. & Kakara, R. (2018) 'Deaths from Falls Among Persons Aged ≥65 Years - United States, 2007-2016', *MMWR. Morbidity and mortality weekly report*, vol. 67, no. 18, pp. 509-514.
Burton, A.E., Shaw, R.L. & Gibson, J.M. (2013) ''I'd like to know what causes it, you know, anything I've done?' Are we meeting the information and support needs of patients with macular degeneration? A qualitative study', *BMJ Open*, vol. 3, no. 11, p. e003306.
Bury, M. (1982) 'Chronic illness as biographical disruption', *Sociology of Health & Illness*, vol. 4, no. 2, p. 167.

Cameron, I.D., Dyer, S.M., Panagoda, C.E., Murray, G.R., Hill, K.D., Cumming, R.G. & Kerse, N. (2018) 'Interventions for preventing falls in older people in care facilities and hospitals', *Cochrane Database of Systematic Reviews*, no. 9.

Campbell, A.J., Borrie, M.J. & Spears, G.F. (1989) 'Risk Factors for Falls in a Community-Based Prospective Study of People 70 Years and Older', *Journal of Gerontology*, vol. 44, no. 4, pp. M112-M117.

Cappleman, A.S. & Thiamwong, L. (2019) 'Fear of Falling Assessment and Interventions in Community-Dwelling Older Adults: A Mixed Methods Case-Series', *Clinical Gerontologist*, pp. 1-12.

Carel, H. (2011) 'Phenomenology and its application in medicine', *Theoretical Medicine and Bioethics*, vol. 32, no. 1, pp. 33-46.

Cawthon, P.M., Harrison, S.L., Barrett-Connor, E., Fink, H.A., Cauley, J.A., Lewis, C.E., Orwoll, E.S. & Cummings, S.R. (2006) 'Alcohol intake and its relationship with bone mineral density, falls, and fracture risk in older men', *Journal of American Geriatrics Society*, vol. 54, no. 11, pp. 1649-1657.

Chang, V.C. & Do, M.T. (2015) 'Risk factors for falls among seniors: implications of gender', *American Journal of Epidemiology*, vol. 181, no. 7, pp. 521-531.

Charmaz, K. & Paterniti, D.A. (1999) *Health, illness and healing : society, social context and self : an anthology*, Oxford University Press.

Chen, E.W., Fu, A.S.N., Chan, K.M. & Tsang, W.W.N. (2012) 'Balance control in very old adults with and without visual impairment', *European Journal of Applied Physiology*, vol. 112, no. 5, pp. 1631-1636.

Chiarelli, P.E., Mackenzie, L.A. & Osmotherly, P.G. (2009) 'Urinary incontinence is associated with an increase in falls: a systematic review', *Australian Journal of Physiotherapy*, vol. 55, no. 2, pp. 89-95.

Chippendale, T. & Boltz, M. (2015) 'The neighborhood environment: perceived fall risk, resources, and strategies for fall prevention', *The Gerontologist*, no. 4, p. 575.

Chippendale, T. & Raveis, V. (2017) 'Knowledge, behavioral practices, and experiences of outdoor fallers: Implications for prevention programs', *Archives of Gerontology and Geriatrics*, vol. 72, pp. 19-24.

Chu, L.W., Chi, I. & Chiu, A.Y. (2005) 'Incidence and predictors of falls in the chinese elderly', *Annals of the Academy of Medicine of Singapore*, vol. 34, no. 1, pp. 60-72.

Chua, B.E., Mitchell, P. & Cumming, R.G. (2004) 'Effects of cataract type and location on visual function: the Blue Mountains Eye Study', *Eye (Lond)*, vol. 18, no. 8, pp. 765-772.

Chung, S.-D., Hu, C.-C., Lin, H.-C., Kao, L.-T. & Huang, C.-C. (2017) 'Increased fall risk in patients with neovascular age-related macular degeneration: a three-year follow-up study', *Acta Ophthalmologica*, no. 8, p. 800.

Clarke, C.L., McMurdo, M.E.T. & Witham, M.D. (2015) 'Falls research: stumbling or striding?', *Age and Ageing*, vol. 44, no. 3, pp. 350-352.

Cleland, C., Reis, R.S., Ferreira Hino, A.A., Hunter, R., Fermino, R.C., Koller de Paiva, H., Czestschuk, B. & Ellis, G. (2019) Built environment correlates of physical activity and sedentary behaviour in older adults: A comparative review between high and low-middle income countries, Elsevier Science B.V., Amsterdam., Great Britain, p. 277.

Clement, C., Edwards, S.L., Rapport, F., Russell, I.T. & Hutchings, H.A. (2018) 'Exploring qualitative methods reported in registered trials and their yields (EQUITY): systematic review', *Trials*, vol. 19, no. 1, p. 589.

Close, J., Ellis, M., Hooper, R., Glucksman, E., Jackson, S. & Swift, C. (1999) 'Prevention of falls in the elderly trial (PROFET): a randomised controlled trial', *Lancet*, vol. 353, no. 9147, pp. 93-97.

Coleman, A.L., Cummings, S.R., Ensrud, K.E., Yu, F., Gutierrez, P., Stone, K.L., Cauley, J.A., Pedula, K.L., Hochberg, M.C., Mangione, C.M. & Study of Osteoporotic, F. (2009) 'Visual field loss and risk of fractures in older women', *Journal of American Geriatrics Society*, vol. 57, no. 10, pp. 1825-1832.

Coleman, A.L., Cummings, S.R., Yu, F., Kodjebacheva, G., Ensrud, K.E., Gutierrez, P., Stone, K.L., Cauley, J.A., Pedula, K.L., Hochberg, M.C., Mangione, C.M. & for the Study of Osteoporotic, F. (2007) 'Binocular Visual-Field Loss Increases the Risk of Future Falls in Older White Women', *Journal of the American Geriatrics Society*, vol. 55, no. 3, pp. 357-364.

Coleman, A.L., Stone, K., Ewing, S.K., Nevitt, M., Cummings, S., Cauley, J.A., Ensrud, K.E., Harris, E.L., Hochberg, M.C. & Mangione, C.M. (2004) 'Higher risk of multiple falls among elderly women who lose visual acuity', *Ophthalmology*, vol. 111, no. 5, pp. 857-862.

Conde, M., Hendry, G. & Skelton, D.A. (2019) 'The Footfall Programme: participant experiences of a lower limb, foot and ankle exercise intervention for falls prevention - an exploratory study', *Journal of frailty, sarcopenia and falls*, vol. 4, no. 3, pp. 78-90.

Connelly, L.M. (2010) 'What Is Phenomenology?', *MEDSURG Nursing*, vol. 19, no. 2, pp. 127-128.

Corlett, A. & Mavin, S. (2018) *Reflexivity and researcher positionality*, in C. Cassell, A.L. Cunliffe & G. Grandy (eds), *The SAGE Handbook of Qualitative Business and Management Research Methods: History and Traditions*, SAGE Publications Ltd, 55 City Road, London, pp. 377-398.

Cornwell, B., Laumann, E.O. & Schumm, L.P. (2008) 'The Social Connectedness of Older Adults: A National Profile', *American Sociological Review*, vol. 73, no. 2, pp. 185-203.

Cosco, T.D., Cooper, R., Kuh, D. & Stafford, M. (2018) 'Socioeconomic inequalities in resilience and vulnerability among older adults: a population-based birth cohort analysis', *International Psychogeriatrics*, vol. 30, no. 5, pp. 695-703.

Costa, M.F., Moreira, S.M., Hamer, R.D. & Ventura, D.F. (2010) 'Effects of age and optical blur on real depth stereoacuity', *Ophthalmic & Physiological Optics*, vol. 30, no. 5, pp. 660-666.

Court-Brown, C.M., Clement, N.D., Duckworth, A.D., Biant, L.C. & McQueen, M.M. (2017) 'The changing epidemiology of fall-related fractures in adults', *Injury*, vol. 48, no. 4, pp. 819-824.

Crabb, D.P., Smith, N.D., Glen, F.C., Burton, R. & Garway-Heath, D.F. (2013) 'How does glaucoma look?: patient perception of visual field loss', *Ophthalmology*, vol. 120, no. 6, pp. 1120-1126.

Crabb, D.P. & Viswanathan, A.C. (2005) 'Integrated visual fields: a new approach to measuring the binocular field of view and visual disability', *Graefe's Archive for Clinical Experimental Ophthalmology*, vol. 243, no. 3, pp. 210-216.

Cresswell, J.W. & Plano Clark, V.L. (2011) *Designing and conducting Mixed Methods Reserach*, 2nd edn, Sage, USA.

Crotty, M. (1998) *The Foundations of Social Science*, Sage, Australia.

Cruz, D.T.d. & Leite, I.C.G. (2018) 'Falls and associated factors among elderly persons residing in the community', *Revista Brasileira de Geriatria e Gerontologia*.

Cumming, R.G., Salkeld, G., Thomas, M. & Szonyi, G. (2000) 'Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission', *Journal of Gerontologly Series A Biological Scences and Medical Sciences*, vol. 55.

Cummings, S.R., Nevitt, M.C., Browner, W.S., Stone, K., Fox, K.M., Ensrud, K.E., Cauley, J., Black, D. & Vogt, T.M. (1995) 'Risk factors for hip fracture in white women. Study of Osteoporotic Fractures Research Group', *New England Journal of Medicine*, vol. 332, no. 12, pp. 767-773.

Curtis, E.M., van der Velde, R., Moon, R.J., van den Bergh, J.P.W., Geusens, P., de Vries, F., van Staa, T.P., Cooper, C. & Harvey, N.C. (2016) 'Epidemiology of fractures in the United Kingdom 1988–2012: Variation with age, sex, geography, ethnicity and socioeconomic status', *Bone*, vol. 87, pp. 19-26.

Cutcliffe, J.R. (2003) 'Reconsidering Reflexivity: Introducing the Case for Intellectual Entrepreneurship', *Qualitative Health Research*, no. 1, p. 136.

Daien, V., Peres, K., Villain, M., Colvez, A., Carriere, I. & Delcourt, C. (2014) 'Visual acuity thresholds associated with activity limitations in the elderly. The Pathologies Oculaires Liees a l'Age study', *Acta Ophthalmologica* vol. 92, no. 7, pp. e500-506.

Dargent-Molina, P., Favier, F., Grandjean, H., Baudoin, C., Schott, A.M., Hausherr, E., Meunier, P.J. & Breart, G. (1996) 'Fall-related factors and risk of hip fracture: the EPIDOS prospective study', *Lancet*, vol. 348, no. 9021, pp. 145-149.

Daskalopoulou, C., Stubbs, B., Kralj, C., Koukounari, A., Prince, M. & Prina, A.M. (2017) 'Physical activity and healthy ageing: A systematic review and meta-analysis of longitudinal cohort studies', *Ageing Research Reviews*, vol. 38, pp. 6-17.

Davidsen, A.S. (2013) 'Phenomenological Approaches in Psychology and Health Sciences', *Qualitative research in psychology*, vol. 10, no. 3, pp. 318-339.

Davies, J.C., Kemp, G.J., Stevens, G., Frostick, S.P. & Manning, D.P. (2001) Bifocal/varifocal spectacles, lighting and missed-step accidents, p. 211

de Boer, M.R., Pluijm, S.M., Lips, P., Moll, A.C., Volker-Dieben, H.J., Deeg, D.J. & van Rens, G.H. (2004) 'Different aspects of visual impairment as risk factors for falls and fractures in older men and women', *Journal of Bone and Mineral Research*, vol. 19, no. 9, pp. 1539-1547.

de Vries McClintock, H.F., Barg, F.K., Katz, S.P., Stineman, M.G., Krueger, A., Colletti, P.M., Boellstorff, T. & Bogner, H.R. (2016) 'Health care experiences and perceptions among people with and without disabilities'.

Deandrea, S., Lucenteforte, E., Bravi, F., Foschi, R., La Vecchia, C. & Negri, E. (2010) 'Risk factors for falls in community-dwelling older people: a systematic review and meta-analysis', *Epidemiology*, vol. 21, no. 5, pp. 658-668.

Delbaere, K., Close, J.C., Mikolaizak, A.S., Sachdev, P.S., Brodaty, H. & Lord, S.R. (2010a) 'The Falls Efficacy Scale International (FES-I). A comprehensive longitudinal validation study', *Age Ageing*, vol. 39, no. 2, pp. 210-216.

Delbaere, K., Close, J.C.T., Brodaty, H., Sachdev, P. & Lord, S.R. (2010b) 'Determinants of disparities between perceived and physiological risk of falling among elderly people: cohort study', *British Medical Journal* vol. 341.

Delbaere, K., Close, J.C.T., Heim, J., Sachdev, P.S., Brodaty, H., Slavin, M.J., Kochan, N.A. & Lord, S.R. (2010c) 'A Multifactorial Approach to Understanding Fall Risk in Older People', *Journal of the American Geriatrics Society*, vol. 58, no. 9, pp. 1679-1685.

Denkinger, M.D., Lukas, A., Nikolaus, T. & Hauer, K. (2015) 'Factors Associated with Fear of Falling and Associated Activity Restriction in Community-Dwelling Older Adults: A Systematic Review', *American Journal of Geriatric Psychiatry*, vol. 23, no. 1, pp. 72-86.

Denzin, N.K. (2012) 'Triangulation 2.0', *Journal of Mixed Methods Research*, vol. 6, no. 2, pp. 80-88.

Denzin, N.K. & Lincoln, Y.S. (2011) *The Sage handbook of qualitative research*, 4th ed. edn, Sage.

Department of Health (1995) *A policy framework for commissioning cancer services – the Calman–Hine Report. A Report by the Expert Advisory Group on Cancer to the Chief Medical Officers of England and Wales.*, in D.o. Health (ed.)London.

Deshpande, N., Metter, E.J., Bandinelli, S., Lauretani, F., Windham, B.G. & Ferrucci, L. (2008a) 'Psychological, physical, and sensory correlates of fear of falling and consequent activity restriction in the elderly: the InCHIANTI study', *American Journal of Physical Medicine & Rehabilitation*, vol. 87, no. 5, pp. 354-362.

Deshpande, N., Metter, E.J., Lauretani, F., Bandinelli, S., Guralnik, J. & Ferrucci, L. (2008b) 'Activity restriction induced by fear of falling and objective and subjective measures of physical function: a prospective cohort study', *Journal of American Geriatrics Society*, vol. 56.

Dhalwani, N.N., Fahami, R., Sathanapally, H., Seidu, S., Davies, M.J. & Khunti, K. (2017) 'Association between polypharmacy and falls in older adults: a longitudinal study from England', *BMJ Open*, vol. 7, no. 10, p. e016358.

Dicicco-bloom, B. & Crabtree, B. (2006) 'The qualitative research interview', *Medical education*, vol. 40, no. 4, pp. 314-321.

Diederichs, C., Berger, K. & Bartels, D.B. (2011) 'The measurement of multiple chronic diseases--a systematic review on existing multimorbidity indices', *The Journals of Gerontology Series A Biological Sciences and Medical Sciences*, vol. 66, no. 3, pp. 301-311.

Dollard, J., Barton, C., Newbury, J. & Turnbull, D. (2012) 'Falls in old age: a threat to identity', *Journal of Clinical Nursing*, vol. 21, no. 17-18, pp. 2617-2625.

Donoghue, O.A., Ryan, H., Duggan, E., Finucane, C., Savva, G.M., Cronin, H., Loughman, J. & Kenny, R.A. (2014) 'Relationship between fear of falling and mobility varies with visual function among older adults', *Geriatrics & Gerontology International*, vol. 14, no. 4, pp. 827-836.

Douglas, G., Pavey, S., Corcoran, C. & Eperjesi, F. (2010) 'Individual's recollections of their experiences in eye clinics and understanding of their eye condition: results from a survey of visually impaired people in Britain', *Ophthalmic & Physiological Optics*, vol. 30, no. 6, pp. 748-757.

Douglas, M. (1992) *Risk and blame. [electronic book] : essays in cultural theory*, London : Routledge, 1992.

Douglas, M. & Wildavsky, A.B. (1982) *Risk and culture. [electronic book] : an essay on the selection of technological and environmental dangers*, Berkeley : University of California Press, 1982 (1983 printing).

Dowling, M. (2007) 'From Husserl to van Manen. A review of different phenomenological approaches', *International Journal of Nursing Studies*, vol. 44, no. 1, pp. 131-142.

Downton, J.H. & Andrews, K. (1991) 'Prevalence, characteristics and factors associated with falls among the elderly living at home', *Aging (Milano)*, vol. 3, no. 3, pp. 219-228.

Duggan, E., Donoghue, O., Kenny, R., Cronin, H., Loughman, J. & Finucane, C. (2017) 'Time to Refocus Assessment of Vision in Older Adults? Contrast Sensitivity but Not Visual Acuity Is Associated With Gait in Older Adults.', *The Journals of Gerontology Series A Biological Sciences and Medical Sciences*, vol. 00, no. 00, pp. 1-6.

Durkheim, E. (1983) *Pragmatism and Sociology*, Cambridge University Press, Cambridge, UK.

DVLA (2019) *Visual disorders: assessing fitness to drive*

Earle, V. (2010) 'Phenomenology as research method or substantive metaphysics? An overview of phenomenology's uses in nursing', *Nursing Philosophy*, vol. 11, no. 4, pp. 286-296.

Ehrlich, J.R., Hassan, S.E. & Stagg, B.C. (2019) 'Prevalence of Falls and Fall-Related Outcomes in Older Adults with Self-Reported Vision Impairment', *Journal of the American Geriatrics Society*, vol. 67, no. 2, pp. 239-245.

Elliot, D.B., Yang, K.C.H. & Whitaker, D. (1995) 'Visual acuity changes throughout adulthood in normal, healthy eyes: Seeing beyond 6/6', *Optometry and Vision Science*, vol. 72, no. 3, pp. 186-191.

Elliott, D., Sanderson, K. & Conkey, A. (1990) 'The reliability of the Pelli-Robson contrast sensitivity chart', *Ophthalmic & Physiological Optics*, vol. 10, no. 1, pp. 21-24.

Elliott, D., Whitaker, D. & MacVeigh, D. (1990) 'Neural contribution to spatiotemporal contrast sensitivity decline in healthy ageing eyes', *Vision Research*, vol. 30, no. 4, pp. 541-547.

