Climate Change Adaptation and Human Health: Reducing Climate Change Health Risks in the Ageing Chinese Population, a KAP study

PELIN KINAY

Submitted in accordance with the requirements for the degree of Doctor of Philosophy

University of Liverpool
Department of Health and Environmental Sciences
2019

The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

CLIMATE CHANGE ADAPTATION AND HUMAN HEALTH: REDUCING CLIMATE CHANGE HEALTH RISKS IN THE AGEING CHINESE POPULATION, A KAP STUDY

2019

Submitted by Pelin Kınay to Xi'an Jiaotong Liverpool University Health and Environmental Sciences Department as a thesis for the degree of Doctor of Philosophy, 2019.

I certify that all material in this thesis which is not my own work has been identified and that no unchanged or acknowledged material has previously been submitted and approved for the award of a degree by this or any other University.

Pelin Kınay

****Dedicated to my family****

ACKNOWLEDGEMENTS

Many people have efforts bringing this piece of work together. It was not an easy journey, had its hardships, had sleepless nights, scary moments, fun moments, but most importantly included the moments of encouragements and self-respect. I would like to initially thank my supervisors to guide me throughout the way. I owe a large debt of gratitude to all of them, who without their constant support and helpful advice this thesis would never have been completed. I got to work with climatologists, public health experts, and climate change experts and get to learn many things on research. I grow fully into a researcher with no doubt thanks to these wonderful minds. I am eternally grateful.

Special thanks to Dr. Deborah Ballantine to help me meet up my supervisory team, she is the one who helped me connect with them. I would like to express my gratitude to Professor Andy Morse, to Dr. Sujie Qin, to Dr. Philip Staddon, and to Dr. Elmer Villanueva and Professor Karyn Morrissey for guiding me through the writing and publishing process, for helping me discover new ways of learning and improving. I would like to thank Dr. Sujie Qin, my primary supervisor, for supporting me mentally and for always being there as a mentor. Also, I would like to state my highest gratitude to the University of Liverpool and XJTLU for granting me the PhD scholarship.

I would also like to acknowledge the helpful discussions with my colleagues in the university, all of these guys will do great in their academic careers, for that I am really happy. My friends who supported me and always gave me courage, thank you guys you know who you are.

My beloved family… I come from a big family; one by one it is impossible to thank everyone as we are very crowded. If I can say thanks to my actual family, I really do hope it will be enough. My sincere thanks to Mr. Mehmet Refik Yücel and Mrs. Ferda Ulutaş for supporting me from the start of my academic journey. Without their support I would have never made it to China and get to achieve what I have achieved to the date. Endless positive energy, prayers and love from my big, beautiful family got me to the point of concluding this PhD. My mother, thank you for always being there and supporting me with all you have, I am now looking forward to pay all this back to you.

"Our virtues and our failings are inseparable, like force and matter. When they separate, man is no more."

Nikola Tesla

"I want to take everything I've seen
and thought and learned and reduce them and relate them and refine them
until I have something of meaning, something of use."

John Steinbeck

ABSTRACT

Adaptation to climate change is now firmly on the agenda of policymakers. Climate change effects have been discernible for over 20 years. The numerous weather-related extreme events that have occurred in recent years around the world demonstrate beyond doubt that we are not prepared for the major future changes projected. Over the next few decades, societies will be faced with living in very different climatic conditions. Climate change, through its impacts on local weather, will adversely impact some areas more or less intensely than others. All sectors of the economy and society will be affected as the climate changes, precipitation patterns change, and extreme weather events become more frequent leading to adverse effects on infrastructure, food production (agriculture, fisheries), business activity, ecosystem services, and human health. Adapting to climate change from a human health perspective is becoming urgent. The World Health Organization has identified climate change as a key health risk and is pursuing several projects to facilitate adaptation. China with its rapidly ageing population will be experiencing health impacts resulting from climate change.

The original contribution of this thesis is presenting the health and weather concerns of Chinese elderly using their knowledge, attitude and practices towards climate change weather and health extremes, and contributing to the literature with wider knowledge in this particular field. This study aimed to evaluate the climate change and health related knowledge, attitudes and practices (KAP) of the elderly population Suzhou, Hefei and Xiamen cities of China. This cross-sectional study included 3466 participants in total. Data regarding demographic characteristics, KAP, and climate change perceptions were collected using a semi-structured questionnaire. The potential impacts of climate change on health are a concern of the elderly in

China and a majority of the elderly in all three cities said that it poses significant risks. When asked about the potential impacts of climate change over majority of participants stated that climate change affected their lifestyle. Participants were most concerned about heatwaves, flooding and drought. The main health risks cited included heatstroke and respiratory diseases. Finally, majority of participants of Suzhou city did not report receiving government assistance for climate change issues. These findings provide insights for potential adaptation strategies targeting the elderly. It is recommended that government should take responsibility in creating awareness strategies to improve the coping capacity of the elderly in China to climate change and its health impacts, and further develop climate change adaptation strategies. Public health communication initiatives should be taken and local governments should pay specific attention to vulnerable segments of the population and constitute and implement effective adaptive strategies for the elderly.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Chapter 1 INTRODUCTION TO CLIMATE CHANGE: FROM GLOBAL TO LOCAL AN EAST CHINA CASE STUDY

This chapter provides an introduction into climate change and its impacts in China and introduces the whole aim of the thesis and outcomes of the research and gives brief explanation on following chapters.

1.1 Introduction

Climate change is considered to be the biggest global health threat of our century (Costello et al., 2009). The Lancet commission stated that the impacts of climate change are already being felt and estimate high risks to future human health (Costello et al., 2009). The direct health effects of climate change include those linked to heat stress, flooding, drought, and increased frequency and intensity of storms. In addition, climate change can also indirectly threaten human health through adverse changes in air pollution, in water security, the spread of disease vectors, food insecurity and under-nutrition (Watts et al., 2015, Al-Amin et al., 2018).

Existing research has largely focused on studies of climate change research in developed countries (Broto and Bulkeley, 2013, Benevolenza and DeRigne, 2018). It is evident that cities are now becoming crucial in dealing with climate change and urbanization is a triggering factor for climate change (Murshed and Saadat, 2018). China has experienced noticeable changes in climate, which could expose millions of residents to extreme heat and summer heat stress that may result in increased health risks. That is why our study has an urban focus in Eastern China. Most of climate change will be impactful in cities (McCarthy et al., 2010, Hughes et al., 2018).

Climate warming and extreme heat events due to urbanization and increased energy consumption are simulated to be as large as the impact double amount of carbon dioxide in some regions, and climate change increases the disparity in extreme hot nights between rural and urban areas (Barata et al., 2011, Harlan and Ruddell, 2011, McCarthy et al., 2010).

Due to human induced global climate change, the climate in China has experienced significant changes in recent years (Qin et al., 2015). Data indicates that the annual average air temperature has increased by 0.5 to 0.8°C over the last 100 years, in conjunction with an increased variability in the amounts of precipitation. Based on this data, researchers predict that precipitation in China may increase by 2 to 3% by 2020 and 5 to 7% by 2050, and that the nationwide annual mean air temperature could increase by 1.3 to 2.1°C in 2020 and 2.3 to 3.3°C in 2050 as compared with that in 2000 (Mu and Khan, 2009). Surface temperatures in Eastern China are projected to increase by another 1˚C to 5˚C by the year 2100. The large size of the affected population, the climate and environmental diversity across regions and the diverse socio-economic status of East China (408 million people) mean that understanding the impact of climate change on health is an important research topic for this region (Zhang et al., 2008b).

It is important to note that here is a significant 'action gap' between what scientists argue is necessary to prevent potentially dangerous climate change and what the government, industry and public are doing (Bushell et al., 2017). That is why it is important to look at the elderly knowledge, adaptation and practices, for better adaptation and to communicate these is a major issue. Prior studies indicate that the presence of links among distinct groups, relationships among individuals who share social identities, or networks of trust across authority gradients may lead to an increase in disaster risk perceptions (Babcicky and Seebauer, 2017, Islam and Walkerden, 2015). However, studies do not always support such correlations. For example, a study undertaken in the UK indicates that strong social networks could potentially increase the vulnerability of the elderly, because to them heatwaves are not significant risks (Wolf et al., 2010). The impact of climate change on the health of the elderly and perceptions of the elderly are important topics as the population is considered amongst the most vulnerable populations, and the elderly have less capacity to fight the impacts of climate change and may be more exposed to these impacts (Al-Amin et al., 2018). However, while a number of studies have been undertaken in China related to the health concerns of climate change, to the date none have yet identified the direct impacts of climate change in conjunction with health impacts on the elderly (Upreti et al., 2017, McMichael et al., 2006, Zhou et al., 2009).

It is important to know what motivates the focus group to behave in certain ways and what may be the reason of a change in their behavior (Knutti, 2019). There is an urgent need to understand how best to communicate the need for adaptation to climate change with the Chinese elderly. In response, this study focuses on understanding the knowledge, attitude and practices of the elderly Chinese population to climate change. This thesis also examines the role of demographic factors, such as age, gender, education and occupation on the elderly perceptions of and response to climate change.

The thesis explores three distinct, yet interlinked questions using cross sectional population-based surveys. The first survey explores on understanding which are the most appropriate communication tools for the elderly Chinese population, focusing on three different communication tools; a video, an infographic and a text-graph instrument. In conjunction with all three a questionnaire was used to evaluate the effectiveness of the communication tools while communicating climate change. The second survey explores the knowledge, attitudes and practices of the elderly on climate change health impacts. To evaluate elderly perceptions, a questionnaire was developed. The last but also the core survey which targeted 3466 elderly people focused on the role of socio-demographic determinants on the knowledge, attitude and practices of the elderly.

1.2 Overall Aims and Objectives

The central aim of this thesis is to understand how the elderly respond to climate change in East China (a current research gap), and to provide connections with elderly socio-demographics and their knowledge, attitude and practices to give recommendations to policymakers and future researchers.

The aims of this work are as follows:

1. To provide information on the knowledge, attitudes and practices of Chinese elderly with regard to climate change and its associate health risks (paying specific attention to chronic cardiovascular and respiratory conditions).
2. To provide information on the three sites of interest (Suzhou, Hefei, Xiamen), and the elderly perceptions of climate change in these cities, and to define the relationships between socio-demographics (age, gender, education and occupation) and numerous independent indicators (knowledge, attitudes and practices, KAP) (Figure 1.1).
3. To provide insights on the most appropriate communication strategies in order better communicate climate change with elderly Chinese.

4. To provide recommendations to policymakers on elderly Chinese wellbeing from climate change health impacts, and further recommendations for future research.

Figure 1.1: Map of study sites in East China showing locations of Suzhou, Hefei and Xiamen cities.

1.3 Structure of the Thesis

This thesis consists of the following five main sections. The first section of the thesis (Chapter 2) provides a literature review on the direct and indirect health impacts of climate change on the vulnerable elderly population in East China. Numerous studies were brought together for the literature review to identify the gap in the literature regarding the elderly health and climate change. This work showed that elderly Chinese have not been deeply studied before and much more effort and attention must be paid on the ageing population regarding climate change in China. Chapter 3 introduces the methodology of the thesis.

The second section of the thesis (Chapter 4) focuses on understanding appropriate communication methods for the elderly with regard to the impact of climate change on their health. Chapter 4 includes a communication study with Chinese elderly of Suzhou city regarding their perceptions on climate change using three communication tools to better assess which tool is more effective in climate change communication with elderly Chinese. The results show that the elderly responded better to infographics and with the use of these visual tools a questionnaire type communication tool is also found effective.

The third part of the thesis included a study on understanding climate change with Chinese elderly in Suzhou and Hefei cities on elderly knowledge, perceptions and practices on climate change. Results included that the majority of the elderly participants, in both Hefei and Suzhou had heard of 'climate change', but when respondents were asked to give an explanation on climate change, most people (95%) referred it as 'weather change'. It was found that more than 70% of the participants learned about climate change through television. Among the many impacts presented in the questionnaire, around half of respondents were most aware of health impacts of storms in both cities, however unawareness regarding climate change was found higher in Hefei city then Suzhou city. In the 4th section (Chapter 6) we studied 3 urban sites (Suzhou, Hefei, and Xiamen) to gain an understanding of the knowledge, attitude and practices to climate change of the elderly in China. In this section we also used regression analysis to assess the relationship between elderly sociodemographic and their knowledge, attitude and practices. This section also presented the views of the elderly participants on climate change, specifically in what ways they feel they are threatened the most and in what ways the adaptation is possible.

The 5th section includes an in-depth discussion of the results of this research with regard to previous research and the conclusion chapters.

The thesis will be structured with seven chapters, the flow and progression of the work is as follows.

Chapter 1: Chapter 1 provides a general introduction to the thesis.

Chapter 2: The literature review introduces the background of the study and addresses the gap in the literature. Recent and future climate change impacts are discussed in this chapter and relative health impacts are evaluated. It is found that the literature does not provide much information on elderly perceptions regarding climate change impacts. This chapter emphasizes mainly on the need for further studies on Chinese elderly and climate change impacts.

Chapter 3: Chapter 3 provides an overview of the methodology used. Methods for individual quantitative studies (Chapter 4, and Chapter 5 and 6) are introduced and the survey design and development sections are provided in detail.

Chapter 4: Chapter 4 is an individual project related to communication of climate change with Chinese elderly. In this study different communication methods were created and tested with a semi-structured questionnaire.

The chapter introduces a project on communication of climate change related issues with Chinese elderly. This chapter also introduces previous studies undertaken in this area and discusses the techniques that are previously used.

Chapter 5: This chapter introduces a second project on understanding climate change, where the project provides data on elderly perceptions, knowledge attitude and practices on a narrow scale (Suzhou and Hefei cities).

Chapter 6: The chapter introduces a third project and provides data on climate change perceptions of Chinese elderly. This chapter provides regional insights on elderly knowledge, attitude and practices towards climate change health and weather impacts. Chapter includes regression analysis for East China cities Suzhou, Hefei and Xiamen separately (referred in the text as Model 1 (Suzhou), Model 2 (Hefei), and Model 3 (Xiamen). The chapter begins with some introduction on these cities and 'All Model' regressions.

Chapter 6 focuses on how the socio-cultural factors are in association with knowledge, attitude and practices of the elderly.

Chapter 7: The chapter forms a discussion and a conclusion chapter for the whole thesis. Previous and current studies are discussed and evaluated for KAP. Then a conclusion for the thesis is presented.