Elliott, D.B., Hurst, M.A. & Weatherill, J. (1990) 'Comparing clinical tests of visual function in cataract with the patient's perceived visual disability', *Eye (Lond)*, vol. 4 (Pt 5), pp. 712-717.

Elliott, D.B., Patla, A.E., Flanagan, J.G., Spaulding, S., Rietdyk, S., Strong, G. & Brown, S. (1995) 'The Waterloo Vision and Mobility Study: postural control strategies in subjects with ARM', *Ophthalmic & Physiological Optics: The Journal Of The British College Of Ophthalmic Opticians (Optometrists)*, vol. 15, no. 6, pp. 553-559.

Elliott, D.B., Patla, A.E., Furniss, M. & Adkin, A. (2000) 'Improvements in Clinical and Functional Vision and Quality of Life after Second Eye Cataract Surgery', *Optometry and Vision Science*, vol. 77, no. 1, pp. 13-24.

Elliott, D.B. & Whitaker, D. (1992) 'Clinical contrast sensitivity chart evaluation', *Ophthalmic & Physiological Optics*, vol. 12, no. 3, pp. 275-280.

Elwood, S.A. & Martin, D.G. (2000) '"Placing" Interviews: Location and Scales of Power in Qualitative Research', *Professional Geographer*, vol. 52, no. 4, pp. 649-657.

Essock, E.A., Fechtner, R.D., Zimmerman, T.J., Krebs, W.K. & Nussdorf, J.D. (1996) 'Binocular function in early glaucoma', *Journal Of Glaucoma*, vol. 5, no. 6, pp. 395-405.

Esterman, B. (1982) 'Functional scoring of the binocular field', *Ophthalmology*, vol. 89, no. 11, pp. 1226-1234.

Evans, J.R., Fletcher, A.E., Wormald, R.P.L., Siu-Woon Ng, E., Stirling, S., Smeeth, L., Breeze, E., Bulpitt, C.J., Nunes, M., Jones, D. & Tulloch, A. (2002) 'Prevalence of visual impairment in people aged 75 years and older in Britain: results from the MRC trial of assessment and managment of older people in the community', *British Journal of Ophthalmology*, vol. 86, pp. 795-800.

Faes, M.C., Reelick, M.F., Joosten-Weyn Banningh, L.W., Gier, M.d., Esselink, R.A. & Olde Rikkert, M.G. (2010) 'Qualitative study on the impact of falling in frail older persons and family caregivers: Foundations for an intervention to prevent falls', *Aging & Mental Health*, vol. 14, no. 7, pp. 834-842.

Fawcett, S.L. (2005) 'An Evaluation of the Agreement Between Contour-Based Circles and Random Dot-Based Near Stereoacuity Tests', *Journal of American Association for Pediatric Ophthalmology and Strabismus*, vol. 9, no. 6, pp. 572-578.

Felson, D.T., Anderson, J.J., Hannan, M.T., Milton, R.C., Wilson, P.W. & Kiel, D.P. (1989) 'Impaired vision and hip fracture. The Framingham Study', *Journal of American Geriatrics Society*, vol. 37, no. 6, pp. 495-500.

Ferris, F.L., 3rd, Kassoff, A., Bresnick, G.H. & Bailey, I. (1982) 'New visual acuity charts for clinical research', *American Journal of Ophthalmology*, vol. 94, no. 1, pp. 91-96.

Ferris, F.L. & Bailey, I. (1996) 'Standardizing the Measurement of Visual Acuity for Clinical Research Studies: Guidelines from the Eye Care Technology Forum', *Ophthalmology*, vol. 103, no. 1, pp. 181-182.

Finucane, M.L. & Holup, J.L. (2006) 'Risk as Value: Combining Affect and Analysis in Risk Judgments', *Journal of Risk Research*, vol. 9, no. 2, pp. 141-164.

Flick, U. (2000) *Episodic Interviewing*, *Qualitative Researching with Text, Image and Sound*, SAGE Publications Ltd, London.
Flick, U. (2009) *An introduction to qualitative research*, 4th ed. edn, Sage.
Franse, C.B., Rietjens, J.A., Burdorf, A., van Grieken, A., Korfage, I.J., van der Heide, A., Mattace Raso, F., van Beeck, E. & Raat, H. (2017) 'A prospective study on the variation in falling and fall risk among community-dwelling older citizens in 12 European countries', *BMJ Open*, vol. 7, no. 6, p. e015827.
Freeman, E.E., Munoz, B., Rubin, G. & West, S.K. (2007) 'Visual field loss increases the risk of falls in older adults: the Salisbury eye evaluation', *Investigative Ophthalmology & Visual Science*, vol. 48, no. 10, pp. 4445-4450.
Freiberger, E. & de Vreede, P. (2011) 'Falls recall—limitations of the most used inclusion criteria', *European Review of Aging and Physical Activity*, vol. 8, no. 2, pp. 105-108.
French, D.D., Margo, C.E., Tanna, A.P., Volpe, N.J. & Rubenstein, L.Z. (2016) 'Associations of Injurious Falls and Self-Reported Incapacities: Analysis of the National Health Interview Survey', *Journal of Patient Safety*, vol. 12, no. 3, pp. 148-151.
Fricke, T.R. & Siderov, J. (1997) 'Stereopsis, stereotests, and their relation to vision screening and clinical practice', *Clinical and Experimental Optometry*, vol. 80, no. 5, pp. 165-172.
Friedman, S.M., Munoz, B., West, S.K., Rubin, G.S. & Fried, L.P. (2002) 'Falls and fear of falling: which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention', *Journal of American Geriatrics Society*, vol. 50.
Frisby, J. (2015) *The Frisby Stereotest: An Introduction And A Review* [Online], Available from: http://frisbystereotest.co.uk/wp-content/uploads/2015/09/Optician-Article-Draft-Low-Resolution-14apr15.pdf (Accessed: 30/4/19).
Fristrom, B. & Lundh, B.L. (2000) 'Colour contrast sensitivity in cataract and pseudophakia', *Acta Ophthalmologica Scandinavica*, vol. 78, no. 5, pp. 506-511.
Furedi, F. (2006) *Culture of Fear Revisited. [electronic book]*, London : Continuum International Publishing, 2006.
Gagnon, M., Jacob, J.D. & McCabe, J. (2015) 'Locating the qualitative interview: reflecting on space and place in nursing research', *Journal of Research in Nursing*, vol. 20, no. 3, pp. 203-215.
Gale, C.R., Cooper, C. & Aihie Sayer, A. (2016) 'Prevalence and risk factors for falls in older men and women: The English Longitudinal Study of Ageing', *Age and Ageing*, vol. 45, no. 6, pp. 789-794.
Gale, C.R., Westbury, L.D., Cooper, C. & Dennison, E.M. (2018) 'Risk factors for incident falls in older men and women: the English longitudinal study of ageing', *BMC Geriatrics*, vol. 18, no. 1, pp. 117-117.
Gallant, M.P., Spitze, G.D. & Prohaska, T.R. (2007) 'Help or Hindrance? How Family and Friends Influence Chronic Illness Self-Management among Older Adults', *Research on Aging*, vol. 29, no. 5, pp. 375-409.
Gamage, N., Rathnayake, N. & Alwis, G. (2019) 'Prevalence and Associated Risk Factors of Falls among Rural Community-Dwelling Older People: A Cross-Sectional Study from Southern Sri Lanka', *Current Gerontology and Geriatrics Research*, vol. 2019, p. 10.
Ganz, D.A., Higashi, T. & Rubenstein, L.Z. (2005) 'Monitoring falls in cohort studies of community-dwelling older people: effect of the recall interval', *Journal of American Geriatrics Society*, vol. 53.
Gardiner, S., Glogowska, M., Stoddart, C., Pendlebury, S., Lasserson, D. & Jackson, D. (2017) 'Older people's experiences of falling and perceived risk of falls in the community: A narrative synthesis of qualitative research', *International Journal of Older People Nursing*, vol. 12, no. 4, p. e12151.

Garnham, L. & Sloper, J.J. (2006) 'Effect of age on adult stereoacuity as measured by different types of stereotest', *British Journal of Ophthalmology*, vol. 90, no. 1, pp. 91-95.
Gazibara, T., Kurtagic, I., Kisic-Tepavcevic, D., Nurkovic, S., Kovacevic, N., Gazibara, T. & Pekmezovic, T. (2017) 'Falls, risk factors and fear of falling among persons older than 65 years of age', *Psychogeriatrics*, vol. 17, no. 4, pp. 215-223.
Gesme, D.H. & Wiseman, M. (2012) 'Reduce risks to patients in your practice', *Journal of oncology practice*, vol. 8, no. 1, pp. e11-e13.
Giddens, A. (1990) *The Consequences of Modernity*, Stanford University Press, Stanford.
Giddens, A. (1991) *Modernity and Self-Identity: Self and Society in the Late Modern Age*, Polity Press, Cambridge.
Gillespie, L.D., Robertson, M.C., Gillespie, W.J., Sherrington, C., Gates, S., Clemson, L.M. & Lamb, S.E. (2012) 'Interventions for preventing falls in older people living in the community', *Cochrane Database of Systematic Reviews*, no. 9.
Ginsburg, A.P. (2003) 'Contrast Sensitivity and Functional Vision', *International Ophthalmology Clinics*, vol. 43, no. 2, pp. 5-15.
Gopinath, B., McMahon, C.M., Burlutsky, G. & Mitchell, P. (2016) 'Hearing and vision impairment and the 5-year incidence of falls in older adults', *Age and Ageing*, vol. 45, no. 3, pp. 409-414.
Gotsens, M., Marí-Dell'Olmo, M., Pérez, K., Palència, L., Martinez-Beneito, M.-A., Rodríguez-Sanz, M., Burström, B., Costa, G., Deboosere, P., Domínguez-Berjón, F., Dzúrová, D., Gandarillas, A., Hoffmann, R., Kovacs, K., Marinacci, C., Martikainen, P., Pikhart, H., Rosicova, K., Saez, M., Santana, P., Riegelnig, J., Schwierz, C., Tarkiainen, L. & Borrell, C. (2013) 'Socioeconomic inequalities in injury mortality in small areas of 15 European cities', *Health & Place*, vol. 24, pp. 165-172.
Gray, D.E. (2004) *Doing Research in the Real World*, Sage Publications Ltd.
Green, J. (1997) *Risk and Misfortune: The Social Construction of Accidents*, University College London Press, London.
Green, J. & Britten, N. (1998) 'Qualitative research and evidence based medicine', *British Medical Journal*, vol. 316, no. 7139, pp. 1230-1232.
Green, J. & Thorogood, N. (2014) *Qualitative methods for health research*, 3rd ed. edn, SAGE.
Greenland, S., Pearl, J. & Robins, J.M. (1999) 'Causal Diagrams for Epidemiologic Research', *Epidemiology*, vol. 10, no. 1, pp. 37-48.
Gregg, E.W., Pereira, M.A. & Caspersen, C.J. (2000) 'Physical activity, falls, and fractures among older adults: a review of the epidemiologic evidence', *Journal of the American Geriatrics Society*, vol. 48, no. 8, pp. 883-893.
Grisso , J.A., Kelsey , J.L., Strom , B.L., Ghiu , G.Y., Maislin , G., O'Brien , L.A., Hoffman , S. & Kaplan , F. (1991) 'Risk Factors for Falls as a Cause of Hip Fracture in Women', *New England Journal of Medicine*, vol. 324, no. 19, pp. 1326-1331.
Guba, E.G. (1990) *The Paradigm dialog*, Sage Publications.
Gubrium, J.F. & Holstein, J.A. (2002) *Handbook of interview research. [electronic book]*, Thousand Oaks, [Calif.] ;London : SAGE, c2002.
Guillemin, M. & Gillam, L. (2004) Ethics, Reflexivity, and 'Ethically Important Moments' in Research, p. 261
Gupta, N., Krishnadev, N., Hamstra, S.J. & Yucel, Y. (2006) 'Depth Perception Deficits in Glaucoma Suspects'.
Gustafsod, P.E. (1998) 'Gender Differences in Risk Perception: Theoretical and Methodological erspectives', *Risk Analysis*, vol. 18, no. 6, pp. 805-811.

Hadjistavropoulos, T., Delbaere, K. & Fitzgerald, T.D. (2011) 'Reconceptualizing the Role of Fear of Falling and Balance Confidence in Fall Risk', *Journal of Aging and Health*, vol. 23, no. 1, pp. 3-23.

Hadjistavropoulos, T., Martin, R.R., Sharpe, D., Lints, A.C., McCreary, D.R. & Asmundson, G.J. (2007) 'A longitudinal investigation of fear of falling, fear of pain, and activity avoidance in community-dwelling older adults', *Journal of Aging and Health*, vol. 19, no. 6, pp. 965-984.

Hanoch, Y., Rolison, J.J. & Freund, A.M. (2018) 'Does Medical Risk Perception and Risk Taking Change with Age?', *Risk Analysis: An International Journal*, vol. 38, no. 5, pp. 917-928.

Haran, M.J., Cameron, I.D., Ivers, R.Q., Simpson, J.M., Lee, B.B., Tanzer, M., Porwal, M., Kwan, M.M., Severino, C. & Lord, S.R. (2010) 'Effect on falls of providing single lens distance vision glasses to multifocal glasses wearers: VISIBLE randomised controlled trial', *British Medical Journal (Clinical Research ed)*, vol. 340.

Hawkley, L.C., Thisted, R.A. & Cacioppo, J.T. (2009) 'Loneliness predicts reduced physical activity: cross-sectional & longitudinal analyses', *Health psychology* vol. 28, no. 3, pp. 354-363.

Hayhoe, M., Gillam, B., Chajka, K. & Vecellio, E. (2009) 'The role of binocular vision in walking', *Visual Neuroscience*, vol. 26, no. 1, pp. 73-80.

Haynes, K. (2012) 'Reflexivity in qualitative research' in G. Symon & C. Cassell (eds), *Qualitative Organizational Research: Core Methods and Current Challenges.*, Sage, London, pp. 72-89.

Health Survey England (2016) *Health Survey for England,m 2016: Questionnaires adn Showcards* [Online], Available from: http://doc.ukdataservice.ac.uk/doc/8334/mrdoc/pdf/8334_hse_2016_questionnaires_showcards.pdf (Accessed: 3/2/17).

Heasley, K., Buckley, J.G., Scally, A., Twigg, P. & Elliott, D.B. (2004) 'Stepping Up to a New Level: Effects of Blurring Vision in the Elderly', *Investigative Ophthalmology & Visual Science*, vol. 45, no. 7, pp. 2122-2128.

Helbostad, J.L., Vereijken, B., Hesseberg, K. & Sletvold, O. (2009) 'Altered vision destabilizes gait in older persons', *Gait Posture*, vol. 30, no. 2, pp. 233-238.

Herzog, H. (2005) 'On Home Turf: Interview Location and Its Social Meaning', *Qualitative Sociology*, vol. 28, no. 1, p. 25.

Hess, R. & Woo, G. (1978) 'Vision through cataracts', *Investigative Ophthalmology & Visual Science*, vol. 17, no. 5, pp. 428-435.

Hewston, P. & Deshpande, N. (2016) 'Falls and Balance Impairments in Older Adults with Type 2 Diabetes: Thinking Beyond Diabetic Peripheral Neuropathy', *Canadian Journal of Diabetes*, vol. 40, no. 1, pp. 6-9.

Hewston, P. & Deshpande, N. (2018) 'Fear of Falling and Balance Confidence in Older Adults With Type 2 Diabetes Mellitus: A Scoping Review', *Canadian Journal of Diabetes*, vol. 42, no. 6, pp. 664-670.

Heyman, B. & Brown, P. (2013) *Perspectives on 'the lens of risk' interview series: interviews with Tom Horlick-Jones, Paul Slovic and Andy Alaszewski*, article, p. 494.

Hildon, Z., Smith, G., Netuveli, G. & Blane, D. (2008) 'Understanding adversity and resilience at older ages', *Sociology of Health & Illness* vol. 30, no. 5, pp. 726-740.

Hill, K.D., Schwarz, J.A., Kalogeropoulos, A.J. & Gibson, S.J. (1996) 'Fear of falling revisited', *Archives of Physical Medicine and Rehabilitation*, vol. 77, no. 10, pp. 1025-1029.

Hillman, A., Tadd, W., Calnan, S., Calnan, M., Bayer, A. & Read, S. (2013) 'Risk, governance and the experience of care', *Sociology of Health & Illness*, vol. 35, no. 6, pp. 939-955.

Hoang, O.T., Jullamate, P., Piphatvanitcha, N. & Rosenberg, E. (2017) 'Factors related to fear of falling among community-dwelling older adults', *Journal of Clinical Nursing*, vol. 26, no. 1-2, pp. 68-76.

Honaker, J.A., Lee, C. & Shepard, N.T. (2013) 'Clinical use of the gaze stabilization test for screening falling risk in community-dwelling older adults', *Otology & Neurotology*, vol. 34, no. 4, pp. 729-735.

Honaker, J.A. & Shepard, N.T. (2011) 'Use of the Dynamic Visual Acuity Test as a screener for community-dwelling older adults who fall', *Journal of Vestibular Research: Equilibrium & Orientation*, vol. 21, no. 5, pp. 267-276.

Horak, F.B. (2006) 'Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls?', *Age and Ageing*, vol. 35, no. suppl_2, pp. ii7-ii11.

Horne, M., Skelton, D.A., Speed, S. & Todd, C. (2014) 'Falls prevention and the value of exercise: salient beliefs among South asian and white british older adults', *Clinical nursing research*, vol. 23, no. 1, pp. 94-110.

Horne, M. & Tierney, S. (2012) 'What are the barriers and facilitators to exercise and physical activity uptake and adherence among South Asian older adults: A systematic review of qualitative studies', *Preventive Medicine*, vol. 55, no. 4, pp. 276-284.

Horton, K. (2007) 'Gender and the risk of falling: a sociological approach', *Journal of Advanced Nursing*, vol. 57, no. 1, pp. 69-76.

Howland, J., Lachman, M.E., Peterson, E.W., Cote, J., Kasten, L. & Jette, A. (1998) 'Covariates of fear of falling and associated activity curtailment', *Gerontologist*, vol. 38, no. 5, pp. 549-555.

Howland, J., Peterson, E.W., Levin, W.C., Fried, L., Pordon, D. & Bak, S. (1993) 'Fear of falling among the community-dwelling elderly', *Journal of Aging and Health*, vol. 5, no. 2, pp. 229-243.

Hu, C.X., Zangalli, C., Hsieh, M., Gupta, L., Williams, A.L., Richman, J. & Spaeth, G.L. (2014) 'What do patients with glaucoma see? Visual symptoms reported by patients with glaucoma', *The American Journal of the Medical Sciences*, vol. 348, no. 5, pp. 403-409.

Hughes, C.C., Kneebone, I.I., Jones, F. & Brady, B. (2015) 'A theoretical and empirical review of psychological factors associated with falls-related psychological concerns in community-dwelling older people', *International Psychogeriatrics*, vol. 27, no. 7, pp. 1071-1087.

Hutchison, E.D. (2005) 'The Life Course Perspective: A Promising Approach for Bridging the Micro and Macro Worlds for Social Workers', *Families in Society*, vol. 86, no. 1, pp. 143-152.

Hwang, A.D., Tuccar-Burak, M., Goldstein, R. & Peli, E. (2018) 'Impact of Oncoming Headlight Glare With Cataracts: A Pilot Study', *Frontiers in Psychology*, vol. 9, p. 164.

International Statistical Classification of Diseases and Related Health Problems 10th Revision [Online], Available from: http://apps.who.int/classifications/icd10/browse/2010/en#/H54.2 (Accessed: 26/4/17).

Ishikawa, T., Desapriya, E., Puri, M., Kerr, J.M., Hewapathirane, D.S. & Pike, I. (2013) 'Evaluating the benefits of second-eye cataract surgery among the elderly', *Journal of Cataract & Refractive Surgery*, vol. 39, no. 10, pp. 1593-1603.

Ivers, R., Cumming, R.G., Mitchell, P., Simpson, J.M. & Peduto, A.J. (2003a) 'Visual risk factors for hip fracture in older people', *J Am Geriatr Soc*, vol. 51, no. 3, pp. 356-363.

Ivers, R., Optom, B., Cumming, R.G., Mitchell, P., Simpson, J.M. & Peduto, A.J. (2003b) 'Visual Risk Factors for Hip Fracture in Older People', *Journal of the American Geriatrics Society*, vol. 51, no. 3, pp. 356-363.

Ivers, R.Q., Cumming, R.G., Mitchell, P. & Attebo, K. (1998) 'Visual impairment and falls in older adults: the Blue Mountains Eye Study', *Journal of American Geriatrics Society*, vol. 46, no. 1, pp. 58-64.

Ivers, R.Q., Norton, R., Cumming, R.G., Butler, M. & Campbell, A.J. (2000) 'Visual impairment and risk of hip fracture', *American Journal of Epidemiology*, vol. 152, no. 7, pp. 633-639.

Jacobs, J.V. (2016) 'A review of stairway falls and stair negotiation: Lessons learned and future needs to reduce injury', *Gait Posture*, vol. 49, pp. 159-167.

Jefferis, B.J., Iliffe, S., Kendrick, D., Kerse, N., Trost, S., Lennon, L.T., Ash, S., Sartini, C., Morris, R.W., Wannamethee, S.G. & Whincup, P.H. (2014) 'How are falls and fear of falling associated with objectively measured physical activity in a cohort of community-dwelling older men?', *BMC Geriatrics*, vol. 14, no. 1, p. 114.

Jiang, J., Long, J., Ling, W., Huang, G., Guo, X. & Su, L. (2015) 'Incidence of fall-related injury among old people in mainland China', *Archives of Gerontology and Geriatrics*, vol. 61, no. 2, pp. 131-139.

Johnson, L., Buckley, J.G., Scally, A.J. & Elliott, D.B. (2007) 'Multifocal spectacles increase variability in toe clearance and risk of tripping in the elderly', *Investigative Ophthalmology & Visual Science*, vol. 48, no. 4, pp. 1466-1471.

Johnson, R.B. & Onwuegbuzie, A.J. (2004) 'Mixed Methods Research: A Research Paradigm Whose Time Has Come', *Educational Researcher*, vol. 33, no. 7, pp. 14-26.

Jones, D.S. (2007) Talking and taking risks: An exploration of women's perceptions of antenatal testing in pregnancy in A.P.a.I. Wilkinson (ed.), *Health, Risk and Vulnerability*, Routledge, London.

Jorstad, E.C., Hauer, K., Becker, C., Lamb, S.E. & ProFa, N.E.G. (2005) 'Measuring the psychological outcomes of falling: a systematic review', *Journal of American Geriatrics Society*, vol. 53, no. 3, pp. 501-510.

Joussen, A.M., Lehmacher, W., Hilgers, R.-D. & Kirchhof, B. (2007) 'Is Significant Relevant? Validity and Patient Benefit of Randomized Controlled Clinical Trials on Age-related Macular Degeneration', *Survey of Ophthalmology*, vol. 52, no. 3, pp. 266-278.

Kacen, L. & Chaitin, J. (2006) The times are a changing: understanding qualitative research in

ambiguous, conflictual and changing contexts, *The Qualitative Report*, vol., no. 2, [Online]. Available from: (Accessed.

Kamil, R.J., Betz, J., Powers, B.B., Pratt, S., Kritchevsky, S., Ayonayon, H.N., Harris, T.B., Helzner, E., Deal, J.A., Martin, K., Peterson, M., Satterfield, S., Simonsick, E.M., Lin, F.R. & Health, A.B.C.s. (2016) 'Association of Hearing Impairment With Incident Frailty and Falls in Older Adults', *Journal of Aging Health*, vol. 28, no. 4, pp. 644-660.

Käufer, S. & Chemero, A. (2015) *Phenomenology : An Introduction*, Polity Press, Oxford, UNITED KINGDOM.

Kaushik, V. & Walsh, C.A. (2019) 'Pragmatism as a Research Paradigm and Its Implications for Social Work Research', *Social Sciences*, vol. 8, no. 9, p. 255.

Kelsey, J.L., Procter-Gray, E., Hannan, M.T. & Li, W. (2012) 'Heterogeneity of falls among older adults: implications for public health prevention', *American Journal Of Public Health*, vol. 102, no. 11, pp. 2149-2156.

Kempen, G.I., van Haastregt, J.C., McKee, K.J., Delbaere, K. & Zijlstra, G.A. (2009) 'Socio-demographic, health-related and psychosocial correlates of fear of falling and

avoidance of activity in community-living older persons who avoid activity due to fear of falling', *BMC Public Health*, vol. 9, p. 170.
Kempen, G.I.J.M., Todd, C.J., Van Haastregt, J.C.M., Zijlstra, G.A.R., Beyer, N., Freiberger, E., Hauer, K.A., Piot-Ziegler, C. & Yardley, L. (2007a) 'Cross-cultural validation of the Falls Efficacy Scale International (FES-I) in older people: results from Germany, the Netherlands and the UK were satisfactory', *Disability And Rehabilitation*, vol. 29, no. 2, pp. 155-162.
Kempen, G.I.J.M., Yardley, L., Van Haastregt, J.C.M., Zijlstra, G.A.R., Beyer, N., Hauer, K. & Todd, C. (2007b) 'The Short FES-I: a shortened version of the falls efficacy scale-international to assess fear of falling', *Age and Ageing*, vol. 37, no. 1, pp. 45-50.
Kesler, A., Leibovich, G., Herman, T., Gruendlinger, L., Giladi, N. & Hausdorff, J.M. (2005) 'Shedding light on walking in the dark: the effects of reduced lighting on the gait of older adults with a higher-level gait disorder and controls', *Journal of Neuroengineering and Rehabilitation*, vol. 2, p. 27.
Khan, J.C., Shahid, H., Thurlby, D.A., Yates, J.R.W. & Moore, A.T. (2008) 'Charles Bonnet Syndrome in Age-Related Macular Degeneration: The Nature and Frequency of Images in Subjects with End-Stage Disease', *Ophthalmic Epidemiology*, vol. 15, no. 3, pp. 202-208.
Kim, J.E. & Moen, P. (2002) 'Retirement Transitions, Gender, and Psychological Well-Being: A Life-Course, Ecological Model', *The Journals of Gerontology: Series B*, vol. 57, no. 3, pp. P212-P222.
Kingston, P. (2000) Falls in later life: status passage and preferred identities as a new orientation, p. 216
Klein, B.E., Klein, R., Lee, K.E. & Cruickshanks, K.J. (1998) 'Performance-based and self-assessed measures of visual function as related to history of falls, hip fractures, and measured gait time. The Beaver Dam Eye Study', *Ophthalmology*, vol. 105, no. 1, pp. 160-164.
Klein, B.E.K., Moss, S.E., Klein, R., Lee, K.E. & Cruickshanks, K.J. (2003) 'Associations of visual function with physical outcomes and limitations 5 years later in an older population: The Beaver Dam eye study', *Ophthalmology*, vol. 110, no. 4, p. 644.
Klein, R., Klein, B.E., Lee, K.E., Cruickshanks, K.J. & Gangnon, R.E. (2006) 'Changes in visual acuity in a population over a 15-year period: the Beaver Dam Eye Study', *American Journal of Ophthalmology*, vol. 142, no. 4, pp. 539-549.
Klein, R., Klein, B.E., Linton, K.L. & De Mets, D.L. (1991) 'The Beaver Dam Eye Study: visual acuity', *Ophthalmology*, vol. 98, no. 8, pp. 1310-1315.
Klein, R. & Klein, B.E.K. (2013) 'The prevalence of age-related eye diseases and visual impairment in aging: current estimates', *Investigative Ophthalmology & Visual Science*, vol. 54, no. 14, pp. ORSF5-ORSF13.
Koski, K., Luukinen, H., Laippala, P. & Kivelä, S.L. (1998) 'Risk factors for major injurious falls among the home-dwelling elderly by functional abilities. A prospective population-based study', *Gerontology*, vol. 44, no. 4, pp. 232-238.
Kotecha, A., Richardson, G., Chopra, R., Fahy, R.T.A., Garway-Heath, D.F. & Rubin, G.S. (2012) 'Balance Control in GlaucomaBalance Control in Glaucoma', *Investigative Ophthalmology & Visual Science*, vol. 53, no. 12, pp. 7795-7801.
Kumar, A., Carpenter, H., Morris, R., Iliffe, S. & Kendrick, D. (2014) 'Which factors are associated with fear of falling in community-dwelling older people?', *Age and Ageing*, vol. 43, no. 1, pp. 76-84.
Labov, W. (1972) *Language in the inner city: studies in the black English vernacular*, University of Pennsylvania Press.
Lach, H.W. (2005) 'Incidence and risk factors for developing fear of falling in older adults', *Public Health Nurs*, vol. 22, no. 1, pp. 45-52.

Lachman, M.E., Howland, J., Tennstedt, S., Jette, A., Assmann, S. & Peterson, E.W. (1998) 'Fear of falling and activity restriction: the survey of activities and fear of falling in the elderly (SAFE)', *The Journals Of Gerontology. Series B, Psychological Sciences And Social Sciences*, vol. 53.

Laidlaw, D.A., Harrad, R.A., Hopper, C.D., Whitaker, A., Donovan, J.L., Brookes, S.T., Marsh, G.W., Peters, T.J., Sparrow, J.M. & Frankel, S.J. (1998) 'Randomised trial of effectiveness of second eye cataract surgery', *Lancet*, vol. 352, no. 9132, pp. 925-929.

Lajoie, Y. & Gallagher, S.P. (2004) Predicting falls within the elderly community: comparison of postural sway, reaction time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers, p. 11

Lakshmanan, Y. & George, R.J. (2013) 'Stereoacuity in mild, moderate and severe glaucoma', *Ophthalmic and Physiological Optics*, vol. 33, no. 2, pp. 172-178.

Lamb, S.E., Fisher, J.D., Gates, S., Potter, R., Cooke, M.W. & Carter, Y.H. (2008) 'A national survey of services for the prevention and management of falls in the UK', *BMC Health Serv Res*, vol. 8, p. 233.

Lamb, S.E., Jørstad-Stein, E.C., Hauer, K., Becker, C., Europe, o.b.o.t.P.o.F.N. & Group, O.C. (2005) 'Development of a Common Outcome Data Set for Fall Injury Prevention Trials: The Prevention of Falls Network Europe Consensus', *Journal of the American Geriatrics Society*, vol. 53, no. 9, pp. 1618-1622.

Lamond, A.J., Depp, C., Allison, M., Langer, R., Reichstadt, J., Moore, D.J., Golshan, S., Ganiats, T.G. & Jeste, D.V. (2008) 'Measurement and Predictors of Resilience Among Community-Dwelling Older Women', *Journal of Pyschiatric Research*, vol. 43, no. 2, pp. 148-154.

Lamoureux, E.L., Chong, E., Wang, J.J., Saw, S.M., Aung, T., Mitchell, P. & Wong, T.Y. (2008) 'Visual impairment, causes of vision loss, and falls: the singapore malay eye study', *Investigative Ophthalmology and Vision Science*, vol. 49, no. 2, pp. 528-533.

Lash, S. (1993) 'Reflexive Modernization: The Aesthetic Dimension', *Theory, Culture & Society*, vol. 10, no. 1, pp. 1-23.

Lash, S., Wynne, B. & Szerszynski, B. (1996) *Risk, environment and modernity : towards a new ecology*, London [etc.] : Sage, 1996.

Lavedán, A., Viladrosa, M., Jürschik, P., Botigué, T., Nuín, C., Masot, O. & Lavedán, R. (2018) 'Fear of falling in community-dwelling older adults: A cause of falls, a consequence, or both?', *PLoS ONE*, vol. 13, no. 3, pp. 1-14.

Lázaro, M., González, A., Latorre, G., Fernández, C. & Ribera, J.M. (2011) 'Postural stability in the elderly: Fallers versus non-fallers', *European Geriatric Medicine*, vol. 2, no. 1, pp. 1-5.

Lazarus, R.S. (1966) *Psychological stress and the coping process*.

Leat, S.J., Chan, L.L., Maharaj, P.D., Hrynchak, P.K., Mittelstaedt, A., Machan, C.M. & Irving, E.L. (2013) 'Binocular vision and eye movement disorders in older adults', *Investigative Ophthalmology & Visual Science*, vol. 54, no. 5, pp. 3798-3805.

Lee, C. & Honaker, J.A. (2013) 'Development of a new gaze stabilization test', *Journal of Vestibular Research: Equilibrium & Orientation*, vol. 23, no. 2, pp. 77-84.

Lee, F., Mackenzie, L. & James, C. (2008) 'Perceptions of older people living in the community about their fear of falling', *Disability and Rehabilitation*, vol. 30, no. 23, pp. 1803-1811.

Lee, S., Lee, C. & Ory, M.G. (2019) 'Association between Recent Falls and Changes in Outdoor Environments near Community-Dwelling Older Adults' Homes over Time: Findings from the NHATS Study', *International Journal of Environmental Research and Public Health*, vol. 16, no. 18.

Lee, S., Lee, C., Ory, M.G., Won, J., Towne, S.D., Jr., Wang, S. & Forjuoh, S.N. (2018) 'Fear of Outdoor Falling Among Community-Dwelling Middle-Aged and Older Adults: The Role of Neighborhood Environments', *Gerontologist*, vol. 58, pp. 1065-1074.
Lee, S.Y. & Koo, N.K. (2005) 'Change of stereoacuity with aging in normal eyes', *Korean Journal of Ophthalmology*, vol. 19, no. 2, pp. 136-139.
Lee, W.-J., Cheng, Y.-Y., Liu, J.-Y., Yang, K.-C. & Jeng, S.-Y. (2011) 'Living alone as a red flag sign of falls among older people in rural Taiwan', *Journal of Clinical Gerontology and Geriatrics*, vol. 2, no. 3, pp. 76-79.
Legood, R., Scuffham, P. & Cryer, C. (2002) 'Are we blind to injuries in the visually impaired? A review of the literature', *Injury Prevention*, vol. 8, no. 2, pp. 155-160.
Legters, K. (2002) 'Fear of falling', *Physical Therapy*, vol. 82, no. 3, pp. 264-272.
Leske, D.A., Birch, E.E. & Holmes, J.M. (2006) 'Real depth vs randot stereotests', *American Journal of Ophthalmology*, vol. 142, no. 4, pp. 699-701.
Letts, L., Moreland, J., Richardson, J., Coman, L., Edwards, M., Ginis, K.M., Wilkins, S. & Wishart, L. (2010) 'The physical environment as a fall risk factor in older adults: Systematic review and meta-analysis of cross-sectional and cohort studies', *Australian Occupational Therapy Journal*, vol. 57, no. 1, pp. 51-64.
Levi, D.M., Knill, D.C. & Bavelier, D. (2015) 'Stereopsis and amblyopia: A mini-review', *Vision Research*, vol. 114, pp. 17-30.
Li, W., Keegan, T.H., Sternfeld, B., Sidney, S., Quesenberry, C.P., Jr. & Kelsey, J.L. (2006) 'Outdoor falls among middle-aged and older adults: a neglected public health problem', *American Journal Of Public Health*, vol. 96, no. 7, pp. 1192-1200.
Lin, F.R. & Ferrucci, L. (2012) 'Hearing loss and falls among older adults in the United States', *Archives of Internal Medicine* vol. 172, no. 4, pp. 369-371.
Lindstrom, A., Davis, H. & Frisby, J.P. (2009) 'Does binocularly perceived depth correlate with reduced stereoacuity?', *Ophthalmic Physiol Opt*, vol. 29, no. 1, pp. 92-98.
Liu, J.Y. (2015) 'Fear of falling in robust community-dwelling older people: results of a cross-sectional study', *Journal of Clinical Nursing*, vol. 24, no. 3-4, pp. 393-405.
López-Soto, P.J., De Giorgi, A., Senno, E., Tiseo, R., Ferraresi, A., Canella, C., Rodríguez-Borrego, M.A., Manfredini, R. & Fabbian, F. (2015) 'Renal disease and accidental falls: a review of published evidence', *BMC Nephrology*, vol. 16, no. 1, p. 176.
Lord, S.R. (2006) 'Visual risk factors for falls in older people', *Age and Ageing*, vol. 35, no. suppl_2, pp. ii42-ii45.
Lord, S.R., Clark, R.D. & Webster, I.W. (1991) 'Visual acuity and contrast sensitivity in relation to falls in an elderly population', *Age and Ageing*, vol. 20, no. 3, pp. 175-181.
Lord, S.R. & Dayhew, J. (2001) 'Visual risk factors for falls in older people', *Journal of American Geriatrics Society*, vol. 49, no. 5, pp. 508-515.
Lord, S.R., Dayhew, J. & Howland, A. (2002) 'Multifocal glasses impair edge-contrast sensitivity and depth perception and increase the risk of falls in older people', *Journal of American Geriatrics Society*, vol. 50, no. 11, pp. 1760-1766.
Lord, S.R. & Menz, H.B. (2000) 'Visual contributions to postural stability in older adults', *Gerontology*, vol. 46, no. 6, pp. 306-310.
Loriaut, P., Loriaut, P., Boyer, P., Massin, P. & Cochereau, I. (2014) 'Visual impairment and hip fractures: a case-control study in elderly patients', *Ophthalmic Res*, vol. 52, no. 4, pp. 212-216.
Lowes, L. & Prowse, M.A. (2001) 'Standing outside the interview process? The illusion of objectivity in phenomenological data generation', *International Journal of Nursing Studies*, vol. 38, no. 4, pp. 471-480.
Lupton, D. (1999) *Risk*, Taylor and Francis.
Lupton, D. (2013) *Risk. [electronic book]*, London : Routledge, 2013.