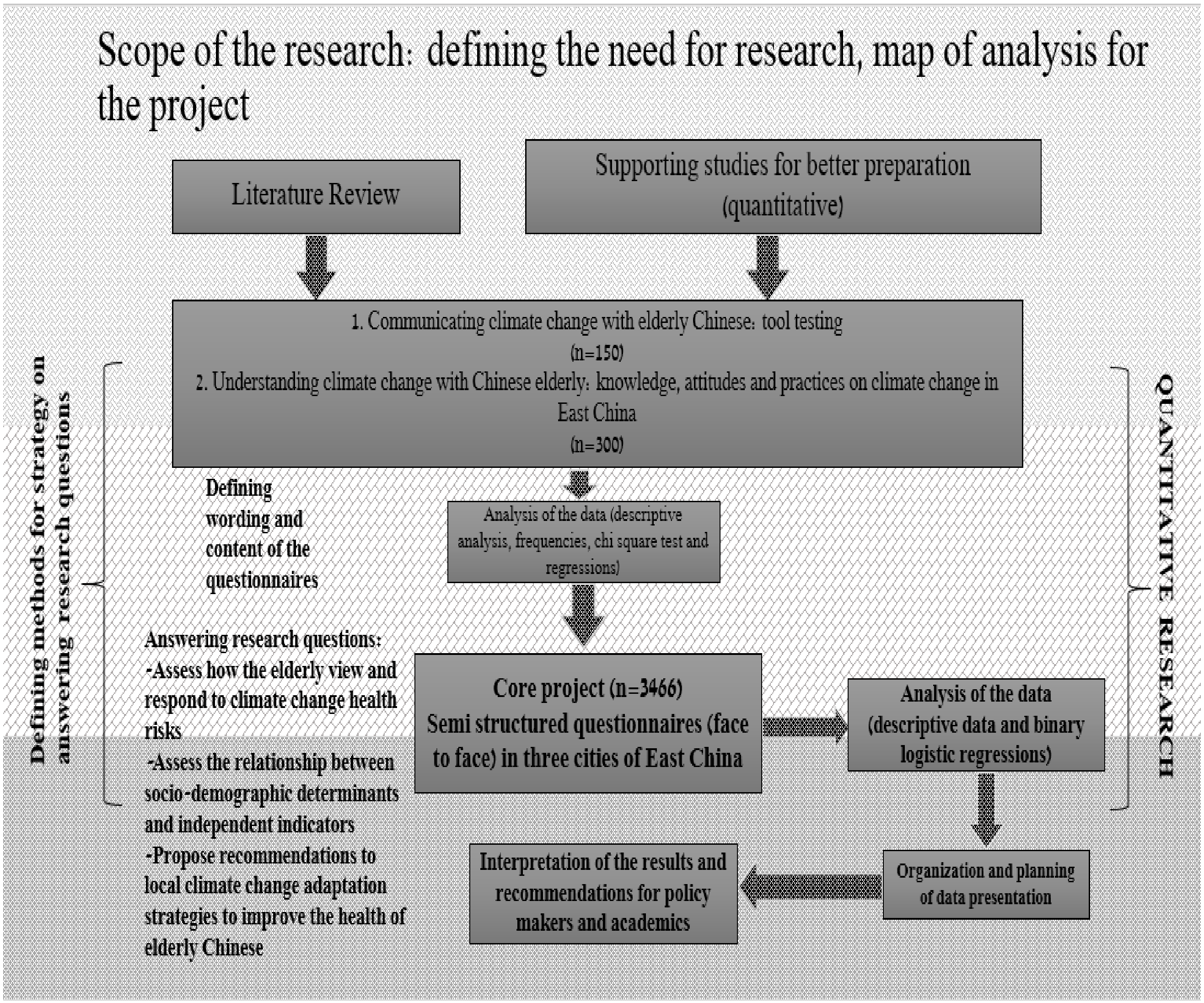


Figure 1.2: Scope of the thesis including the literature review, and three projects that constructed this thesis.

1.4 Outputs of the Research

Three papers were produced for publication.

- Published: 'Direct and indirect health impacts of climate change on the vulnerable elderly population in East China', published in Environmental Reviews. "Kınay, P., Morse, A.P., Villanueva, E.V., Morrissey, K. and Staddon, P.L., 2019. Direct and indirect health impacts of climate change on the vulnerable elderly population in East China. *Environmental Reviews*, *27*(3), pp.295-303."
- Under review: 'Understanding climate change: Knowledge, attitudes and practices of Chinese elderly on climate change and their health in East China', submitted to Regional Environmental Change.
- In preparation: 'Communicating Climate Change with Chinese elderly' for Environmental Communication.

1.5 Summary

The work undertaken in this thesis provides an important contribution to the literature. In this thesis quantitative approaches were undertaken (semi-structured questionnaires). The whole work aims to provide new aspects to unstudied areas, generally elderly health, and elderly perceptions of climate change risks. Socio-demographic relationships were constructed with climate change related knowledge attitude and practices of the elderly and how these associations can help in risk reduction were evaluated. Risk reduction strategies if any, can be used at the national level if applicable. The analysis using a regressions approach provides useful information and knowledge that help to 1) improve our understanding on elderly perceptions; 2) explore relationships between demographic characteristics of the elderly and their knowledge, attitude and practices; 3) establish a basis for future research in China for elderly-climate change related studies and 4) propose recommendations depending on results and observations for policymakers, future research and academics. More research looking at different aspects of climate change impacts in elderly and elderly perceptions could be carried out using this data as a secondary tool building on the findings and data form this thesis.

CHAPTER 2 PAPER 1

DIRECT AND INDIRECT HEALTH IMPACTS OF CLIMATE CHANGE ON VULNERABLE ELDERLY POPULATION IN EAST CHINA: A REVIEW

Published in Environmental Reviews.

"Kınay, P., Morse, A.P., Villanueva, E.V., Morrissey, K. and Staddon, P.L., 2019. Direct and indirect health impacts of climate change on the vulnerable elderly population in East China. *Environmental Reviews*, *27*(3), pp.295-303."

Note: This chapter is in accepted manuscript format. Table and figure numbering in this chapter is as the exact numbering in the accepted format of the published paper and it follows the journal numbering. Sub numbering and table and figure numbering is not included in the 'Table of Contents' and in the 'List of Tables and Figures' for this chapter.

Please see 'Appendix A' for the published version.

Chapter 2 PAPER 1 DIRECT AND INDIRECT HEALTH IMPACTS OF CLIMATE CHANGE ON THE VULNERABLE ELDERLY POPULATION IN EAST CHINA

Pelin Kınay[a,b], Andrew P Morse[b], Elmer V Villanueva[a], KarynMorrissey[c], and Philip L Staddon[d]*

[a]Department of Health and Environmental Sciences, Xi'an Jiaotong-Liverpool University, Suzhou, People's Republic of China;

[b]Department of Geography and Planning, University of Liverpool, Liverpool, United Kingdom;

[c]Medical School, University of Exeter, Exeter, United Kingdom;

[d]School of Environment, Earth and Ecosystem Sciences, University of Gloucestershire Public university in Cheltenham, United Kingdom.

*Pelin Kınay, Department of Environmental Science, Xi'an Jiaotong-Liverpool University, 111 Ren'ai Road, Suzhou Industrial Park, Suzhou, Jiangsu 215123, People's Republic of China.
Email: Kinay.Pelin@xjtlu.edu.cn.
Telephone: +86 15850232571

ABSTRACT

The latest scientific advances on the impacts of climate change on the health of the elderly in East China were reviewed consulting peer-reviewed publications from 2000-2017. The direct impacts of climate change result from rising temperatures, heatwaves, and increases in the frequency of complex extreme weather events such as windstorms, floods, and droughts. The health and social consequences of these events are far-reaching, ranging from reduced labor productivity and heat-related deaths, through to direct physical injury during extreme weather events, the spread of infectious diseases, and mental health effects following widespread flooding or prolonged drought. Research has indicated that climate change will have the greatest impact on vulnerable groups of people, including the elderly population. However, there is a dearth of empirical evidence, a lack of focus on vulnerable segments of the population (especially elderly), limited understanding of how health status will change in the future, and lack of acknowledgement of how different regions in China vary in terms of the consequences of climate change. The main risk in East China that climate change may exacerbate is flooding (sea-level rise, coastal and riverine, flood risk). However, in some regions of East China such as in the provinces of Anhui, Jiangsu, Hebei and Shandong the biggest climate change risk is considered to be drought. Main health risks linked to climate change are evident as cardiovascular and respiratory diseases (heat stroke, exhaustion, and asthma), often caused by interactions between heatwave episodes and concurrent poor air quality.

Key words: Climate change, East China, elderly, health impacts, flooding, heatwaves.