2nd ed.
Luukinen, H., Koski, K., Laippala, P. & Md, S.-L.K. (1997) 'Factors Predicting Fractures During Falling Impacts Among Home-Dwelling Older Adults', *Journal of the American Geriatrics Society*, vol. 45, no. 11, pp. 1302-1309.
Lysack, C.L. (2010) Chapter 23 - Household and Neighborhood Safety, Mobility, in P.A. Lichtenberg (ed.), *Handbook of Assessment in Clinical Gerontology (Second Edition)*, Academic Press, San Diego, pp. 619-646.
MacAulay, R.K., Allaire, T.D., Brouillette, R.M., Foii, H.C., Bruce-Keller, A.J., Han, H.M., Johnson, W.D. & Keller, J.N. (2015) 'Longitudinal assessment of neuropsychological and temporal/spatial gait characteristics of elderly fallers: taking it all in stride', *Frontiers in Aging Neuroscience*, vol. 7, p. 7.
Mackenbach, J.P., Martikainen, P., Looman, C.W., Dalstra, J.A., Kunst, A.E., Lahelma, E. & group, m.o.t.S.w. (2004) 'The shape of the relationship between income and self-assessed health: an international study', *International Journal of Epidemiology*, vol. 34, no. 2, pp. 286-293.
Mackenzie, L., Byles, J. & Higginbotham, N. (2002) 'A prospective community-based study of falls among older people in Australia: Frequency, circumstances, and consequences', *OTJR: Occupation, Participation and Health*, vol. 22, no. 4, pp. 143-152.
Maki, B.E., Holliday, P.J. & Topper, A.K. (1991) 'Fear of falling and postural performance in the elderly', *Journal of Gerontology*, vol. 46, no. 4, pp. M123-131.
Manoranjan, A., Shrestha, S. & Shrestha, S. (2013) 'Effect of bilateral age-related cataract on stereoacuity', *Strabismus*, vol. 21, no. 2, pp. 116-122.
Mantyjarvi, M. & Laitinen, T. (2001) 'Normal values for the Pelli-Robson contrast sensitivity test', *Journal of Cataract and Refractive Surgery*, vol. 27, no. 2, pp. 261-266.
Marengoni, A., Angleman, S., Melis, R., Mangialasche, F., Karp, A., Garmen, A., Meinow, B. & Fratiglioni, L. (2011) 'Aging with multimorbidity: a systematic review of the literature', *Ageing Research Reviews*, vol. 10, no. 4, pp. 430-439.
Marmor, M.F. (1986) 'Contrast sensitivity versus visual acuity in retinal disease', *The British Journal of Ophthalmology*, vol. 70, no. 7, pp. 553-559.
Marmot, M. (2010) *Fair society, healthy lives : the Marmot Review : strategic review of health inequalities in England post-2010*,
Marmot, M., Allen, J., Bell, R., Bloomer, E. & Goldblatt, P. (2012) 'WHO European review of social determinants of health and the health divide', *The Lancet*, vol. 380, no. 9846, pp. 1011-1029.
Masnoon, N., Shakib, S., Kalisch-Ellett, L. & Caughey, G.E. (2017) 'What is polypharmacy? A systematic review of definitions', *BMC geriatrics*, vol. 17, no. 1, pp. 230-230.
Mason, J. (2018) *Qualitative researching*, Third edition. edn, SAGE.
Masten, A.S., Best, K.M. & Garmezy, N. (1990) 'Resilience and development: Contributions from the study of children who overcome adversity', *Development and Psychopathology*, vol. 2, no. 4, pp. 425-444.
Masud, T. & Morris, R.O. (2001) 'Epidemiology of falls', *Age and Ageing*, vol. 30, no. suppl_4, pp. 3-7.
McAlinden, C., Pesudovs, K. & Moore, J.E. (2010) 'The development of an instrument to measure quality of vision: the Quality of Vision (QoV) questionnaire', *Investigative Ophthalmology & Visual Science*, vol. 51, no. 11, pp. 5537-5545.
McGinley, P., Ansari, E., Sandhu, H. & Dixon, T. (2019) 'The cost burden of falls in people with glaucoma in National Health Service Hospital Trusts in the UK', *Journal of Medical Economics*, p. 7.

McKee, K.J., Orbell, S., Austin, C.A., Bettridge, R., Liddle, B.J., Morgan, K. & Radley, K. (2002) 'Fear of falling, falls efficacy, and health outcomes in older people following hip fracture', *Disability And Rehabilitation*, vol. 24, no. 6, pp. 327-333.

Merleau-Ponty, M. (1962) *Phenomenology of perception*, London : Routledge & Kegan Paul, 1962.

Michalsen, A. (2003) 'Risk assessment and perception', *Injury control and safety promotion*, vol. 10, no. 4, pp. 201-204.

Milat, A.J., Watson, W.L., Monger, C., Barr, M., Giffin, M. & Reid, M. (2011) 'Prevalence, circumstances and consequences of falls among community-dwelling older people: results of the 2009 NSW Falls Prevention Baseline Survey', *New South Wales Public Health Bulletin*, vol. 22, no. 4, pp. 43-48.

Mills C. Wright (1959) *The Sociological Imagination*, Oxford University Press.

Moran, D. (1999) *Introduction to Phenomenology*, Routledge, London, UNITED KINGDOM.

Morgan, D.L. (1998) 'Practical Strategies for Combining Qualitative and Quantitative Methods: Applications to Health Research', *Qualitative Health Research*, vol. 8, no. 3, pp. 362-368.

Morgan, D.L. (2014) 'Pragmatism as a Paradigm for Social Research', *Qualitative Inquiry*, vol. 20, no. 8, pp. 1045-1053.

Muraki, S., Akune, T., Oka, H., Ishimoto, Y., Nagata, K., Yoshida, M., Tokimura, F., Nakamura, K., Kawaguchi, H. & Yoshimura, N. (2013) 'Physical performance, bone and joint diseases, and incidence of falls in Japanese men and women: a longitudinal cohort study', *Osteoporosis International*, vol. 24, no. 2, pp. 459-466.

Murphy, J. & Isaacs, B. (1982) 'The Post-Fall Syndrome - a Study of 36 Elderly Patients', *Gerontology*, vol. 28, no. 4, pp. 265-270.

Murphy, S.L., Dubin, J.A. & Gill, T.M. (2003) 'The development of fear of falling among community-living older women: predisposing factors and subsequent fall events', *Journal of Gerontologly Series A Biological Scences and Medical Sciences*, vol. 58, no. 10, pp. M943-947.

Nakamura, D.M., Holm, M.B. & Wilson, A. (1998) 'Measures of balance and fear of falling in the elderly: A review', *Physical and Occupational Therapy in Geriatrics*, vol. 15, no. 4, pp. 17-32.

National Statistics (2015) *English indices of deprivation 2015* [Online], Available from: (https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015) (Accessed: 30/4/19).

Nelson, P., Aspinall, P. & O'Brien, C. (1999) 'Patients' perception of visual impairment in glaucoma: a pilot study', *British Journal of Ophthalmology*, vol. 83, no. 5, p. 546.

Nevitt, M.C., Cummings, S.R., Kidd, S. & Black, D. (1989) 'Risk factors for recurrent nonsyncopal falls. A prospective study', *JAMA*, vol. 261, no. 18, pp. 2663-2668.

Nguyen, A.M., Arora, K.S., Swenor, B.K., Friedman, D.S. & Ramulu, P.Y. (2015) 'Physical activity restriction in age-related eye disease: a cross-sectional study exploring fear of falling as a potential mediator', *BMC Geriatrics*, vol. 15, p. 64.

NHS *How often can I havea free NHS eye test?* [Online], Available from: (https://www.nhs.uk/common-health-questions/nhs-services-and-treatments/how-often-can-i-have-a-free-nhs-eye-test/) (Accessed: 22/10/19).

NICE (2004) *Falls: The assessment and prevention of falls in older people. Clinical guideline 21*.

NICE (2013) *Falls in older people: assessing risk and prevention*, vol. 2017, no 9/4/17.

NICE (2019a) *2019 surveillance of falls in older people: assessing risk and prevention (NICE guideline CG161)*,

NICE (2019b) *Falls - risk assessment* [Online], Available from: https://cks.nice.org.uk/falls-risk-assessment#!topicSummary (Accessed: 12 November 2019).

Nieves, J.W., Formica, C., Ruffing, J., Zion, M., Garrett, P., Lindsay, R. & Cosman, F. (2005) 'Males have larger skeletal size and bone mass than females, despite comparable body size', *Journal of Bone and Mineral Research*, vol. 20, no. 3, pp. 529-535.

Norman, J.F., Norman, H.F., Craft, A.E., Walton, C.L., Bartholomew, A.N., Burton, C.L., Wiesemann, E.Y. & Crabtree, C.E. (2008) 'Stereopsis and aging', *Vision Research*, vol. 48, no. 23, pp. 2456-2465.

O'Connor, A.R., Birch, E.E., Anderson, S. & Draper, H. (2010) 'The functional significance of stereopsis', *Investigative Ophthalmology & Visual Science*, vol. 51, no. 4, pp. 2019-2023.

Odell, N.V., Hatt, S.R., Leske, D.A., Adams, W.E. & Holmes, J.M. (2009a) 'The effect of induced monocular blur on measures of stereoacuity', *Journal of American Association for Pediatric Ophthalmology and Strabismus*, vol. 13, no. 2, pp. 136-141.

Odell, N.V., Hatt, S.R., Leske, D.A., Adams, W.E. & Holmes, J.M. (2009b) 'The effect of induced monocular blur on measures of stereoacuity', *Journal of AAPOS : the official publication of the American Association for Pediatric Ophthalmology and Strabismus*, vol. 13, no. 2, pp. 136-141.

Office of National Statistics (2017) *Overview of the UK population: March 2017*, vol. 2017, no 10/4/17, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/mar2017.

Oh-Park, M., Xue, X., Holtzer, R. & Verghese, J. (2011) 'Transient Versus Persistent Fear of Falling in Community-Dwelling Older Adults: Incidence and Risk Factors', *Journal of American Geriatrics Society*, vol. 59, pp. 1225-1231.

Ong, B.N., Richardson, J.C., Porter, T. & Grime, J. (2014) 'Exploring the relationship between multi-morbidity, resilience and social connectedness across the lifecourse', *Health (London)*, vol. 18, no. 3, pp. 302-318.

Owsley, C. (2003) 'Contrast sensitivity', *Ophthalmology Clinics of North America*, vol. 16, no. 2, pp. 171-177.

Owsley, C. (2011) 'Aging and vision', *Vision Research*, vol. 51, no. 13, pp. 1610-1622.

Owsley, C., Huisingh, C., Clark, M.E., Jackson, G.R. & McGwin, G., Jr. (2016) 'Comparison of Visual Function in Older Eyes in the Earliest Stages of Age-related Macular Degeneration to Those in Normal Macular Health', *Current Eye Research*, vol. 41, no. 2, pp. 266-272.

Owsley, C., Sekuler, R. & Siemsen, D. (1983) 'Contrast sensitivity throughout adulthood', *Vision Research*, vol. 23, no. 7, pp. 689-699.

Owsley, C. & Sloane, M.E. (1987) 'Contrast sensitivity, acuity, and the perception of 'real-world' targets', *British Journal of Ophthalmology*, vol. 71, no. 10, pp. 791-796.

Palagyi, A., McCluskey, P., White, A., Rogers, K., Meuleners, L., Ng, J.Q., Morlet, N. & Keay, L. (2016) 'While We Waited: Incidence and Predictors of Falls in Older Adults With CataractFalls in Older Adults With Cataract', *Investigative Ophthalmology & Visual Science*, vol. 57, no. 14, pp. 6003-6010.

Palagyi, A., Ng, J.Q., Rogers, K., Meuleners, L., McCluskey, P., White, A., Morlet, N. & Keay, L. (2017) 'Fear of falling and physical function in older adults with cataract: Exploring the role of vision as a moderator', *Geriatrics & Gerontology International*, vol. 17, no. 10, pp. 1551-1558.

Paley, J. (2017) *Phenomenology as qualitative research. a critical analysis of meaning attribution*, Routledge.

Palys, T. (2008) Purposive sampling, in L.M. Given (ed.), *The Sage Encyclopedia of Qualitative Research Methods.* , vol. 2, Sage, Los Angeles, pp. 697-698.

Patino, C.M., McKean-Cowdin, R., Azen, S.P., Allison, J.C., Choudhury, F. & Varma, R. (2010) 'Central and peripheral visual impairment and the risk of falls and falls with injury', *Ophthalmology*, vol. 117, no. 2, pp. 199-206 e191.

Patton, M.Q. (1990) *Qualitative evaluation and research methods*, Newbury Park, Calif. : Sage Publications, 1990.

2nd ed.

Pauelsen, M., Nyberg, L., Röijezon, U. & Vikman, I. (2018) 'Both psychological factors and physical performance are associated with fall-related concerns', *Aging Clinical and Experimental Research*, vol. 30, no. 9, pp. 1079-1085.

Paulus, W.M., Straube, A. & Brandt, T. (1984) 'Visual stabilization of posture. Physiological stimulus characteristics and clinical aspects', *Brain*, vol. 107 (Pt 4), pp. 1143-1163.

Payette, M.C., Belanger, C., Leveille, V. & Grenier, S. (2016) 'Fall-Related Psychological Concerns and Anxiety among Community-Dwelling Older Adults: Systematic Review and Meta-Analysis', *PLoS One*, vol. 11, no. 4, p. e0152848.

Peel, N.M. (2011) 'Epidemiology of Falls in Older Age', *Canadian Journal on Aging / La Revue canadienne du vieillissement*, vol. 30, no. 1, pp. 7-19.

Peshkin, A. (1988) 'In Search of Subjectivity. One's Own', *Educational Researcher*, vol. 17, no. 7, pp. 17-21.

Piano, M.E.F. & O'Connor, A.R. (2013) 'The Effect of Degrading Binocular Single Vision on Fine Visuomotor Skill Task PerformanceDegraded BSV and Visuomotor Tasks', *Investigative Ophthalmology & Visual Science*, vol. 54, no. 13, pp. 8204-8213.

Pickard, S. (2010) 'The role of governmentality in the establishment, maintenance and demise of professional jurisdictions: the case of geriatric medicine', *Sociology of Health & Illness*, vol. 32, pp. 1072-1086.

Pickwell, L.D., Kaye, N.A. & Jenkins, T.C. (1991) 'Distance and near readings of associated heterophoria taken on 500 patients', *Ophthalmic and Physiological Optics*, vol. 11, no. 4, pp. 291-296.

Pin, S. & Spini, D. (2016) 'Impact of falling on social participation and social support trajectories in a middle-aged and elderly European sample', *SSM Popul Health*, vol. 2, pp. 382-389.

Pineles, S.L., Repka, M.X., Yu, F., Lum, F. & Coleman, A.L. (2015) 'Risk of musculoskeletal injuries, fractures, and falls in medicare beneficiaries with disorders of binocular vision', *JAMA Ophthalmology*, vol. 133, no. 1, pp. 60-65.

Pinquart, M. & Sörensen, S. (2000) 'Influences of socioeconomic status, social network, and competence on subjective well-being in later life: A meta-analysis', *Psychology and Aging*, vol. 15, no. 2, pp. 187-224.

Pinxten, W. & Lievens, J. (2014) 'The importance of economic, social and cultural capital in understanding health inequalities: using a Bourdieu-based approach in research on physical and mental health perceptions', *Sociology of Health & Illness*, vol. 36, no. 7, pp. 1095-1110.

Podsiadlo, D. & Richardson, S. (1991) 'The timed "Up & Go": a test of basic functional mobility for frail elderly persons', *Journal of the American Geriatrics Society*, vol. 39, no. 2, pp. 142-148.

Pohl, P., Nordin, E., Lundquist, A., Bergström, U. & Lundin-Olsson, L. (2014) 'Community-dwelling older people with an injurious fall are likely to sustain new injurious falls within 5 years - a prospective long-term follow-up study', *BMC Geriatrics*, vol. 14, no. 1, p. 120.

Poinoosawmy, D., Nagasubramanian, S. & Gloster, J. (1980) 'Colour vision in patients with chronic simple glaucoma and ocular hypertension', *British Journal of Ophthalmology*, vol. 64, no. 11, pp. 852-857.