Introduction

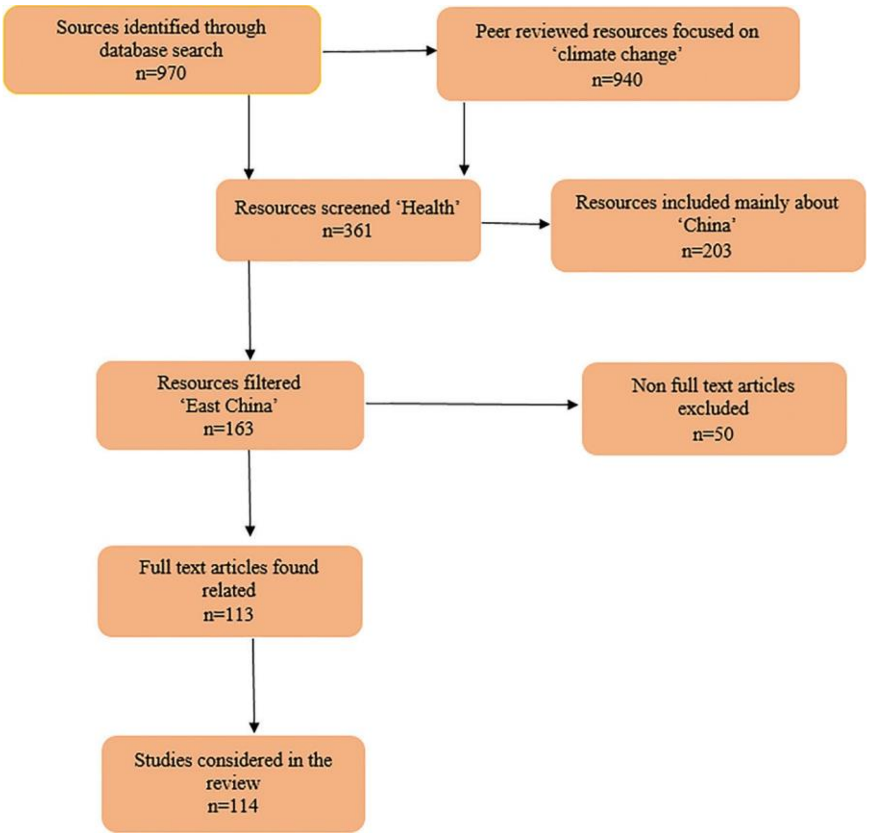
Many prevalent human diseases respond to climatic conditions (Liang and Gong, 2017). Links between weather and climate exist for cardiovascular diseases (Kim et al., 2015), respiratory illnesses (Hopkinson et al., 2017) and infectious diseases, including water-, food- and vector-borne, are well established (Patz et al., 2005). Climate change is one of the greatest challenges currently facing humanity and it is considered to be the biggest global threat to public health this century (Costello et al., 2009). *The Lancet* Commission on Climate Change and Human Health note that the impacts of climate change, through rising temperatures, heatwaves, and increases in the frequency of complex extreme weather events such as windstorms, floods, and droughts are already being felt and through these events climate change impacts will have substantial costs to human health (Portier et al., 2013, Costello et al., 2009). Climate change will affect human health via multiple pathways of direct and indirect impacts (Massad et al., 2011, Frumkin et al., 2008). The effects of climate change on human health will include health problems linked to heat stress, flooding, and increased frequency and intensity of storms (Easterling et al., 2000). For example, cardiovascular and respiratory diseases, may be induced by heatwaves and air quality interactions (Kan et al., 2012). Climate change also indirectly threatens human health through adverse changes in temperature (Peel et al., 2013), vector borne infectious diseases (Epstein, 2001), and via food and water quality and security (Myers et al., 2017). Forced migration and shortage of resources can also be predicted as indirect impacts of climate change on human health (Watts et al., 2015).

The climate in China and East China have already experienced significant changes in recent years (Qin et al., 2015). This review focuses on the impacts of climate change on health of the elderly in East China, which is home to 408 million people, and is one of the key economic areas in China. Demographically, population projections predict that by 2050 one third of the Chinese population will be elderly (aged older than 65) (Yao-Dong et al., 2013). The elderly are a population group that has been identified as being particularly vulnerable and susceptible to the wide range of environmental and societal impacts of climate (Zeng et al., 2010). Thus, the future health profile and needs of this population needs to be a key consideration for Chinese policymakers. Several studies have been carried out in China related to the health concerns of climate change and some have quantified the direct impacts of climate change in the health on elderly population (Wu et al., 2016, Zhou et al., 2017, McMichael et al., 2006). Most studies focuses on health impacts of extreme heat and highlights the health risks to the elderly population (cardiovascular, respiratory, stroke, ischemic heart disease) (Chen et al., 2017, Zhang et al., 2017). Given the large size of the affected population, the climate and environmental diversity across regions and the diverse socio-economic status across East China, it is considered timely to review and summarize the latest scientific advances in understanding the likely future health impacts of climate change. Here, a broad range of studies on the potential risks of climate change impacts in China are reviewed, and the current state of knowledge on the health impacts of climate change in the elderly Chinese population is presented and methods and limitations of previous research are examined.

Approach

Peer-reviewed publications that reported the impact of future climate scenarios on risks to health are reviewed. Web of Science, Environment Complete (EBSCO), Google Scholar and Science Direct databases were used for the research. The review is based on a structured literature search, but did not include a formal meta-analysis, as too few studies reported suitable effect size for meaningful comparison. The search terms were used in combination and included ‘climate change’, ‘health’, ‘China’, and ‘elderly’, ‘East China’ were used to filter the resources. This search returned many off-topic articles, as evidenced by their titles and abstracts. Due to the large number of publications, we cannot give an exhaustive overview of all studies. Instead, the most important, relevant and novel publications were considered to form the main body of review. Overall, since 2000, 970 full articles were identified including 940 confirmed as peer reviewed. Within these results a further search was performed with the term ‘health impacts’ and this filter resulted in 361 articles. The final search identified 163 studies and 114 studies were chosen for this review as they were highly relevant (Figure 1).

Figure 1: Prisma flow chart for literature review.



Recent and Future Climate Change in China

Future predictions indicate that climate change may exacerbate a wide range of extreme weather events in China, including typhoons, floods, and droughts (Kan, 2011). For China different emission scenarios estimate that, by the year 2020 averaged annual mean temperature will increase by 1.5–2.1°C, by the year 2050 by 2.3–3.3°C, and by year 2100 by 3.9–6°C (Ding et al., 2007). Across most of China future temperatures are expected to rise another 1.3 to 5°C by the end of the century, in comparison to the global average predicted rise of 1 to 3.7°C (Guoju et al., 2005, Ding et al., 2007).

Studies have shown recent trends in annual and summer total precipitation, and the large regional precipitation variability in China (Shi et al., 2003, Zhai et al., 2005). In the last decade China has suffered a series of extreme droughts, including the spring-summer drought in northern China in 2000 and 2001, the spring drought in Yunnan in 2005, the spring-summer drought in Sichuan and Chongqing in 2006, the summer drought in southern China in 2007, the summer drought in Chongqing in 2008, and the spring-summer drought in five southwest provinces in 2010 (Barriopedro et al., 2012). Indeed, data on droughts and floods in the Yangtze and Yellow Rivers over the last 2000 years found that while the intensity of flooding in the 20th century was comparable to historical events, previous drought events were less intense (Zheng et al., 2006). Between 1876 and 1878 a drought occurred in China which was considered as an extreme climate event after the cold climate at the end of the Little Ice Age (this is a period between about 1300 and 1870) (De'er and Youye, 2010).

Sea-level rise in East China is another further concern (Wellner and Bartek, 2003). China Meteorological Administration states that a sea-level rise of 60 cm by 2050 could make economic growth in Shanghai vulnerable, and also poses risks to health for vulnerable segments of the population (Hu, 2017).

Vulnerability to Climate Change

The concept of vulnerability is defined as an important extension of traditional risk analysis, which is focused primarily on natural hazards (Otto et al., 2017, Leichenko and O'Brien, 2002, Kok and Jäger, 2009, Turner et al., 2003). Table 1 presents various concepts of vulnerability (Füssel, 2007).