Pomerance, G.N. & Evans, D.W. (1994) 'Test-retest reliability of the CSV-1000 contrast test and its relationship to glaucoma therapy', *Investigative Ophthalmology & Visual Science*, vol. 35, no. 9, pp. 3357-3361.
Pope, C. & Mays, N. (1995) 'Qualitative Research: Reaching the parts other methods cannot reach: an introduction to qualitative methods in health and health services research', *British Medical Journal*, vol. 310, no. 6996, p. 42.
Powell, L.E. & Myers, A.M. (1995) 'The Activities-Specific Balance Confidence (ABC) scale', *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, vol. 50A, no. 1, pp. M28-M34.
Prudham, D. & Evans, J.G. (1981) 'Factors associated with falls in the elderly: a community study', *Age Ageing*, vol. 10, no. 3, pp. 141-146.
Public Health England (2017) *Reducing health inequalities: system, scale and sustainability*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/731682/Reducing_health_inequalities_system_scale_and_sustainability.pdf.
Public Health England (2019a) *Public Health Outcomes Framework* [Online], Available from: https://fingertips.phe.org.uk/search/falls#page/3/gid/1/pat/6/par/E12000002/ati/202/are/E08000012/iid/22401/age/27/sex/4 (Accessed: 16/1/20).
Public Health England (2019b) *Social prescribing: applying All Our Health* [Online], Available from: https://www.gov.uk/government/publications/social-prescribing-applying-all-our-health/social-prescribing-applying-all-our-health#social-prescribing (Accessed: 15/10/19).
Putnam, R.D. (2000) *Bowling alone : the collapse and revival of American community*, Simon & Schuster.
Radner, W. & Benesch, T. (2019) 'Age-related course of visual acuity obtained with ETDRS 2000 charts in persons with healthy eyes', *Graefe's Archive for Clinical and Experimental Ophthalmology: Incorporating German Journal of Ophthalmology*, vol. 257, no. 6, p. 1295.
Railo, H., Saastamoinen, J., Kylmala, S. & Peltola, A. (2018) 'Binocular disparity can augment the capacity of vision without affecting subjective experience of depth', *Scientific Reports*, vol. 8, p. 9.
Ramrattan, R.S., Wolfs, R.W., Panda-Jonas, S. & et al. (2001) 'Prevalence and causes of visual field loss in the elderly and associations with impairment in daily functioning: The rotterdam study', *Archives of Ophthalmology*, vol. 119, no. 12, pp. 1788-1794.
Ramulu, P. (2009) 'Glaucoma and disability: which tasks are affected, and at what stage of disease?', *Current opinion in ophthalmology*, vol. 20, no. 2, pp. 92-98.
Ramulu, P.Y., van Landingham, S.W., Massof, R.W., Chan, E.S., Ferrucci, L. & Friedman, D.S. (2012) 'Fear of falling and visual field loss from glaucoma', *Ophthalmology*, vol. 119, no. 7, pp. 1352-1358.
Rapp, K., Freiberger, E., Todd, C., Klenk, J., Becker, C., Denkinger, M., Scheidt-Nave, C. & Fuchs, J. (2014) 'Fall incidence in Germany: results of two population-based studies, and comparison of retrospective and prospective falls data collection methods', *BMC geriatrics*, vol. 14, pp. 105-105.
Reeves, S., Albert, M., Kuper, A. & Hodges, B.D. (2008) 'Why use theories in qualitative research?', *British Medical Journal*, vol. 337, p. a949.
Reid, M.C., Boutros, N.N., O'Connor, P.G., Cadariu, A. & Concato, J. (2002) 'The health-related effects of alcohol use in older persons: a systematic review', *Subst Abus*, vol. 23, no. 3, pp. 149-164.
Richman, J., Lorenzana, L.L., Lankaranian, D. & et al. (2010) 'Importance of visual acuity and contrast sensitivity in patients with glaucoma', *Archives of Ophthalmology*, vol. 128, no. 12, pp. 1576-1582.

Ricoeur, P. (1980) 'Narrative Time', *Critical Inquiry*, vol. 7, no. 1, pp. 169-190.
Rivasi, G., Kenny, R.A., Ungar, A. & Romero-Ortuno, R. (2019) 'Predictors of Incident Fear of Falling in Community-Dwelling Older Adults', *Journal of the American Medical Directors Association*.
RNIB (2007) *Older people and eye tests. Don't let age rob you of your sight* RNIB,
Robertson, L. & Hale, B. (2011) 'Interviewing Older People: Relationships in Qualitative Research. ', *The Internet Journal of Allied Health Sciences and Practice*, vol. 9, no. 3, p. Article 10.
Rodriguez, A. & Smith, J. (2018) 'Phenomenology as a healthcare research method', *Evidence Based Nursing*, vol. 21, no. 4, pp. 96-98.
Rolando, M., Iester, M., Macri, A. & Calabria, G. (1998) 'Low spatial-contrast sensitivity in dry eyes', *Cornea*, vol. 17, no. 4, pp. 376-379.
Rossat, A., Beauchet, O., Nitenberg, C., Annweiler, C. & Fantino, B. (2009) 'Risk factors for fear of falling: a cross-sectional population-based study', *Journal of American Geriatrics Society*, vol. 57, no. 7, pp. 1304-1306.
Rowe, F.J. (2016) *Visual fields via the visual pathway*, 2nd ed. edn, CRC Press.
Rowe, J.W. & Kahn, R.L. (1987) 'Human aging: usual and successful', *Science*, vol. 237, p. 143+.
Rowe, J.W. & Kahn, R.L. (1997) Successful Aging, p. 433
Rubenstein, L.Z. (2006) 'Falls in older people: epidemiology, risk factors and strategies for prevention', *Age and Ageing*, vol. 35 Suppl 2, pp. ii37-ii41.
Rubin, G.S. (1988) 'Reliability And Sensitivity Of Clinical Contrast Sensitivity Tests', *Clinical Vision Sciences*, vol. 2, no. 3, pp. 169-177.
Rubin, G.S., Munoz, B., Bandeen-Roche, K. & West, S.K. (2000) 'Monocular versus binocular visual acuity as measures of vision impairment and predictors of visual disability', *Investigative Ophthalmology & Visual Science*, vol. 41, no. 11, pp. 3327-3334.
Rutter, M. (2012) 'Resilience as a dynamic concept', *Development and Psychopathology* vol. 24, , pp. 335–344.
Sadala, M.L.A. & Adorno, R.d.C.F. (2002) 'Phenomenology as a method to investigate the experience lived: a perspective from Husserl and Merleau Ponty's thought', *Journal of Advanced Nursing*, vol. 37, no. 3, pp. 282-293.
Samuelsson, C.M., Hansson, P.-O. & Persson, C.U. (2019) 'Early prediction of falls after stroke: a 12-month follow-up of 490 patients in The Fall Study of Gothenburg (FallsGOT)', *Clinical Rehabilitation*, vol. 33, no. 4, pp. 773-783.
Sandelowski, M. (2000) 'Combining Qualitative and Quantitative Sampling, Data Collection, and Analysis Techniques in Mixed-Method Studies', *Research in Nursing & Health*, vol. 23, no. 3, pp. 246-255.
Sandlund, M., Pohl, P., Ahlgren, C., Skelton, D.A., Melander-Wikman, A., Bergvall-Kåreborn, B. & Lundin-Olsson, L. (2018) 'Gender Perspective on Older People's Exercise Preferences and Motivators in the Context of Falls Prevention: A Qualitative Study', *BioMed Research International*, vol. 2018, pp. 1-11.
Scheffer, A.C., Schuurmans, M.J., van Dijk, N., van der Hooft, T. & de Rooij, S.E. (2008) 'Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons', *Age and Ageing*, vol. 37, no. 1, pp. 19-24.
Schepens, S., Ananda, S., Painter, J.A. & Murphy, S.L. (2012) 'Relationship between fall-related efficacy and activity engagement in community-dwelling older adults: a meta-analytic review', *American Journal of Occupational Therapy*, vol. 66.
Schneck, M.E., Haegerstrom-Portnoy, G., Lott, L.A., Brabyn, J.A. & Gildengorin, G. (2004) 'Low contrast vision function predicts subsequent acuity loss in an aged population: the SKI study', *Vision Research*, vol. 44, no. 20, pp. 2317-2325.

Schoene, D., Heller, C., Aung, Y.N., Sieber, C.C., Kemmler, W. & Freiberger, E. (2019) 'A systematic review on the influence of fear of falling on quality of life in older people: is there a role for falls?', *Clinical Interventions In Aging*, vol. 14, pp. 701-719.

Schwenk, M., Lauenroth, A., Stock, C., Moreno, R.R., Oster, P., McHugh, G., Todd, C. & Hauer, K. (2012) 'Definitions and methods of measuring and reporting on injurious falls in randomised controlled fall prevention trials: a systematic review', *BMC Medical Research Methodology*, vol. 12, no. 1, p. 50.

Seeman, T.E. (2000) 'Health Promoting Effects of Friends and Family on Health Outcomes in Older Adults', *American Journal of Health Promotion*, vol. 14, no. 6, pp. 362-370.

Seery, M.D. (2011) 'Resilience:A Silver Lining to Experiencing Adverse Life Events?', *Current Directions in Psychological Science*, vol. 20, no. 6, pp. 390-394.

Seppala, L.J., van der Velde, N., Masud, T., Blain, H., Petrovic, M., van der Cammen, T.J., Szczerbińska, K., Hartikainen, S., Kenny, R.A., Ryg, J., Eklund, P., Topinková, E., Mair, A., Laflamme, L., Thaler, H., Bahat, G., Gutiérrez-Valencia, M., Caballero-Mora, M., Landi, F., Emmelot-Vonk, M.H., Cherubini, A., Baeyens, J.P., Correa-Pérez, A., Gudmundsson, A., Marengoni, A., O'Mahony, D., Parekh, N., Pisa, F.E., Rajkumar, C., Wehling, M., Ziere, G., Task, t.E., Drugs, F.G.o.F.-R.-I. & Pharmacology, t.E.S.I.G.o. (2019) 'EuGMS Task and Finish group on Fall-Risk-Increasing Drugs (FRIDs): Position on Knowledge Dissemination, Management, and Future Research', *European Geriatric Medicine*, vol. 10, no. 2, pp. 275-283.

Shaheen, A.F., Sourlas, A., Horton, K., McLean, C., Ewins, D., Gould, D. & Ghoussayni, S. (2018) 'Effects of lighting illuminance levels on stair negotiation performance in individuals with visual impairment', *Journal of Electromyography and Kinesiology*, vol. 39, pp. 8-15.

Shannon-Baker, P. (2016) 'Making Paradigms Meaningful in Mixed Methods Research', *Journal of Mixed Methods Research*, vol. 10, no. 4, pp. 319-334.

Sheldon, J.H. (1960) 'On the Natural History of Falls in Old Age', *British Medical Journal* vol. 2, no. 5214, pp. 1685-1690.

Sherrington, C., Fairhall, N.J., Wallbank, G.K., Tiedemann, A., Michaleff, Z.A., Howard, K., Clemson, L., Hopewell, S. & Lamb, S.E. (2019) 'Exercise for preventing falls in older people living in the community', *Cochrane Database of Systematic Reviews*, no. 1.

Sibley, K.M., Voth, J., Munce, S.E., Straus, S.E. & Jaglal, S.B. (2014) 'Chronic disease and falls in community-dwelling Canadians over 65 years old: a population-based study exploring associations with number and pattern of chronic conditions', *BMC Geriatrics*, vol. 14, p. 22.

Silverman, D. (2010) *Doing qualitative research : a practical handbook*, 3rd ed. edn, SAGE.

Sim, J., Saunders, B., Waterfield, J. & Kingstone, T. (2018) 'Can sample size in qualitative research be determined a priori?', *International Journal of Social Research Methodology*, vol. 21, no. 5, pp. 619-634.

Skelton, D.A. (2001) 'Effects of physical activity on postural stability', *Age and Ageing*, vol. 30 Suppl 4, pp. 33-39.

Skelton, D.A. & Todd, C.J. (2007) 'Prevention of Falls Network Europe: a thematic network aimed at introducing good practice in effective falls prevention across Europe. Four years on', *J Musculoskelet Neuronal Interact*, vol. 7, no. 3, pp. 273-278.

Sloane, M.E., Owsley, C. & Alvarez, S.L. (1988) 'Aging, senile miosis and spatial contrast sensitivity at low luminance', *Vision Research*, vol. 28, no. 11, pp. 1235-1246.

Slovic, P. (2000) *The perception of risk*, London : Earthscan, 2000.

Soares, W.J.S., Lopes, A.D., Nogueira, E., Candido, V., de Moraes, S.A. & Perracini, M.R. (2019) 'Physical Activity Level and Risk of Falling in Community-Dwelling Older

Adults: Systematic Review and Meta-Analysis', *Journal of Aging & Physical Activity*, vol. 27, no. 1, pp. 34-43.
Sotimehin, A.E., Yonge, A.V., Mihailovic, A., West, S.K., Friedman, D.S., Gitlin, L.N. & Ramulu, P.Y. (2018) 'Locations, Circumstances, and Outcomes of Falls in Patients With Glaucoma', *Am J Ophthalmol*, vol. 192, pp. 131-141.
Spector, R. (1990) *Clinical Methods: The History, Physical, and Laboratory Examinations*, 3rd edition edn, Butterworths.
Stevens, J.A. & Sogolow, E.D. (2005) *Gender differences for non-fatal unintentional fall related injuries among older adults*, vol. 11, pp. 115-119.
Stowe, J.D. & Cooney, T.M. (2015) 'Examining Rowe and Kahn's Concept of Successful Aging: Importance of Taking a Life Course Perspective', *The Gerontologist*, vol. 55, no. 1, pp. 43-50.
STROBE (2007) *STROBE Statement—Checklist of items that should be included in reports of case-control studies* [Online], Available from: https://www.strobe-statement.org/fileadmin/Strobe/uploads/checklists/STROBE_checklist_v4_case-control.pdf (Accessed: 14/12/19).
Summary of the Updated American Geriatrics Society/British Geriatrics Society Clinical Practice Guideline for Prevention of Falls in Older Persons (2011), p. 148
Superstein, R., Boyaner, D., Overbury, O. & Collin, C. (1997) 'Glare disability and contrast sensitivity before and after cataract surgery', *Journal of Cataract & Refractive Surgery*, vol. 23, no. 2, pp. 248-253.
Suzuma, K., Inoue, S., Horii, T., Kawakami, R. & Miura, T. (2008) 'Assessment of Stereopsis Before and After Photodynamic Therapy With Verteporfin in Patients With Age-Related Macular Degeneration', *Investigative Ophthalmology & Visual Science*, vol. 49, p. 6023.
Szabo, S.M., Janssen, P.A., Khan, K., Lord, S.R. & Potter, M.J. (2010) 'Neovascular AMD: an overlooked risk factor for injurious falls', *Osteoporosis International: A Journal Established As Result Of Cooperation Between The European Foundation For Osteoporosis And The National Osteoporosis Foundation Of The USA*, vol. 21, no. 5, pp. 855-862.
Tashakkori, A. & Teddlie, C. (2003) *Handbook of mixed methods in social & behavioral research*, SAGE Publications.
Taylor, D.J., Edwards, L.A., Binns, A.M. & Crabb, D.P. (2018) 'Seeing it differently: self-reported description of vision loss in dry age-related macular degeneration', *Ophthalmic and Physiological Optics*, vol. 38, no. 1, pp. 98-105.
Teddlie, C. & Tashakkori, A. (2009) *Foundations of mixed methods research : integrating quantitative and qualitative approaches in the social and behavioral sciences*, Los Angeles ;London : SAGE, 2009.
Teddlie, C. & Yu, F. (2007) 'Mixed Methods Sampling: A Typology With Examples', *Journal of Mixed Methods Research*, no. 1, pp. 77-100.
Thayer, H.S. (1968) *Meaning and Action: A Critical History of Pragmatism*, Bobbs-Merrill, Indianapolis.
The College of Optometrists (2014) *Focus on Falls-report*, https://www.college-optometrists.org/resourceLibrary/focus-on-falls---report.html
The Royal Society (1992) *Risk: Analysis, perception and management. Report of a Royal Society study group.*, The Royal Society, London
Thetford, C., Bennett, K.M., Hodge, S., Knox, P.C. & Robinson, J. (2015) 'Resilience and vision impairment in older people', *Journal of Aging Studies*, vol. 35, pp. 37-48.
ThÉVenaz, P., Wild, J.D. & Edie, J.M. (1962) *What is phenomenology?, and other essays*, Chicago : Quadrangle Books, 1962.

Thibaud, M., Bloch, F., Tournoux-Facon, C., Brèque, C., Rigaud, A.S., Dugué, B. & Kemoun, G. (2012) 'Impact of physical activity and sedentary behaviour on fall risks in older people: a systematic review and meta-analysis of observational studies', *European Review of Aging and Physical Activity*, vol. 9, no. 1, pp. 5-15.
Thiem, U., Klaaßen-Mielke, R., Trampisch, U., Moschny, A., Pientka, L. & Hinrichs, T. (2014) 'Falls and EQ-5D rated quality of life in community-dwelling seniors with concurrent chronic diseases: a cross-sectional study', *Health and Quality of Life Outcomes*, vol. 12, p. 2.
Tinetti, M.E., De Leon, C.F.M., Doucette, J.T. & Baker, D.I. (1994) 'Fear of Falling and Fall-Related Efficacy in Relationship to Functioning Among Community-Living Elders', *Journal of Gerontology*, vol. 49, no. 3, pp. M140-M147.
Tinetti, M.E. & Powell, L. (1993) 'Fear of Falling and Low Self-Efficacy - a Cause of Dependence in Elderly Persons', *Journals of Gerontology*, vol. 48, pp. 35-38.
Tinetti, M.E., Richman, D. & Powell, L. (1990) 'Falls efficacy as a measure of fear of falling', *Journal of Gerontology*, vol. 45, no. 6, pp. P239-243.
Tinetti, M.E. & Speechley, M. (1989) 'Prevention of falls among the elderly', *The New England Journal Of Medicine*, vol. 320, no. 16, pp. 1055-1059.
Tinetti, M.E., Speechley, M. & Ginter, S.F. (1988) 'Risk factors for falls among elderly persons living in the community', *New England Journal of Medicine*, vol. 319, no. 26, pp. 1701-1707.
Tischler, L. & Hobson, S. (2005) 'Fear of Falling: A Qualitative Study Among Community-Dwelling Older Adults', *Physical & Occupational Therapy In Geriatrics*, vol. 23, no. 4, pp. 37-53.
Todd, C. & Skelton, D. (2004) *What are the main risk factors for falls among older people and what are the most effective interventions to prevent these falls?* , WHO Regional Office for Europe (Health Evidence Network), Copenhagen
Tornstam, L. (1997) 'Gerotranscendence: The contemplative dimension of aging', *Journal of Aging Studies*, vol. 11, no. 2, pp. 143-154.
Tudor, A. (2003) 'A (macro) sociology of fear?', *The Sociological Review*, vol. 51 no. 2, pp. 238-256.
Tulloch, J. & Lupton, D. (2003) *Risk and everyday life. [electronic book]*, London ;Thousand Oaks : Sage Publications, 2003.
Turano, K., Rubin, G.S., Herdman, S.J., Chee, E. & Fried, L.P. (1994) 'Visual stabilization of posture in the elderly: fallers vs. nonfallers', *Optometry And Vision Science: Official Publication Of The American Academy Of Optometry*, vol. 71, no. 12, pp. 761-769.
Turano, K.A., Broman, A.T., Bandeen-Roche, K., Munoz, B., Rubin, G.S., West, S. & Team, S.E.E.P. (2004) 'Association of visual field loss and mobility performance in older adults: Salisbury Eye Evaluation Study', *Optometry & Vision Science*, vol. 81, no. 5, pp. 298-307.
Vale, A., Buckley, J.G. & Elliott, D.B. (2008) 'Gait alterations negotiating a raised surface induced by monocular blur', *Optometry & Vision Science*, vol. 85, no. 12, pp. 1128-1134.
van den Akker, M., Buntinx, F. & Knottnerus, J. (2009) 'Comorbidity or multimorbiditywhat's in a name? A review of literature', *European Journal of General Practice.*, vol. 2, pp. 65-70.
van der Meulen, E., Zijlstra, G.A.R., Ambergen, T. & Kempen, G.I.J.M. (2014) 'Effect of Fall-Related Concerns on Physical, Mental, and Social Function in Community-Dwelling Older Adults: A Prospective Cohort Study', *Journal of the American Geriatrics Society*, vol. 62, no. 12, pp. 2333-2338.

van der Pols, J.C., Bates, C.J., McGraw, P.V., Thompson, J.R., Reacher, M., Prentice, A. & Finch, S. (2000) 'Visual acuity measurements in a national sample of British elderly people', *British Journal of Ophthalmology*, vol. 84, no. 2, pp. 165-170.

van Landingham, S.W., Massof, R.W., Chan, E., Friedman, D.S. & Ramulu, P.Y. (2014) 'Fear of falling in age-related macular degeneration', *BMC Ophthalmology*, vol. 14, pp. 10-10.

van Manen, M. (1997) *Researching lived experience : human science for an action sensitive pedagogy*, 2nd ed. edn, Althouse Press.