Table 1. Various concepts of vulnerability (based on Füssel 2007).

System (the system or region and/or population group and/or sector of concern)
Human environment
Geographical region
Economic sector
Natural system
Attribute of concerns (the valued attribute (or variables of concern) of the vulnerable system that are threatened by its exposure to the hazard)
Human health and life
Existence and natural identity
Biodiversity and ecosystem services
Income and livelihood
Hazards (the external stressor (or set of stressors) of concern)
External – floods
Internal – unsustainable farming practices
Temporal reference (the time period of interest)
Current
Future

Vulnerabilities may vary greatly from those associated with human health to built infrastructure (Heltberg et al., 2009). Human vulnerability factors can be divided into five groups: natural vulnerability, human vulnerability, social vulnerability, financial vulnerability and physical vulnerability (Thow and de Blois, 2008) (Figure 2). The vulnerability level of human populations vary depending on conditions (McMichael, 2003). For example, some population subgroups may have difficulty adapting to climate change because of scarce resources, lack of information, poor public health infrastructure, as well as a lack of effective guidance and help (Corvalan et al., 2005).

Figure 2. Vulnerability factors (based on Thow and De Blois 2008).

Population groups including the elderly, children, and disabled people are considered particularly vulnerable to climate change (Watts et al., 2015). Age is a well-known risk factor for heat related illness and death and the elderly are under the greatest risk (Basu and Samet, 2002).

Increased human health vulnerability to climate change is associated with many factors including rapid population growth, (as in the case of China) poverty and hunger, poor health, low levels of education, and lack of access to information on climate change (Füssel and Klein, 2006, Demirkesen and Evrendilek, 2017). It has been shown that the elderly (people who are 65 years or older) are particularly vulnerable to the impacts of heatwaves. For example, the 2003 heatwave in Shanghai was reported to have caused a 12 percent increase in total deaths and a 19 percent increase in cardiovascular mortality amongst the elderly (Huang et al., 2010). It has also been reported that high temperature mortality risks were highest for women over 65 years old in Jinan, China. A recent study established a social vulnerability index at the county level with a composite index to climate change focusing on urbanized cities on the Chinese east coast (54 cities govern 407 county-level divisions containing counties, county-level cities, and city districts) and found that more work on health and social care should be put toward this sensitive elderly group (Ge et al., 2017).

These findings indicate that human health interventions aimed at mitigating the climate change health impacts require an in-depth understanding of vulnerable population. Improving understanding of vulnerability to climate change health impacts is a clear research gap in China that requires urgent attention from public health researchers.

Uncertainty on Climate Impacts and Human Health

Uncertainty defined in the context of risk, restricts our ability to measure the risks associated with different events (Hillen et al., 2017). In China much of the climate change uncertainty has focused on crop yields and scarcity in water resources which are two of the biggest indirect impacts of climate change on health (Kang et al., 2017). The uncertainty of the direct impacts of climate change on human health has received very little attention in China. However, some research has examined climate change issues that will indirectly impact on human health, including precipitation, temperature, weather variability and water management. Research has found that the uncertainty in predictions of future precipitation

(Piao et al., 2010), future temperature trends, weather variability (Piao et al., 2010), and water security of the responses of crops to changes in climate, diseases, pests and atmospheric constituents all of which can have an important impact on human health (Pahl-Wostl, 2007). Climate change challenges on existing water resources management practices should be considered amongst the factors that have additional uncertainty in future (Pahl-Wostl, 2007). For adaptation to change, integrated water resources management must therefore take climate change impacts under full consideration to enhance the potential of the resources (Guo et al., 2002). On water management uncertainty, there are still many gaps in the climate change assessment methodologies and many uncertainties in the climate health projections (Yong-Jian et al., 2013). Some studies have focused on the potential uncertainty of the effect of climate change, and mathematical methods have been employed for model constructions (Piao et al., 2010).

On temperature extremes, uncertainty ranges were completed as 0.084°C/decade and 0.037°C/decade for the minimum and maximum temperature trends, respectively. Due to the lack of reliable observations, there are uncertainties on tropical cyclones in the exploration of results (Zou and Zhao, 2010). Li et al. (2016) focused on rich range of uncertainties related to heat related climate change impacts, population demographics and adaptation, however modeling future adaptation is still considered as a big challenge (Li et al., 2016).

Impacts of Climate Change on Health

The WHO (2016) estimated that, in 2012, 12.6 million deaths (23% of all deaths worldwide) were attributable to modifiable environmental factors, many of which could be influenced by climate change or are related to the driving forces of climate change (Neira and Prüss-Ustün, 2016). Links between weather and climate exist for cardiovascular diseases (Kim et al., 2015), respiratory illnesses (Hopkinson et al., 2017) and a number of infectious diseases (Patz et al., 2005). As noted above, many prevalent human diseases respond to climatic conditions (Liang and Gong, 2017). Human health in China will also be affected by climate change in numerous ways such as mortality from extreme weather events; changes in quality of air and water; and changes in the ecology of infectious disease vectors (Kan et al., 2012). Indeed, some of the most common infectious diseases including malaria and dengue, are those transmitted by mosquitoes, many of which have exhibited changes to their species range in the last decade (Liang and Gong, 2017, Tian et al., 2015, Yu et al., 2015). *The Lancet* Commission (Costello, 2009) identified six factors that connect climate change to adverse health outcomes: changing patterns of disease and mortality, food, water and sanitation, shelter and human settlements, extreme events, and population and migration. The following sections will focus on the impact of increased extreme events linked to climate change will have on human health (Figure 3, Table 2).

Figure 3: Health impacts of climate change.

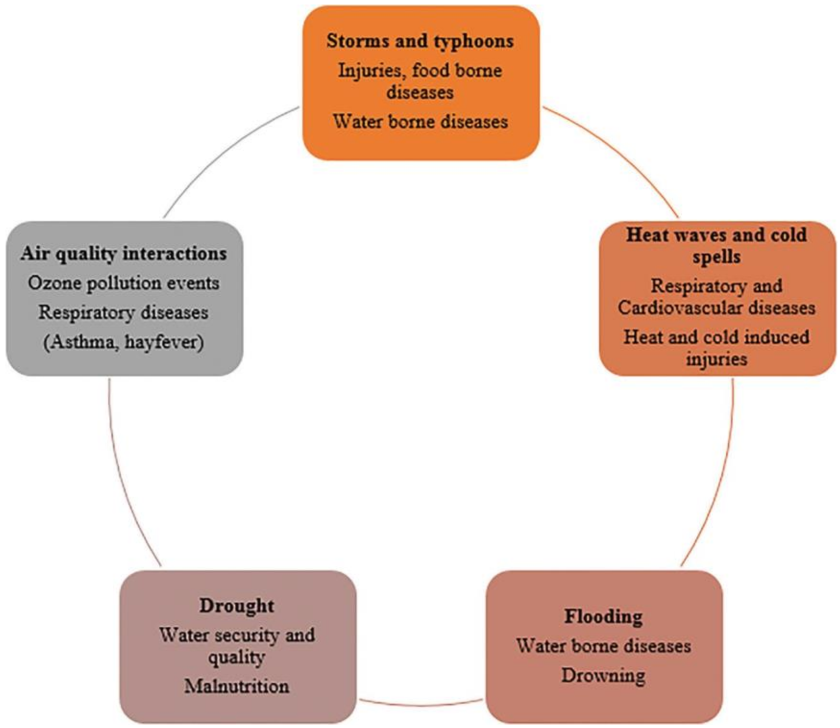


Table 2: Climate change impacts on health.

Storms and typhoons	Heat waves and cold spells	Flooding	Drought	Air-quality interactions
Increased number of storms and typhoons, East China is strictly affected (Lu and Zhao 2013)	Increase in frequency (Luber and McGeehin 2008; Robinson 2001), less attention given to cold spells (Staddon et al. 2014)	Has led to the highest number of mortalities in the 20th century (O'Connor and Costa 2004)	From 1900 to 2012, people in China severely affected by drought (Stanke et al. 2013)	Respiratory infections, cardiovascular diseases, and lung cancer (Arceo et al. 2016; Currie and Neidell 2005; Currie et al. 2009)
In Guangdong, potential loss in economy and health (Kang et al. 2015)	Vulnerable population groups susceptible to extreme temperatures, both hot and cold (Davídkovová et al. 2014; Tian et al. 2012; Li et al. 2016; De'Donato et al. 2013; Ma et al. 2013)	Flooding is of great concern to the different levels of Chinese government (Zhang and Liu 2006)	Malnutrition and mortality, water-related diseases, airborne and dust-related diseases, vector borne diseases, and mental health effects (Stanke et al. 2013)	Air pollutants increase the risk of coronary heart disease mortality and respiratory problems (PM_{10}, $PM_{2.5}$) (Zhao et al. 2017; D'Amato et al. 2013)
Increased risk of transmitted infectious diseases (Zheng et al. 2017; Kang et al. 2015)	Extreme heat can cause heat stroke and dehydration, as well as cardiovascular, respiratory, and cerebrovascular disease risks (Yao-Dong et al. 2013; Zeng et al. 2014).	East China is severely affected by floods throughout history (Zhang 2012)	Northwest, north, and northeast of China, an increase in frequency of droughts (Yu et al. 2014)	PM_{10}-induced health losses are evident in China (Zhang et al. 2008)
Public health risks and impacts of a tornado in Funing, East China, the elderly (group aged 75–84 years) had highest risk of death (Wang et al. 2017)	Metropolitan areas in the Pearl River Delta are at risk of extreme heat (Yao-Dong et al. 2013)	An ares of East China measuring 130,000 km^2 was flooded resulting in health impacts including injuries (Gautam and Van Der Hoek 2003; Ye and Glantz 2005; Jonkman 2005; Shao-Hong et al. 2012)		$PM_{2.5}$ is positively related to daily mortality of people especially of older adults (Schwartz 2000)
	5% excess deaths were linked with heat waves in 66 Chinese communities, with the highest excess deaths in North East and South China (Ma et al. 2015)	Drowning, injuries, and hypothermia are direct impacts of flood (Du et al. 2010)		In Beijing some severe haze events were studied (Gao et al. 2015; Yin et al. 2015).
	Increased heart disease mortality in China is linked with extreme temperatures (Guo et al. 2012)	People with limited physical capacity or limited mobility are at particularly high risk (Galea et al. 2005; Jonkman and Kelman 2005)		Respiratory and cardiovascular hospitalization are associated with dust events after adjusting 319 the effect of sulphur dioxide and (or) nitrogen dioxide (Pan and Liu 2011; Wang et al. 2004)
	Cold spells lead to increases in patients with fractures due to the icy ground(Yao-Dong et al. 2013)	China's coastal region (East China) is physically vulnerable to coastal flooding (Wang et al. 2011; Ahern et al. 2005; Fang et al. 2017; Zhang et al. 2002; Lilai et al. 2016; Wang et al. 2012*a*)		

Climate Change Impacts on Health: Storms and Typhoons

Climate change is expected to lead to an increased number of storms and typhoons and East China is one of the regions seriously affected by tropical storms (Lu and Zhao, 2013). Previous research in Guangdong, South China, found that the landing of tropical cyclones not only causes substantial direct economic losses but also threatens human health (Kang et al., 2015). Research has found that tropical cyclones increase the risk of transmitted infectious diseases (Zheng et al., 2017). Study in Guangdong city between years 2005-2011 concluding that there is an increase on the infectious diarrhea incidents after tropical cyclones (Kang et al., 2015). An assessment on the public health risks and impacts of a tornado in Funing, East China concluded that elderly (75-84 year group) was at the highest risk death (RR (relative risk)=82.16; 95% CI (confidence interval)=19.66, 343.33) and injury (RR=31.80; 95% CI=17.26, 58.61), and females were at 53% higher risk of death than males (RR=1.53; 95% CI=1.02, 2.29) (Wang et al., 2017).

Climate Change Impacts on Health: Heatwaves and Cold Spells

Heat waves are increasing in frequency (Luber and McGeehin, 2008, Robinson, 2001). Population groups with high vulnerability to heatwaves and cold spells (Davídkovová et al., 2014) include the elderly, children and/or people with chronic diseases who are more susceptible to extreme temperatures, both hot and cold (Tian et al., 2012). Being exposed to extreme heat can cause heat stroke and dehydration, as well as cardiovascular, respiratory, and cerebrovascular disease risks which may cause insomnia, fatigue, clinical exacerbation, or death from heatstroke (Yao-Dong et al., 2013, Zeng et al., 2014). It is estimated that the heat waves will cause severe health impacts on the metropolitan areas in the Pearl River Delta as heat waves become more intense and longer in duration (Yao-Dong et al., 2013). Many studies that have investigated heat wave related mortality (Li et al., 2017, Yin and Wang, 2017, Luo and Lau, 2017, Zhou et al., 2017) but less attention has been given to the health effects of cold spells (Staddon et al., 2014) in the context of global climate change (Zhou et al., 2014). It is important to note that climate change may lead to warmer winters but with greater weather variability leading to the counter intuitive effect of more cold spells occurring. A recent study shows that a total of 5% excess deaths were associated with heat waves in 66 Chinese communities, with the highest excess deaths in North China, followed by East China and South China (Ma et al., 2015). In Beijing research on the elderly found that ignoring adaptation and demographic changes among elderly who are most susceptible to heat leads to differences in estimations on future heat-related mortality (Li et al., 2016).

Increased mortality rates are associated also with cold waves in populations around the world (Ryti et al., 2016). Both extremely cold and hot temperatures increase heart disease mortality in China (Guo et al., 2012). The elderly are more vulnerable to low temperatures than young people which can trigger some chronic diseases (De'Donato et al., 2013). Also, cold spells lead to increases in patients with fractures from the possible injuries of icy ground (Yao-Dong et al., 2013). In Shanghai a study done on the elderly showed that cold spells had a significant impact in elderly people with increasing mortality rates (age greater than 65) (Ma et al., 2013).

Climate Change Impacts on Health: Flooding

River Flooding

Flooding events are generally considered among the deadliest natural disasters, and have led to the highest number of mortalities in the 20th century (O'Connor and Costa, 2004). Flood disasters have been recognized as the most severe natural hazard in China since the country frequently experiences natural disasters, of which flooding is of great concern to the different levels of Chinese government (Zhang and Liu, 2006). For East China disastrous flooding in several river valleys across East China in 1755, serious flooding occurred in the middle and lower reaches of the Yellow River in 1756 and 1757, a rarely seen precipitation pattern of north-flood and south-drought in China for two successive years (Zhang, 2012). In 1931 in Central China there were a series of floods that occurred and these floods took the lives of nearly 4 million people (Zong and Chen, 2000). In the summer of 1991, an area in the East of China measuring 130,000km^2 was flooded and 3 million houses were damaged or destroyed resulting in health impacts including injuries (for those who sustained open wounds etc.)

(Gautam and Van Der Hoek, 2003). After, China suffered extensive flooding in three areas during the 1998 summer: along the Yangtze River in South Central China (Ye and Glantz, 2005). East China also experienced a series of severe floods during the summer of 1998 and these floods adversely affected the human population, directly and indirectly (Jonkman, 2005). Regions most at risk are: central North China, the Huaihe River (provinces: Henan, Anhui, Jiangsu), the middle and lower reaches of the Yangtze River, and the Pearl River Basin (cities around Shanghai, Nantong, Zhenjiang, Nanjing, Tongling, Wuhu, Jingzhou) (Shao-Hong et al., 2012). Drowning, injuries, hypothermia are amongst the immediate direct health impacts of floods (Du et al., 2010). All populations affected by a flood are at direct or indirect risk of health impacts during and after the event, but the literature also mentions the certain groups are at higher risk than others. People with limited physical capacity or limited mobility, who require home care or regular visits to health care facilities, and who have weak social networks, poor flood awareness, few resources and little access to flood warnings are at particularly high risk (Galea et al., 2005). Information on risk factors for flood-related death remains limited, and those drowning in their own homes are largely the elderly as they are less mobile (Jonkman and Kelman, 2005).