Vandenbroucke Jan, P., von Elm, E., Altman, D., Gøtzsche, P., C., Mulrow, C., D. , Pocock, S., J., Poole, C., Schlesselman, J., J. & Egger, M. (2007) 'Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): Explanation and Elaboration', *Epidemiology*, vol. 18, no. 6, p. 805.

Verbaken, J.H. & Johnston, A.W. (1986) 'Population Norms For Edge Contrast Sensitivity', *American Journal of Optometry and Physiological Optics*, vol. 63, no. 9, pp. 724-732.

Verghese, P., Tyson, T.L., Ghahghaei, S. & Fletcher, D.C. (2016) 'Depth Perception and Grasp in Central Field Loss', *Investigative Ophthalmology & Visual Science*, vol. 57, no. 3, pp. 1476-1487.

Verma, S.K., Willetts, J.L., Corns, H.L., Marucci-Wellman, H.R., Lombardi, D.A. & Courtney, T.K. (2016) 'Falls and Fall-Related Injuries among Community-Dwelling Adults in the United States', *PloS one*, vol. 11, no. 3, pp. e0150939-e0150939.

Vishwanath, D. & Hibbard, P.B. (2013) 'Seeing in 3-D With Just One Eye Stereopsis Without Binocular Vision', *Psychological Science*, vol. 24, no. 9, pp. 1673-1685.

Wagnild, G. (2003) 'Resilience and successful aging. Comparison among low and high income older adults', *Journal of Gerontological Nursing*, vol. 29, no. 12, pp. 42-49.

Waitzkin, H. (1985) 'Information Giving in Medical Care', *Journal of Health and Social Behavior*, vol. 26, no. 2, p. 81.

Walker, C. & Peterson, C.L. (2018) 'A sociological approach to resilience in health and illness', *Journal of Evaluation in Clinical Practice*, vol. 24, no. 6, pp. 1285-1290.

Wang, M.Y., Rousseau, J., Boisjoly, H., Schmaltz, H., Kergoat, M.-J., Moghadaszadeh, S., Djafari, F. & Freeman, E.E. (2012) 'Activity limitation due to a fear of falling in older adults with eye disease', *Investigative Ophthalmology & Visual Science*, vol. 53, no. 13, pp. 7967-7972.

Ward-Griffin, C., Hobson, S., Kloseck, M., Vandervoort, A., Crilly, R. & Melles, P. (2004) 'Falls and fear of falling among community-dwelling seniors: The dynamic tension between exercising precaution and striving for independence', *Canadian Journal on Aging*, vol. 23, no. 4, pp. 307-318.

Wengraf, T. (2001) *Qualitative research interviewing. [electronic book] : biographic narrative and semi-structured methods*, London : SAGE, 2001.

White, U.E., Black, A.A., Wood, J.M. & Delbaere, K. (2015) 'Fear of Falling in Vision Impairment', *Optometry and Vision Science*, vol. 92, no. 6, pp. 730-735.

WHO (2007) *WHO global report on falls prevention in older age*, www.who.int/ageing/publications/Falls_prevention7March.pdf

Wild, K., Wiles, J.L. & Allen, R.E.S. (2013) 'Resilience: thoughts on the value of the concept for critical gerontology', *Ageing and Society*, vol. 33, no. 1, pp. 137-158.

Wiles, J.L., Wild, K., Kerse, N. & Allen, R.E.S. (2012) 'Resilience from the point of view of older people: 'There's still life beyond a funny knee'', *Social Science & Medicine*, vol. 74, no. 3, pp. 416-424.

Williams, S. (2000) 'Chronic illness as biographical disruption or biographical disruption as chronic illness? Reflections on a core concept', *Sociology of Health & Illness*, vol. 22, no. 1, pp. 40-67.

Windle, G. (2011) 'What is resilience? A review and concept analysis', *Reviews in Clinical Gerontology*, vol. 21, no. 2, pp. 152-169.
Wood, J.M., Lacherez, P., Black, A.A., Cole, M.H., Boon, M.Y. & Kerr, G.K. (2011) 'Risk of Falls, Injurious Falls, and Other Injuries Resulting from Visual Impairment among Older Adults with Age-Related Macular Degeneration', *Investigative Ophthalmology & Visual Science*, vol. 52, no. 8, pp. 5088-5092.
Wood, J.M., Lacherez, P.F., Black, A.A., Cole, M.H., Boon, M.Y. & Kerr, G.K. (2009) 'Postural stability and gait among older adults with age-related maculopathy', *Investigative Ophthalmology & Visual Science*, vol. 50, no. 1, pp. 482-487.
Woolcott, J.C., Richardson, K.J., Wiens, M.O., Patel, B., Marin, J., Khan, K.M. & Marra, C.A. (2009) 'Meta-analysis of the Impact of 9 Medication Classes on Falls in Elderly Persons', *Archives of internal medicine (1960)*, no. 21, p. 1952.
World Health Organization (2011) *World Report On Disability, Chapter 6 Enabling Environments*,
World Health Organization (2019) *Age-friendly environments* [Online], Available from: https://www.who.int/ageing/projects/age-friendly-environments/en/ (Accessed).
Wright, L.A. & Wormald, R.P.L. (1992) 'Stereopsis and ageing', *Eye (Basingstoke)*, vol. 6, no. 5, pp. 473-476.
Wu, F. & Sheng, Y. (2019) 'Social support network, social support, self-efficacy, health-promoting behavior and healthy aging among older adults: A pathway analysis', *Archives of gerontology and geriatrics*, vol. 85.
Wu, H. & Ouyang, P. (2017) 'Fall prevalence, time trend and its related risk factors among elderly people in China', *Archives of Gerontology and Geriatrics*, vol. 73, pp. 294-299.
Wuerger, S. (2013) 'Colour constancy across the life span: evidence for compensatory mechanisms', *PLoS One*, vol. 8, no. 5, p. e63921.
Wynne, B. (1996) May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide, in S. Lash, B. Szerszynski & B. Wynne (eds), *Risk, Environment and Modernity*, SAGE Publications, London.
Yang, Y., Hu, X., Zhang, Q. & Zou, R. (2016) 'Diabetes mellitus and risk of falls in older adults: a systematic review and meta-analysis', *Age and Ageing*, vol. 45, no. 6, pp. 761-767.
Yardley, L., Beyer, N., Hauer, K., Kempen, G., Piot-Ziegler, C. & Todd, C. (2005) 'Development and initial validation of the Falls Efficacy Scale-International (FES-I)', *Age and Ageing*, vol. 34, no. 6, pp. 614-619.
Yardley, L., Donovan-Hall, M., Francis, K. & Todd, C. (2006) 'Older people's views of advice about falls prevention: a qualitative study', *Health Education Research*, vol. 21, no. 4, pp. 508-517.
Yardley, L. & Smith, H. (2002) 'A Prospective Study of the Relationship Between Feared Consequences of Falling and Avoidance of Activity in Community-Living Older People', *The Gerontologist*, vol. 42, no. 1, pp. 17-23.
Yekta, A.A., Pickwell, L.D. & Jenkins, T.C. (1989) 'Binocular vision, age and symptoms', *Ophthalmic and Physiological Optics*, vol. 9, no. 2, pp. 115-120.
Yip, J.L.Y., Khawaja, A.P., Broadway, D., Luben, R., Hayat, S., Dalzell, N., Bhaniani, A., Wareham, N., Khaw, K.-T. & Foster, P.J. (2014) 'Visual acuity, self-reported vision and falls in the EPIC-Norfolk Eye study', *British Journal of Ophthalmology*, vol. 98, no. 3, pp. 377-382.
Yonge, A.V., Swenor, B.K., Miller, R., Goldhammer, V., West, S.K., Friedman, D.S., Gitlin, L.N. & Ramulu, P.Y. (2017) 'Quantifying Fall-Related Hazards in the Homes of Persons with Glaucoma', *Ophthalmology*, vol. 124, no. 4, pp. 562-571.

Yuki, K., Tanabe, S., Kouyama, K., Fukagawa, K., Uchino, M., Shimoyama, M., Ozeki, N., Shiba, D., Ozawa, Y., Abe, T. & Tsubota, K. (2013) 'The Association Between Visual Field Defect Severity and Fear of Falling in Primary Open-Angle GlaucomaFear of Falling and Primary Open-Angle Glaucoma', *Investigative Ophthalmology & Visual Science*, vol. 54, no. 12, pp. 7739-7745.

Yunchuan, Z., Alderden, J., Lind, B.K. & Heejung, K. (2018) 'A Comprehensive Assessment of Risk Factors for Falls in Community-Dwelling Older Adults', *Journal of Gerontological Nursing*, vol. 44, no. 10, pp. 40-48.

Zakerian, S.A., Yazdanirad, S., Gharib, S., Azam, K. & Zare, A. (2018) 'The effect of increasing the illumination on operators' visual performance in the control-room of a combined cycle power plant', *Annals of Occupational and Environmental Medicine*, vol. 30, no. 1, p. 56.

Zali, M., Farhadi, A., Soleimanifar, M., Allameh, H. & Janani, L. (2017) 'Loneliness, fear of falling, and quality of life in community-dwelling older women who live alone and live with others', *Educational Gerontology*, vol. 43, no. 11, pp. 582-588.

Zaroff, C.M., Knutelska, M. & Frumkes, T.E. (2003) 'Variation in Stereoacuity: Normative Description, Fixation Disparity, and the Roles of Aging and Gender', *Investigative Ophthalmology & Visual Science*, vol. 44, no. 2, pp. 891-900.

Zecevic, A.A., Salmoni, A.W., Speechley, M. & Vandervoort, A.A. (2006) 'Defining a fall and reasons for falling: comparisons among the views of seniors, health care providers, and the research literature', *Gerontologist*, vol. 46, no. 3, pp. 367-376.

Zhang, C.Z., Hua, T.M., Li, G.Z., Tang, C.H., Sun, Q.Y. & Zhou, P.L. (2008) 'Visual function declines during normal aging', *Current Science*, vol. 95, no. 11, pp. 1544-1550.

Zijlstra, G.A., Van Haastregt, J.C., Van Eijk, J.T., Van, R.E., Stalenhoef, P.A. & Kempen, G.I. (2007) 'Prevalence and correlates of fear of falling, and associated avoidance of activity in the general population of community-living older people', *Age and Ageing*, vol. 36.

Appendix 1-Search terms for literature reviews in Chapters 2 and 3

	Literature search terms for Chapter 2.		Literature search terms for Chapter 3.
1.	Accidental falls	24.	4 AND Fear
2.	Falls	25.	“Fear of falling”
3.	Falling	26.	8 AND 25
4.	1 or 2 or 3	27.	Ophthal* AND 25
5.	4 AND prevalence	28.	“Visual impairment” AND 25
6.	4 AND incidence	29.	“Falls Efficacy Scale”
7.	4 AND risk factors	30.	25 AND risk factors
8.	Vision/	31.	25 AND measures
9.	Visual acuity	32.	25 AND “ABC”
10	Contrast sensitivity	33.	25 AND Balance
11	Stereo*	34.	25 AND “Activity limitation”
12	“Depth Perception”	35.	“Timed up to go test”
13	“Binocular vision”	36.	25 AND Glaucoma
14	“Visual Field*”	37.	Age related macular degeneration
15	8 or 9 or 10 or 11 or 12 or 13 AND Ag?ing	38.	AMD
16	4 AND Contrast sensitivity	39.	34 or 35
17	4 AND Stereo*	40.	25 AND 36
18	4 AND “Depth Perception”	41.	25 AND Cataract*
19	4 AND Depth perception	42.	25 AND Visual impairment
20	4 AND “Visual Field*”	43.	Risk theories
21	4 AND “Binocular vision”	44.	“Risk perception”
22	“Gaze stabili?ation”	45.	Fear AND Risk
23	“Head stabili?ation”	46.	“Risk management” AND “Health*
24	20 or 21	47.	41 AND “Health*
25	4 AND 22	48.	Resilience AND Health*
26	Balance AND 22	49.	Resilience AND “Visual impairment”

Appendix 2-Ethical milestones

Ethics milestones for VIFE (Visual Impairment and Falls in the Elderly) study

Date	Ethics milestone	Notes
11/1/17	HRA approval (appendix) REC reference: 16/LO/2249	Protocol version 2.2. approved
12/4/17	Amendment number 1.0 submitted (appendix)	Changes in protocol due to amendment in clinical testing, addition of sociodemographic questions in the case record form and a change of cognitive impairment test.
7/6/17	Amendment number 1.0 approved	Protocol version 2.7 (appendix) Participant information sheet version 1.6 (parts 1, 2 and 3) (appendix) and Case record form 1.7 (appendix) approved
30/10/17	Amendment number 1.1 submitted (appendix)	Changes in the sample of the qualitative phase, therefore an amendment to the protocol. A travel fee of £10 was included to participants travelling to the Royal Liverpool Hospital for their visual assessment. Interview schedule submitted as per the request of the favourable opinion granted on 11/1/17
4/12/17	Amendment number 1.1 approved	Protocol version 2.8 (appendix) Participant information sheet version 1.7 (parts 1 and 2)

4/7/18	Amendment number 1.2 (appendix)	Change in the sample size of the quantitative phase of the study, therefore a change in the protocol
22/8/18	Amendment number 1.2 approved	Protocol version 2.9 (appendix)

Appendix 3-Six-item Cognitive Impairment Test (6CIT)

Six-item Cognitive Impairment Test (6CIT)
- Kingshill Version 2000

1. What year is it?	Correct - 0 points Incorrect - 4 points
2. What month is it?	Correct - 0 points Incorrect - 3 points
3. Give the patient an address phrase to remember with 5 components - eg: John, Smith, 42, High St, Bedford.	
4. About what time is it (within one hour)?	Correct - 0 points Incorrect - 3 points
5. Count backwards from 20-1.	Correct - 0 points 1 error - 2 points More than one error - 4 points
6. Say the months of the year in reverse.	Correct - 0 points 1 error - 2 points More than one error - 4 points
7. Repeat address phrase.	Correct - 0 points 1 error - 2 points 2 errors - 4 points 3 errors - 6 points 4 errors - 8 points All wrong - 10 points

6CIT score = ____ /28

Appendix 4- Participant information sheet

Project Title: Impact of Visual Impairment on falls and fear of falling-Part 1
You are invited to take part in this research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with your family, friends, hospital specialist or GP if you wish. If you need more information please contact the research team whose telephone number is at the end of this sheet.
Thank you for reading this.

Why is the study being done?
With the ageing population set to increase and evidence to show that the risk of falls increases with age, it is necessary to investigate the impact of vision on falls and fear of falling to improve quality of life into old age. Currently there is considerable variability across the country in terms of the visual assessments offered and onward referral for visual conditions. Therefore, we set out to determine any links between vision and falls as part of a larger study exploring the impact of visual impairment on falls and fear of falling.
Hence the main reason for carrying out this research is:

- We want to find out whether visual functions are different in people who have fallen (falls group) compared to those who have not suffered a fall in the last 5 years (control group).

Why you are being invited to take part?
You are being invited to take part as you may be eligible for one of the following groups:

1. Have had a fall and presented to a falls unit or A&E department (falls group)
2. You have not had a fall in the last 5 years and are a similar age to somebody who has had a fall (control group).

Do I have to take part?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive. If you decide to withdraw or become ineligible to continue with the study, we will keep your data up until the time you withdraw. No new data will be collected.

What happens in the study if you decide to help us?
The duration of the study is 36 months, however you will only be expected to participate for 1 visit for the visual assessment. Below is a schedule of what you can expect:

- You will be given this information about the study and answer any questions you may have. If you are happy to give consent at this time, you will be asked to sign the consent form and complete a questionnaire of 6 questions to check that you have a sufficient working memory to be able to take part in the project (score of <7). If your score is above 7, you will be referred to the GP with this information for further investigation. You can also take the information sheet and contact us at your convenience to consent.

- A follow up appointment will be made for you to attend St. Paul's Eye Unit at the Royal Liverpool Hospital to have your visual functions measured. Below is a schedule of visits:

- St Paul's Eye Unit, Royal Liverpool Hospital: This visit is anticipated to last no more than 1 hour 30 minutes where you will be asked some general questions including your health and physical activity and have the following tests done which are non-invasive and we can schedule any breaks in as and when you feel tired:
    - Timed up to go test
    - Vision test for near and distance
    - Test for your ability to spot differences in contrast
    - Ability to use both eyes together as a pair
    - Test to check how the eyes move into different positions
    - 3D test for near
    - Visual field to test your peripheral vision

What do I have to do?
This study will not affect any treatment you may be on. You will be given an appointment to attend St. Paul's eye unit, Royal Liverpool Hospital to have the vision assessment.