Coastal Flooding

Under future climate change, altered patterns of precipitation and sea-level rise are expected to increase in frequency and intensity of floods in many coastal regions (Ahern et al., 2005). China's coastal region is physically vulnerable to sea-level rise and associated coastal flooding because of its low topography (Wang et al., 2011). The East Sea, South Sea and East China regions with high population density have the greatest exposure to coastal flooding risk from sea-level rise (Fang et al., 2017, Zhang et al., 2002). Xiamen is proposing an integrated assessment approach to sea-level rise and storm tide-induced flood risks on a coastal urban system (Lilai et al., 2016). Half of Shanghai is projected to be at risk of flooding by the year 2100, and 46% of the seawalls and levees would be breached, and sea-level rise projections show 86.6 mm, 185.6 mm, and 433.1 mm rise by 2030, 2050, and 2100, respectively (Wang et al., 2012).

Climate Change Impacts on Health: Drought

Drought is a major natural hazard determined by water availability being significantly below normal conditions for a region (Sheffield et al., 2012). For the period of 1900-2012, China was amongst the countries with the greatest number of people affected by drought (Stanke et al., 2013). During the three most recent decades Northwest, North, and Northeast of China have seen an increase in droughts frequency (Yu et al., 2014).

Drought impacts on health are generally indirect and include: malnutrition and mortality due to decreased crop yields, water-related diseases due to increasing concentrations of pollutants and algae, airborne and dust-related diseases, vector borne diseases; mental health effects (Stanke et al., 2013). Although information on droughts' health impacts is available globally, specifically in East China, related elderly population, the information in the literature is very limited.

Climate Change Impacts on Health: Air Quality Interactions

There is a considerable literature on the relationship between air quality and numerous health problems, including respiratory infections, cardiovascular diseases, and lung cancer (Arceo et al., 2016, Currie et al., 2009, Currie and Neidell, 2005). Air quality is strongly dependent on weather and is therefore sensitive to climate (Jacob and Winner, 2009). Changes in the climate will impact air quality, for example by increasing formation of ozone during heatwaves (Stedman, 2004). Most air pollutants significantly increase the risk of coronary heart disease mortality especially particular matter (PM_{10}, $PM_{2.5}$) (Zhao et al., 2017). Due to climate change, patterns of air pollution are changing in urban areas, and this brings a huge threat to respiratory health. Other air contaminants of relevance to human health, including smoke from wildfires and airborne pollens and molds, may be influenced by climate change (Kinney, 2008).

Studies related PM_{10} induced health losses are evident, covering most of the large and medium-sized cities in China (Zhang et al., 2008a). $PM_{2.5}$ is known for its harm to the human respiratory system, and is positively related to daily mortality of people especially of older adults (RR=1.5%, 95% CI:1.1–1.9%) (RR: Relative risk, CI: Confidence interval) (Schwartz, 2000). According to the Chinese disease surveillance report, mortality due to respiratory diseases, cardiovascular diseases and neoplasm is higher in the over 60 age group (Zhou et al., 2016). In Beijing some severe haze events were studied, studies about the quantification of PM_{10} health effects can help in policy making if they are revealed (Gao et al., 2015, Yin et al., 2015).

Dust storms have also been positively associated with excess mortality in China (Wang et al., 2004). Respiratory and cardiovascular hospitalization are associated with the dust events after adjusting the effect of sulphur dioxide and/ornitrogen dioxide (Pan and Liu, 2011). Although literature provides information on the interaction between air quality and climate change impacts, more research is needed in this area. Research should focus on air quality interactions with climate change and what the consequences will be for population health.

Conclusions

The impact of climate change on human health is beginning to receive more attention, however except for heatwave impacts; specific information on how climate change will impact the health of the ageing Chinese population is sparse. This review highlights the broad range of health risks linked to climate change and identifies where more research effort is needed. In particular, more quantitative and epidemiological studies are required to better understand the likely impact of climate change on the health of the growing elderly populations affected. This research gap requires further investment if we are to have an evidence-based adaptation strategy to climate change. Furthermore, research is urgently required on the indirect pathways by which climate change will impact the health of elderly Chinese and other segments of the population. China, with its ageing population, rapid development and likely climate change impacts, has a great challenge in safeguarding the health of its population in the face of demographic and environmental changes of a magnitude rarely seen. Hence, this research gap on quantitative and epidemiological studies must be addressed if we are to have an evidence-based adaptation strategy to climate change.

Chapter 3 RESEARCH METHODS

3.1 Introduction

This chapter introduces the research methodology of the dissertation. The study sites are introduced, research strategy is outlined, research method, and, methods of data collection, participant sampling, research process, and the type of data analysis (with ethical considerations and the research limitations of the project) are introduced. It is important to note that in this chapter all of the methods used in this thesis are described in detail.

3.2 City Scoping

All three cities chosen as experiment sites in this thesis belong to different East China provinces (Jiangsu, Anhui and Fujian). Study sites are mainly chosen for their dense elderly population. As urban areas of East China they represent sociodemographic, economic and cultural differences. The cities are also chosen because they will experience different expected climate hazards in the future. As outlined in Chapter 1-1.1 Introduction climate change will have the largest impact in urban areas. In response, this thesis focused on three large urban areas in East China; Suzhou, Hefei and Xiamen, with similar elder population density but with different climate features, and with different climate hazards (Mi et al., 2019, Deng et al., 2020, Semenza et al., 2008). These three locations with expected climatic changes in the future and climate change impacts will now be scoped in detail.

3.2.1 Suzhou

Suzhou city is located in north latitude 31°3', east longitude 120°6'. It belongs to the north subtropical humid monsoon climate zone, with warm, humid and rainy weather, and the average annual temperature is 25.5°C (Min and Zhang, 2016).

Suzhou city was included in the research sites because of the following reasons: An ageing society, a society considered as ageing when 10% of its population is over 60 years of age, or 7% of its population is over 65 years of age. A society is regarded as 'super ageing society' when 20% of its population is over 60 years of age. Suzhou is considered as a super ageing society (Liu, 2018), as Suzhou City will have 24% of its population over the age of 60 (Chen and Liu, 2017) in coming years. Since the year 2012, a net increase of about 70,000 residents every year was recorded. At the end of 2016, seniors in Suzhou accounted for 1,708,816 people, which was 5% of Suzhou's 6,781,957 registered residents. Residents aged from 70 to 79 grew 32,440 to reach 528,700, accounting for 29.65% of all senior residents. Residents aged over 80 accounted for about 15% of the ageing population.

With this amount of elderly living in Suzhou, it was considered useful to include Suzhou among experiment sites. In conjunction with its ageing population changes, Suzhou city is also projected to be adversely impacted by climate change. It is projected that most of the land will be regularly flooded (river flooding) (Zhang et al., 2008b). Since all three cities are predicted to experience different impacts as climate changes it is important to note that elderly in these regions will need to undertake different adaptation measures in order to cope with the impacts of climate change.