Are there any risks or side effects?
The study is observational and all testing is non-invasive manner and there are no medicines involved. The participant may feel tired after having their eyes tested using different tests. The participant will be offered regular breaks throughout.

What are the possible benefits of taking part?
There are no clinical benefits of taking part in this study. However, the knowledge gained from this study will help us to understand the impact of visual impairment on falls and fear of falling.
You will be given a £10 contribution towards your travel costs to St. Paul's Eye Unit, Royal Liverpool Hospital.

What if I am unhappy or if there is a problem?
If you are unhappy, or if there is a problem, please feel free to let us know by contacting **Professor Simon Harding, (sharding@liv.ac.uk or 0151 794 9051)** and we will try to help. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have

grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms will be available to you.

Will my taking part in this study be kept confidential?
All information which is collected (including information from your hospital records) about you during the course of the research will be kept strictly confidential. Any information about you which leaves the hospital will have your name and address removed so that you cannot be recognised from it. A copy of your name and address will be kept in a separate file in a locked cabinet (on the hospital premises) separate to the data collected for this research.

The University of Liverpool is the sponsor for this study based in the UK. We will be using information from you and/or your medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. University of Liverpool will keep identifiable information about you for 5 years after the study has finished.
Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.
You can find out more about how we use your information by contacting Jignasa Mehta (jigs@liverpool.ac.uk or phone 0151 795 8510). Our Data Protection Officer is Victoria Heath and you can contact them at V.Heath@liverpool.ac.uk.

What will happen to the results of the research study?
Once the study is completed 18 months from the date the study started, the results will be reported in eye related journals. Your personal details will not be revealed in any publication. You have the option to receive a summary report of the findings after they have been collected and analysed (see consent form). If you would like a copy of the summary report we will keep your name and address separate from your collected data in a locked cabinet to maintain confidentiality.

Who is organising and funding the research study?
This study is being funded by the Dunhill Medical Trust and organised by the members of the research team; Mrs Jignasa Mehta, Professor Jude Robinson, Dr David Newsham and Professor Simon Harding.

Who has reviewed the study?
This study has been reviewed by the funding body (Dunhill Medical Trust).

Contact for further information

For further information or if you wish to discuss any part of the study please contact any of the investigators:

Principle Investigator
Mrs Jignasa Mehta
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Tel: 0151 794 9051
Email: sharding@liv.ac.uk

What to do next?

After you have read this information sheet carefully, and are willing to participate in this study please complete a consent form. You will then be given a copy of the information sheet and the consent form to keep.

THANK YOU FOR READING THIS INFORMATION SHEET AND FOR CONSIDERING TO TAKE PART IN THIS STUDY

CONSENT FORM

Project Title: Impact of Visual Impairment on falls and fear of falling-PART 1

Name of Researcher: Mrs Jignasa Mehta, Prof. Jude Robinson, Dr David Newsham, Prof. Simon Harding

Please initial box

1. I confirm that I have read and understand the information sheet dated 24/05/18(version 1.8) for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

3. I agree to take part in the above study.

4. I agree for the researcher to access my hospital records to record any relevant information e.g. other general health conditions and medication.

5. I understand that, under the GDPR, the data I provide for this study will be stored for 5 years and that I am free to withdraw consent for my data to be collected, processed, or stored at any time. However, if the data has already been anonymised it will not be possible to withdraw my data.

6. I would like a copy of the report containing a summary of the results of the study.

YES/NO

Name of Participant	Date	Signature
Name of Witness (Individual who has read the participant information sheet to the participant)	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

1 for Participant; 1 for researcher; 1 to be kept with hospital notes

Participant Code

CASE REPORT FORM

Version: 1.7 (25th March 2017)

PROTOCOL: [*VIFE (Visual Impairment and Falls in the Elderly) Version 2.7*

IMPACT OF VISUAL IMPAIRMENT ON FALLS AND FEAR OF FALLING IN THE ELDERLY

Participant Study Number:										
REC Reference:	1	6	/	L	0	/	2	2	4	9

Researcher: Jignasa Mehta

Research contact: 0151 795 8510/ 07799 211121(M)

General Instructions for Completion of the Case Report Forms (CRF)

Completion of CRFs

- A CRF must be completed for each study participant who is successfully enrolled
- For reasons of confidentiality, the name and initials of the study participant should **not** appear on the CRF.

General

- Please print all entries in BLOCK CAPITAL LETTERS using a **black** ballpoint pen.
- All text and explanatory comments should be brief.
- Answer every question explicitly; do not use ditto marks.
- Do not leave any question unanswered. If the answer to a question is unknown, write "**NK**" (Not Known). If a requested test has not been done, write "**ND**" (Not Done). If a question is not applicable, write "**NA**" (Not Applicable).

Dates and Times

- All date entries must appear in the format DD-MMM-YYYY e.g. 05-May-2009. The month abbreviations are as follows:

January	=	Jan	May	=	May	September	=	Sep
February	=	Feb	June	=	Jun	October	=	Oct
March	=	Mar	July	=	Jul	November	=	Nov
April	=	Apr	August	=	Aug	December	=	Dec

In the absence of a precise date for an event or therapy that precedes the participant's inclusion into the study, a partial date may be recorded by recording "NK" in the fields that are unknown e.g. where the day and month are not clear, the following may be entered into the CRF:

N	K	N	K		2	0	0	9
DD		MMM			YYYY			

- All time entries must appear in **24-hour format** e.g. 13:00. Entries representing midnight should be recorded as 00:00 with the date of the new day that is starting at that time.

Correction of Errors

- **Do not** overwrite erroneous entries, or use correction fluid or erasers.
- Draw a straight line through the entire erroneous entry without obliterating it.
- Clearly enter the correct value next to the original (erroneous) entry.
- Date and initial the correction.

PARTICIPANT INFORMATION		
Participant Number		
Study Site		
Date of Informed Consent	D D M M M Y Y Y Y	
Date of Birth	D D M M M Y Y Y Y	Or estimated age ______
Gender	☐1 Male ☐2 Female	
Date of Enrolment	D D M M M Y Y Y Y	
POSTCODE AREA		
6 Item Cognitive Impairment Test (6CIT)		
Inclusion/exclusion criteria *Patient must meet all criteria to be eligible for the study	Met all ☐1.	Not met* ☐2.

History of falls in the last 5 years	
Number of falls	**0-**☐0 **1-**☐1 **2-**☐2 **3-**☐3 **4-**☐4 **5-**☐5 **>5-**☐6
Description of fall	**NA**☐0 **Unsure** ☐1 **Just dropped**☐2 **Legs gave way**☐3 **Trip** ☐4 Other ☐5
Did the fall occur during dim light levels?	**NA**☐0 **Yes** ☐1 **No** ☐2

Falls Efficacy Scale	
Was the FES-I used **Yes** ☐1 **No** ☐2	
Timed up to go test (seconds)	__|__|__

Do you use a walking aid? **Always** ☐1 **Never** ☐2 **Occasionally** ☐2

Do you have any hearing impairment **Yes** ☐1 **No** ☐2

Medical History			
Postural hypotension ☐1	**Osteoarthritis** ☐2	**Parkinsons** ☐3	**Diabetes** ☐4
Stroke ☐5	**Osteoporosis** ☐6	**Cardiopulmonary disorders** ☐7	**Hypertension** ☐9
Renal Disease ☐10	**Other** ☐11	**State others:**	

MEDICATION HISTORY - *Make multiple copies of this page if required*

Taking more than 4 medications	☐1 Yes ☐2 No

Medication Name (write NK if unknown)	Start Date	Stop Date
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing
____________	D D M M M Y Y Y Y *OR* ☐1 Unknown	D D M M M Y Y Y Y *OR* ☐1 Ongoing

HOUSEHOLD DATA

Who usually lives with you in your home?	
Live alone	☐1
Spouse/Partner	☐2
Child/grandchild > 18 years	☐4
Sibling	☐6
Parent	☐7
Relation - other	☐8
Unrelated (e.g. carer)	☐9

Support other than the people living with you?	
Family	☐1
Carers/statutory	☐2
Friends	☐3
Nil	☐4
Other	
Please specify:	

On average how often do you socialise in and out of the home and how many alcoholic drinks would you have on average/week?

	No. of days/week	Average no. of alcoholic drinks consumed
Out of the home		
At home with people		

PHYSICAL ACTIVITY (RAPA)	
Was the RAPA used (attach to CRF)	Yes ☐ No ☐

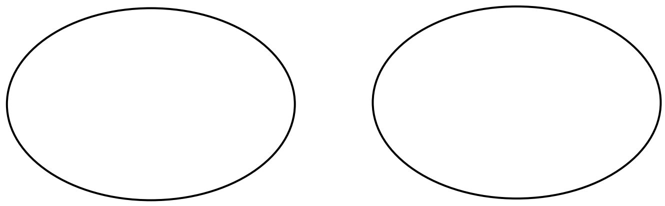
EQ-5D	
Was the EQ-5D-5L administered (attach to CRF)	Yes ☐ No ☐

VISUAL ASSESSMENT

Do you wear glasses ? ☐1 Yes (tick one of the following) ☐2 No	
Distance glasses	☐1
Reading glasses	☐2
Multi-focals	☐3
Bifocal	☐4
Contact lenses	☐5
Low vision aids	☐6
When were you last seen by an eye professional ? <6 months ☐1 6- 12 months ☐2 >12 months ☐3 ≥24 months ☐4	

VISUAL ACUITY Distance (LogMAR)					
	R		.		
	L		.		

VISUAL ACUITY Near (LogMAR)	**R** [ ] . [ ] [ ] [ ] **L** [ ] . [ ] [ ] [ ]
Do you have double vision when looking either straight ahead or looking down ?	☐1 Yes (document position) ☐2 No Position ______________________

Ocular motility (to clarify the response above)	
Contrast sensitivity (CSV-1000E) Record row letter and circle number	**R** A [ ] B [ ] C [ ] D [ ] **L** A [ ] B [ ] C [ ] D [ ] **BEO** A [ ] B [ ] C [ ] D [ ]
Pelli Robson	**R** [ ] . [ ] [ ] [ ] **L** [ ] . [ ] [ ] [ ]

	BEO	
Stereoacuity (seconds of arc)	**33cms**	
Prism fusion range (Prism dioptres)	**Near-33cms** **Base In** **Base Out**	**Distance-6m** **Base In** **Base Out**
Visual Field (attach to CRF)	**Record No.**	

ADVERSE EVENTS – *make multiple copies of this page if required*

Adverse event name	
Intensity	☐1 Mild ☐2 Moderate ☐3 Severe
If SAE specify:	☐1 Death ☐2 Life-threatening ☐3 Persistent or symptomatic disability or incapacity ☐4 Hospitalisation or prolongation of hospitalisation ☐5 Congenital anomaly or birth defect ☐6 Other important medical event
Onset Date	D D M M M Y Y Y Y
End Date	D D M M M Y Y Y Y **OR** ☐ Ongoing at the end of study
Therapy	☐1 None ☐2 Drug ☐3 Other ☐4 Drug and other
Outcome	☐1 Recovered ☐2 Recovering ☐3 Recovering with sequelae ☐4 Continuing ☐99 Not Known ☐5 Fatal
Relationship to Study	☐1 Certain ☐2 Probable ☐3 Possible ☐4 Unlikely ☐6 Unclassified ☐5 Not related

FINAL STUDY OUTCOME

Subject has completed the study? ☐1	**Completion date :** D D M M M Y Y Y Y
If NOT completed specify last follow up date:	D D M M M Y Y Y Y

Reason not completed:

(Tick only **one** box)

☐1 Significant non-compliance

☐2 Became ineligible during the study

☐4 Consent withdrawn

☐5 Lost to follow-up

☐6 Other (specify) ______________________

Remarks:

____

____

____

Investigator's Statement: I have reviewed the data recorded in this CRF and confirm that the data are complete and accurate

Investigator (Full name): ______________________________________

Investigator Signed? ☐1

Signature Date: D D M M M Y Y Y Y

Appendix 6-Falls-Efficacy Scale-International

Falls Efficacy Scale-I

How concerned are you about the possibility of falling? Think about how you usually do the activities below.

Please tick the box which is closes to your OWN opinion to show how concerned you are about falling whilst doing the activity. If you do not do the activity, please say whether you would be concerned about falling **IF** you did the activity.

Q	Question	Not at all concerned 1	Somewhat concerned 2	Fairly concerned 3	Very concerned 4
1	Cleaning the house (e.g. sweep, vacuum, dust)				
2	Getting dressed or undressed				
3	Preparing simple meals				
4	Taking a bath or shower				
5	Going to the shop				
6	Getting in or out of a chair				
7	Going up or down stairs				
8	Walking around in the neighbourhood				
9	Reaching for something above your head or on the ground				
10	Going to answer the telephone before it stops ringing				

11	Walking on a slippery surface (e.g. wet or icy)				
12	Visiting a friend or relative				
13	Walking in a place with crowds				
14	Walking on an uneven surface (e.g. rocky ground, poorly maintained pavement)				
15	Walking up or down a slope				
16	Going out to a social event (e.g. religious service, party or meeting)				
Sub Total					
Total					/64

Appendix 7-RAPA (Rapid Assessment of Physical Activity)

https://depts.washington.edu/hprc/resources/products-tools/rapa/

Appendix 8-EQ-5D

Health Questionnaire

English version for the UK

SCRIPT FOR FACE-TO-FACE ADMINISTRATION

GENERAL INTRODUCTION

It is suggested that the interviewer follows the script of the EQ-5D-5L. Although allowance should be made for the interviewer's particular style of speaking, the wording of the questionnaire instructions should be followed as closely as possible. In the case of EQ-5D-5L descriptive system on pages 2 and 3 of the questionnaire, the precise wording must be followed.

It is recommended that the interviewer has a copy of the EQ-5D-5L in front of him or her and gives a second copy of the EQ-5D-5L to the respondent for reference. This enables the respondent's answers to be entered directly on the EQ-5D-5L by the interviewer on behalf of the respondent (i.e. the appropriate boxes on page 2 and 3 are marked and the scale on page 4 is marked at the point indicating the respondent's 'health today').

If the respondent asks for clarification, the interviewer can help by re-reading the question verbatim. The interviewer should not try to offer his or her own explanation but suggest that the respondent uses his or her own interpretation.

If the respondent has difficulty regarding which response to choose, the interviewer should repeat the question verbatim and ask the respondent to answer in a way that most closely resembles his or her thoughts about his or her health today.

INTRODUCTION TO EQ-5D-5L

We are trying to find out what you think about your health. I will first ask you some simple questions about your health TODAY. I will then ask you to rate your health on a measuring scale. I will explain what to do as I go along, but please interrupt me if you do not understand something or if things are not clear to you. Please also remember that there are no right or wrong answers. We are interested here only in your personal view.

EQ-5D-5L DESCRIPTIVE SYSTEM - PAGE 2: INTRODUCTION

First, I am going to read out some questions. Each question has a choice of five answers. Please tell me which answer best describes your health TODAY.

Do not choose more than one answer in each group of questions.

(Note to interviewer: it may be necessary to remind the respondent regularly that the timeframe is TODAY. It may also be necessary to repeat the questions verbatim)

EQ-5D-5L DESCRIPTIVE SYSTEM - PAGE 2: TASK

MOBILITY

First, I'd like to ask you about mobility. Would you say that you have:

1. **<u>No</u> problems in walking about?**
2. **<u>Slight</u> problems in walking about?**
3. **<u>Moderate</u> problems in walking about?**
4. **<u>Severe</u> problems in walking about?**
5. **You are <u>unable to</u> walk about?**

(Note to interviewer: mark the appropriate box on the EQ-5D-5L questionnaire)

SELF-CARE

Next I'd like to ask you about self-care. Would you say that you have:

1. **<u>No</u> problems washing or dressing yourself?**
2. **<u>Slight</u> problems washing or dressing yourself?**
3. **<u>Moderate</u> problems washing or dressing yourself ?**

4. **<u>Severe</u> problems washing or dressing yourself?**
5. **You are <u>unable to</u> wash or dress yourself?**

(Note for administrator: mark the appropriate box on the EQ-5D-5L questionnaire)

USUAL ACTIVITIES

Next, I'd like to ask you about usual activities, for example work, study, housework, family or leisure activities. Would you say that you have?

1. **<u>No</u> problems doing your usual activities?**
2. **<u>Slight</u> problems doing your usual activities?**
3. **<u>Moderate</u> problems doing your usual activities?**
4. **<u>Severe</u> problems doing your usual activities?**
5. **You are <u>unable to</u> do your usual activities?**

(Note for administrator: mark the appropriate box on the EQ-5D-5L questionnaire)

PAIN / DISCOMFORT

Next I'd like to ask you about pain or discomfort. Would you say that you have:

1. **<u>No</u> pain or discomfort?**
2. **<u>Slight</u> pain or discomfort?**
3. **<u>Moderate</u> pain or discomfort?**
4. **<u>Severe</u> pain or discomfort?**
5. **<u>Extreme</u> pain or discomfort?**

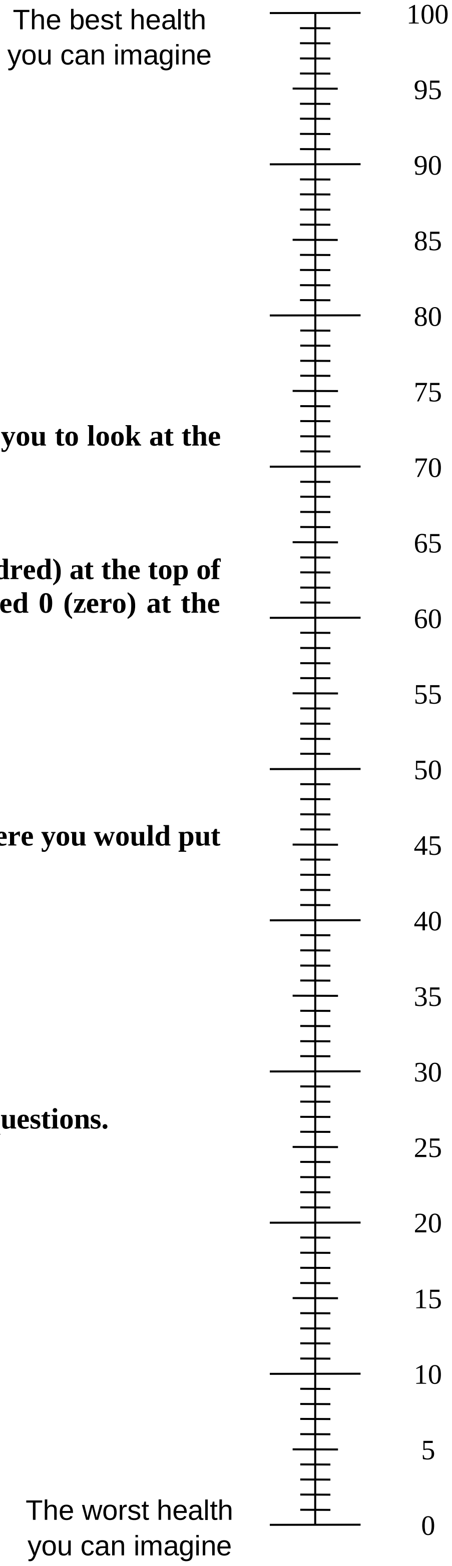
(Note for administrator: mark the appropriate box on the EQ-5D-5L questionnaire)

ANXIETY / DEPRESSION

Finally, I'd like to ask you about anxiety or depression. Would you say that you are:

1. **<u>Not</u> anxious or depressed?**
2. **<u>Slightly</u> anxious or depressed?**
3. **<u>Moderately</u> anxious or depressed?**
4. **<u>Severely</u> anxious or depressed?**
5. **<u>Extremely</u> anxious or depressed?**

(Note for administrator: mark the appropriate box on the EQ-5D-5L questionnaire)



EQ VAS - PAGE 4: INTRODUCTION

I would now like to ask you to do a rather different task.

To help you say how good or bad your health is, I'd like you to look at the scale, which is similar to a thermometer.

The best health you can imagine is marked 100 (one hundred) at the top of the scale and the worst health you can imagine is marked 0 (zero) at the bottom.

EQ VAS - PAGE 4: TASK

I would now like you to tell me the point on this scale where you would put your health TODAY.

Thank you for taking the time to answer these questions.

Appendix 9- Missing data table

Vision Variables	Fallers n (%)	Non-fallers n (%)
RVA (Distance)	2 (1 PL, 1CF) (2.4%)	1 PL (1.2%)
LVA (Distance)	3 (2 PL, 1 NPL) (3.6%)	2 (HM, PL) (2.4%)
BVA (Distance)	45 missing as did not measure (54%)	19 missing as did not measure (22.9%)
Difference between RVA&LVA	5 (due to above for RVA &LVA) (6%)	3 (due to above for RVA & LVA) (3.6%)
RVA (Near)	2 PL (2.4%)	1 PL (1.2%)
LVA (Near)	2 PL, 1 NPL (3.6%)	2 (HM, PL) (2.4%)
Difference in RVA&LVA for Nr	4 (due to above for RVA &LVA) (4.8%)	3 (due to above for RVA &LVA) (3.6%)
Frisby Stereo	11 unable to detect stereo (13%)	10 unable to detect stereo (12%)
Pell-Robson CS (RE)	1 (1.2%)	0
Pell-Robson CS (LE)	2 (2.4%)	1 (1.2%)
Pell-Robson CS (BE)	0	0
Prism Fusion range BO-Near	10 unable to fuse (12%)	11 unable to fuse (13.2%)
Prism Fusion range BI-Near	10 unable to fuse (12%)	11 unable to fuse (13.2%)
Prism Fusion range BO-Distance	11 unable to fuse (13.2%)	12 unable to fuse (14.5%)
Prism Fusion range BI-Distance	11 unable to fuse (13.2%)	12 unable to fuse (14.5%)
VF data	Need to go back to notes	0

Non-visual	Fallers n (%)	Non-fallers n (%)
Income affecting deprivation in older people index	3 (3.6%) due to not being returned, therefore missing	2 (2.4%) due to not being returned, therefore missing

TUTG test	2 (2.4%) unable to perform test as wheelchair bound	0
EQ- Visual analogue scale score	1 (1.2%) missing	0

Appendix 10- Indicative interview schedules

Indicative qualitative interview schedule for Fallers with age-related ophthalmic conditions

1. Tell me about the recent fall you had; how it happened, how you felt, how did you get help?

2. How have you felt since the fall?

3. How did you feel when you got diagnosed with [eye condition]? Did you think at the time about how it may affect you or your routine?

4. What can you tell me about your sight and how it affects you? Tell me about any changes you have noticed in how you see things or do things? (e.g. colour or pouring cups of tea/judging distances, bumping into things)

5. Could you tell me about how concerned you are about your sight and having a fall.

6. Tell me about the eye professionals that you see and how regularly and their recommendations

Indicative qualitative interview schedule for participants recently diagnosed with age-related ophthalmic conditions but not experienced a fall since their diagnosis.

1. Tell me about how you got diagnosed with [eye condition] and how often you saw an eye professional before this diagnosis (? Talk about glasses and buying them)

2. How did you feel when you got diagnosed with [eye condition]? Did you think at the time about how it may affect you or your routine?

3. What can you tell me about your sight and how it affects you? Tell me about any changes you have noticed in how you see things or do things?

4. Could you tell me about how concerned you are about your sight and having a fall.

5. Tell me about any falls you had before you were diagnosed with [eye condition]?

Appendix 11-Participant Information Sheet-Part 2

PARTICIPANT INFORMATION SHEET

Project Title: Impact of Visual Impairment on falls and fear of falling-PART 2

You are invited to take part in this research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with your family, friends, hospital specialist or GP if you wish. If you need more information please contact the research team whose telephone number is at the end of this sheet.
Thank you for reading this.

Why is the study being done?
With the ageing population set to increase and evidence to show that the risk of falls increases with age, it is necessary to investigate the impact of age-related visual impairment on fear of falling to improve quality of life into old age. There is a lack of information published on how age-related ophthalmological eye diseases impact on the fear of falling and changes in lifestyle compared to an individual who has no eye condition. Therefore, we have set out to explore the impact of age-related eye diseases on fear of falling in individuals as part of a larger study exploring the impact of visual impairment on falls and fear of falling.
Hence the main reason for carrying out this research study is:

- To explore the extent and differences in fear of falling across people who have either age-related macular degeneration (AMD), glaucoma or cataracts and have suffered a fall and also people who do not have an eye condition but have suffered a fall.

Why you are being invited to take part?
You are being invited to take part as you may be an eligible participant due to the following reason:

- Have either AMD, glaucoma or cataracts and have had a fall.

Do I have to take part?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive. If you decide to withdraw or become ineligible to continue with the study, we will keep your data up until the time you withdraw. No new data will be collected.

What happens in the study if you decide to help us?
The duration of the study is 36 months, however you will only be expected to participate for 1 visit to speak with Jignasa Mehta regarding falls and/or your eye condition. Below is a schedule of what you can expect:

- You will be given this information about the study and answer any questions you may have. If you are happy to give consent at this time, you will be asked to sign the consent form. You can also take the information sheet and contact us at your convenience to consent.

- An appointment will be made with you to arrange a visit with Jignasa Mehta that is convenient for you in terms of date and location to talk about your experience of falling and your eye condition if you have one and complete a short questionnaire on the fear of falling. The conversation about your experience will be audio recorded and will be transcribed at a later stage by an experienced individual who has signed a confidentiality agreement.

- Some general information about yourself, health and physical activity will also be collected during this visit.

What do I have to do?
This study will not affect any treatment you may be on. Once you have given your consent, Jignasa Mehta will contact you to arrange a date, time and location that is convenient to you to arrange a visit.

Are there any risks or side effects?
There are no risks or side effects. You may feel emotional speaking with Jignasa about your experiences but any issues raised are confidential and will be sensitively managed. Jignasa will offer you the number of a contact for counselling support.

What are the possible benefits of taking part?
There are no clinical benefits of taking part in this study. However, the knowledge gained from this study will help us to understand the impact of visual impairment on falls and fear of falling.
Unfortunately, there is no reimbursement of any costs incurred to take part in the research or any payment to take part.

What if I am unhappy or if there is a problem?
If you are unhappy, or if there is a problem, please feel free to let us know by contacting **Professor Jude Robison, (jerob@liverpool.ac.uk, 0151 794 9051)** and we will try to help. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms will be available to you.

Will my taking part in this study be kept confidential?
All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you which leaves the hospital will have your name and address removed so that you cannot be recognised from it. A copy of your name and address will be kept in a separate file in a locked cabinet (on the hospital premises) separate to the data collected for this research. Following the study all material including audio tapes and transcripts will be archived in the University of Liverpool whilst maintaining confidentiality and will be kept for a maximum of 10 years after which it will be destroyed.
The University of Liverpool is the sponsor for this study based in the UK. We will be using information from you and/or your medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. University of Liverpool will keep identifiable information about you for 5 years after the study has finished.
Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information by contacting Jignasa Mehta (jigs@liverpool.ac.uk or phone 0151 795 8510). Our Data Protection Officer is Victoria Heath and you can contact them at V.Heath@liverpool.ac.uk.

What will happen to the results of the research study?
Once the study is completed 18 months from the date the study started, the results will be reported in eye related journals. Your personal details will not be revealed in any publication. You have the option to receive a summary report of the findings after they have been collected and analysed (see consent form). If you would like a copy of the summary report we will keep your name and address separate from your collected data in a locked cabinet to maintain confidentiality.

Who is organising and funding the research study?
This study is being funded by the Dunhill Medical Trust and organised by the members of the research team; Mrs Jignasa Mehta, Professor Jude Robinson, Dr David Newsham and Professor Simon Harding.

Who has reviewed the study?
This study has been reviewed by the funding body (Dunhill Medical Trust).

Contact for further information
For further information or if you wish to discuss any part of the study please contact any of the investigators:

Principle Investigator
Mrs Jignasa Mehta
Department of Sociology
Eleanor Rathbone Building
University of Liverpool
Bedford Street South
Liverpool
L69 7ZA
Tel: 0151 795 8610
Email: jigs@liv.ac.uk

Professor Jude Robinson
School of Law and Social Justice
Eleanor Rathbone Building
University of Liverpool
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Dr David Newsham
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Professor Simon Harding
Department of Eye And Vision Science
Institute of Ageing and Chronic Disease
The Apex Building
6 West Derby Street
Liverpool
L7 8TX

Tel: 0151 794 9051
Email: sharding@liv.ac.uk

What to do next?
After you have read this information sheet carefully, and are willing to participate in this study please complete a consent form. You will then be given a copy of the information sheet and the consent form to keep.
THANK YOU FOR READING THIS INFORMATION SHEET AND FOR CONSIDERING TO TAKE PART IN THIS STUDY

CONSENT FORM

Project Title: Impact of Visual Impairment on falls and fear of falling-PART 2

Name of Researcher: Mrs Jignasa Mehta, Prof. Jude Robinson, Dr David Newsham, Prof. Simon Harding   Please initial box

1. I confirm that I have read and understand the information sheet dated 24/05/18(version 1.8) for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. ☐

3. I agree to take part in the above study. ☐

4. I agree for the researcher to access my hospital records to record any relevant information e.g. other general health conditions and medication. ☐

5. I understand that, under the GDPR, the data I provide for this study will be stored for 5 years and that I am free to withdraw consent for my data to be collected, processed, or stored at any time. However, if the data has already been anonymised it will not be possible to withdraw my data. ☐

6. I would like a copy of the report containing a summary of the results of the study.
YES/NO

Name of Participant **Date** **Signature**

Name of Witness **Date** **Signature**
(Individual who has read the participant information sheet to the participant)

Name of Person taking consent Date Signature
(if different from researcher)

Researcher Date Signature

1 for Participant; 1 for researcher; 1 to be kept with hospital notes

Participant Code

Appendix 12-Participant Information Sheet-Part 3

PARTICIPANT INFORMATION SHEET

<u>Project Title: Impact of Visual Impairment on falls and fear of falling-PART 3</u>

You are invited to take part in this research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with your family, friends, hospital specialist or GP if you wish. If you need more information please contact the research team whose telephone number is at the end of this sheet.

Thank you for reading this.

Why is the study being done?

With the ageing population set to increase and evidence to show that the risk of falls increases with age, it is necessary to investigate the impact of age-related visual impairment on fear of falling to improve quality of life into old age. There is a lack of information published on how age-related ophthalmological eye diseases impact on the fear of falling and changes in lifestyle. Therefore, we have set out to explore the impact of age-related eye diseases on the lifestyle of individuals since their diagnosis as part of a larger study exploring the impact of visual impairment on falls and fear of falling.

Hence the main reason for carrying out this research study is:

- To explore the impact of AMD, glaucoma and cataracts on the lifestyle of participants who have not suffered a fall since their diagnosis.

Why you are being invited to take part?

You are being invited to take part as you have recently (within the last 2 years) been diagnosed with either AMD, glaucoma or cataracts.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a

consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive. If you decide to withdraw or become ineligible to continue with the study, we will keep your data up until the time you withdraw. No new data will be collected.

What happens in the study if you decide to help us?

The duration of the study is 36 months, however you will only be expected to participate for 1 visit to speak with Jignasa Mehta regarding your lifestyle before and after you were diagnosed with your eye condition. Below is a schedule of what you can expect:

You will be given this information about the study and answer any questions you may have. If you are happy to take part at this time, you will be asked to sign the consent form. You may instead choose to take the information sheet and contact us at your convenience to consent.

An appointment which is convenient for you in terms of date, time and location will be made with you to arrange a visit with Jignasa Mehta. The visit will involve talking about your experience of your eye condition and how it may have affected you since the diagnosis and complete a short questionnaire on the fear of falling. The conversation about your experience will be audio recorded and will be transcribed at a later stage by an experienced individual who has signed a confidentiality agreement.

Some general information about yourself, health and physical activity will also be collected during this visit.

What do I have to do?

This study will not affect any treatment you may be on. Once you have given your consent, Jignasa Mehta will contact you to arrange a date, time and location that is convenient to you to arrange a visit.

Are there any risks or side effects?

There are no risks or side effects. You may feel emotional speaking with Jignasa about your experiences but any issues raised are confidential and will be sensitively managed. Jignasa will offer you the number of a contact for counselling support.

What are the possible benefits of taking part?

There are no clinical benefits of taking part in this study. However, the knowledge gained from this study will help us to understand the impact of visual impairment on falls and fear of falling.

Unfortunately, there is no reimbursement of any costs incurred to take part in the research or any payment to take part.

What if I am unhappy or if there is a problem?

If you are unhappy, or if there is a problem, please feel free to let us know by contacting Professor Jude Robison, (jerob@liverpool.ac.uk, 0151 794 9051) and we will try to help. If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal National Health Service complaints mechanisms will be available to you.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you which leaves the hospital will have your name and address removed so that you cannot be recognised from it. A copy of your name and address will be kept in a separate file in a locked cabinet (on the hospital premises) separate to the data collected for this research. Following the study all material including audio tapes and transcripts will be archived in the University of Liverpool whilst maintaining confidentiality and will be kept for a maximum of 10 years after which it will be destroyed.

The University of Liverpool is the sponsor for this study based in the UK. We will be using information from you and/or your medical records in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly. University of Liverpool will keep identifiable information about you for 5 years after the study has finished.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained. To safeguard your rights, we will use the minimum personally-identifiable information possible.

You can find out more about how we use your information by contacting Jignasa Mehta (jigs@liverpool.ac.uk or phone 0151 795 8510). Our Data Protection Officer is Victoria Heath and you can contact them at V.Heath@liverpool.ac.uk.

What will happen to the results of the research study?

Once the study is completed 18 months from the date the study started, the results will be reported in eye related journals. Your personal details will not be revealed in any publication. You have the option to receive a summary report of the findings after they have been collected and analysed (see consent form). If you would like a copy of the summary report we will keep your name and address separate from your collected data in a locked cabinet to maintain confidentiality.

Who is organising and funding the research study?

This study is being funded by the Dunhill Medical Trust and organised by the members of the research team; Mrs Jignasa Mehta, Professor Jude Robinson, Dr David Newsham and Professor Simon Harding.

Who has reviewed the study?

This study has been reviewed by the funding body (Dunhill Medical Trust).

Contact for further information

For further information or if you wish to discuss any part of the study please contact any of the investigators:

Principle Investigator
Mrs Jignasa Mehta
Department of Sociology
Eleanor Rathbone Building
University of Liverpool
Bedford Street South
Liverpool
L69 7ZA
Tel: 0151 795 8510
Email: jigs@liv.ac.uk

Professor Jude Robinson
School of Law and Social Justice
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University of Liverpool
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Professor Simon Harding
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Liverpool
L7 8TX

Tel: 0151 794 9051
Email: sharding@liv.ac.uk

What to do next?

After you have read this information sheet carefully, and are willing to participate in this study please complete a consent form. You will then be given a copy of the information sheet and the consent form to keep.

THANK YOU FOR READING THIS INFORMATION SHEET AND FOR CONSIDERING TO TAKE PART IN THIS STUDY

CONSENT FORM

Project Title: Impact of Visual Impairment on falls and fear of falling-PART 3

Name of Researcher: Mrs Jignasa Mehta, Prof. Jude Robinson, Dr David Newsham, Prof. Simon Harding

Please initial box

I confirm that I have read and understand the information sheet dated 24/5/18(version 1.7) for the above study and have had the opportunity to ask questions.

☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

☐

I agree to take part in the above study. ☐

I agree for the researcher to access my hospital records to record any relevant information e.g. other general health conditions and medication.

☐

I understand that, under the GDPR, the data I provide for this study will be stored for 5 years and that I am free to withdraw consent for my data to be collected, processed, or stored at any time. However, if the data has already been anonymised it will not be possible to withdraw my data.

☐

I would like a copy of the report containing a summary of the results of the study.

YES/NO

Name of Participant Date Signature

Name of Witness Date Signature

(Individual who has read the participant information sheet to the participant)

Name of Person Date Signature

taking consent

(if different from researcher)

Researcher Date Signature

1 for Participant; 1 for researcher; 1 to be kept with hospital notes

Appendix 13-Codes (examples) and themes

	Themes		
	Seeing sight	***Fall and fear of falling***	***Getting on with it***
Codes	Depth	Description	Resilience
	Cataracts	Consequences (Physical, loss of confidence, fear)	Social activity
	Glasses	Environmental dangers	Support (family, healthcare, social, financial)
	Lighting	Mechanical cause	Healthcare knowledge and information
	Difference in sight	Vision and falls	Age and self
	Consequences of sight impairment	Anxiety	Risk
	Contrast	Embarrassment	Confidence
	Glaucoma	Cautious	Physical activity