3.2.2 Hefei

Hefei is the capital and largest city of Anhui Province in China. Being a prefecture-level city, it is the political, economic, and cultural center of Anhui. Hefei according to the 2017 sampling survey has a population of 7,965,000 inhabitants, 5,670,000 of whom reside in urban areas. The elderly population represents 16.7% of this population. Anhui region will experience drought as an exacerbated impact of climate change as the precipitation fluctuates (Sheng et al., 2008). Hefei has a humid subtropical climate with four distinct seasons. Hefei's annual average temperature is 16.18°C (61.1°F). Its annual precipitation is just slightly over 1,000 millimeters, being heavier from May through August. The city sees irregular snowfalls that rarely turn significant. Springs are generally relatively pleasant. Summers here are oppressively hot and humid, with a July average of 28.3°C (82.9°F). Hefei as an aging city will also face different climate hazards (drought) in the future with its increasing elderly population.

3.2.3 Xiamen

Xiamen city on the East China coast has a subtropical maritime climate with abundant rainfall, with an average annual temperature of approximately 21°C. Now exacerbated by climate change, Xiamen coastal zone is facing the risk of sea-level rise and increased typhoon risk. In Xiamen, there are 323,300 elderly people aged over 60 accounting for 14% of the city's total population. Xiamen is well positioned to assess the early impact of climate change due to its coastal location. There are already several signs of climate change affecting Xiamen: severe weather, increased pollution, and rising sea-levels. Typhoons have become more active in recent years impacting on Xiamen and its surrounding areas. For decades, typhoon season has generally occurred between June and September. Recent years, typhoons have begun showing up earlier (March and April) and lasting longer (through November and even December). Other weather patterns, such as storms in the city, drought in the rural areas and changes in temperature, are becoming more severe (Sugar, 2010). Over the next fifty years, Xiamen can also expect to see rising sea-levels. In Xiamen, climate change will not only impact the weather directly but also will impact public health and local GDP indirectly. That is why considering the elderly health here, Xiamen was included amongst the study sites.

3.3 Research Strategy

The research undertaken in this dissertation was an applied, onsite practice. As noted, to date, the impact of climate change on elderly health is not well studied in China. This thesis provides the first overview of the knowledge, attitude and practices (KAP) of Chinese elderly with regard to climate change and extends the KAP literature on climate change to examine these by wider demographic and socioeconomic factors.

An adequate understanding of the socio-cultural and economic aspects of the public can help with the implementation of adaptation strategies. Such information has typically been gathered through various types of cross-sectional surveys, the most popular and widely used being the knowledge, attitude, and practice (KAP) survey, also called the knowledge, attitude, behaviour and practice (KABP) survey (Green, 2001, Hausmann-Muela et al., 2003).

Knowledge, attitude and practices surveys are the studies of a distinctive population in order to collect information on what is known, what is felt or believed (Ojomo et al., 2015). The KAP survey tradition was first born in the field of family planning and population studies in the 1950s. KAP surveys were designed to measure the extent to which an obvious hostility to the idea and organisation of family planning existed among different populations. To provide information on the knowledge, attitudes, and practices in family planning these surveys could be used for programme purposes around the world (Cleland, 1973, Ratcliffe, 1976). In the 60's and 70's KAP surveys were used in Africa to utilize family planning activities (Schopper et al., 1993). Later on, the amount of studies on community perspectives and human behaviour grew rapidly in response to the needs of international aid organisations for the primary health care approaches (WHO, 2008).

The attractiveness of KAP surveys is attributable to characteristics such as an easy design, quantifiable data, ease of interpretation and concise presentation of results, generalisability of small sample results to a wider population, cross-cultural comparability, speed of implementation, and the ease with which one can train numerators (Bhattacharyya, 1997). KAP surveys can help identify knowledge gaps, cultural beliefs, and behavioral patterns that may identify needs and problems of the target population, and barriers to help them (Pillay, 2005). These surveys also help understanding of commonly known information, attitudes, and factors that influence behavior (Stone and Campbell, 1984). The population studied being the elderly, with the aim is to understand the perceptions and practices - the easiest method to convey information is through simplified quantitative KAP questionnaires.

Quantitative KAP surveys are also well-established methods in the field of climate change (Pidgeon, 2012, Plotnikoff et al., 2004, Seroussi et al., 2019) as a means of understanding individual behaviors (Karami et al., 2017, Thomas and Baptiste, 2018). For the purpose of this thesis, the survey questions were aligned with previous studies on KAP and climate change (Akerlof et al., 2010, Kabir et al., 2016b), and adapted to Chinese culture for some of the demographic questions (income related questions later being excluded in the second and in the third projects, because Chinese elderly refused to answer these questions in the first pilot project).

3.4 Research Methods and Approaches

In order to satisfy the objectives of the dissertation, three quantitative surveys were designed and administered on-site and face to face. The elderly was conveniently approached in the parks, public areas and they were presented with the surveys, although each question required an explanation from the interviewers for elderly to better understand the information that the research team want to deliver.

As noted in the Introduction, this thesis sought to understand three distinct, yet interlinked methods. To better communicate climate change, the first study sought to find new communication means with the elderly. Previous studies have informed on various communication techniques (radio, television, internet) tested with different population groups (Li, 2015, Skanavis et al., 2019). To date, none informed on the elderly climate change communication with simplified tools (Berhe, 2020, Bieniek-Tobasco et al., 2019, Depoux et al., 2017). The communication project was undertaken in order to eliminate the communication barriers with the elderly; let it be the language, attitudes towards the researcher, or basically how the elderly population react to these kinds of data collection methods. In this project elderly were shown three communication tools: a video, an infographic and a text-graph. Each tool was designed including same information (visuals being kept similar in order to represent same information). These tools were created for the elderly, and the language was kept as simple as possible. The second approach covered two cities, Suzhou and Hefei. Here, the participants were surveyed on their knowledge, perceptions and practices (Chapter 5). The third and core part of the project involved three cities, Suzhou, Hefei and Xiamen, where socio-demographic/KAP relationship was assessed.

3.5 Quantitative Study

3.5.1 Data Collection Methods and Tools

For the purpose of this thesis a quantitative data collection method was adopted, which included three on-site semi-structured questionnaires for all three individual component studies.

A paper-based method was adopted for all individual surveys and this method is called Paper and Pencil Interviewing (PAPI) (Wright et al., 1998, Booth-Kewley et al., 2007). To ensure the elderly participants understood the questions better, all questions were simplified, and presented in large fonts. Data was collected in different time spans, during the doctoral program period.

For the first project data collection took place in Suzhou city (Chapter 4). For this project, three tools (an infographic, a video, and a text-graph) were designed for the elderly, to better understand, or assess which communication tool is more effective when exchanging information with elderly regarding climate change. The first tool created was a video, including various pictures on climate change weather impacts (flooding, drought, heatwaves, and air pollution) and climate change health impacts (respiratory diseases, heat stroke). The chosen impacts are existent in the literature although the tools created for this thesis are novel. Scientists in China and all over the world have also mentioned these impacts, using the same terms (health and weather impacts of climate change) while designing their research (Anderson, 2011, Skanavis et al., 2019, Koteyko et al., 2015, Wu and Lee, 2015, Li, 2015). The second tool was an infographic including same information presented in the video tool. The third tool was a text-graph tool, which included graphs on temperature rise and information on climate change health and weather impacts. After viewing the tools elderly were asked to answer specific questions regarding climate change health and weather impacts. The questionnaire was related to the tools that were presented to the elderly (APPENDIX C Table 1).

The second survey focused on the knowledge, attitude and practices of elderly residents in Hefei and Suzhou. The questionnaire included three sections apart from the demographics section. Each section included 4 questions. For the data collection, two undergraduate students were recruited (Chapter 5).

For the main climate change project three study sites were defined (Suzhou, Hefei and Xiamen). A questionnaire was prepared for the survey study. Apart from Suzhou and Hefei cities Xiamen city was defined as the third study site. A team of undergraduate students from the Health and Environmental Sciences department were recruited. Students were chosen from the regions the study took place in because of the dialects the elderly speak. Data collection sites generally included the parks, where elderly go to do sports, play Chinese chess or have tea. The questionnaire was also related to KAP of the elderly however, the purpose of the project was also to evaluate associations between socio-demographic determinants and KAP of the elderly.

3.5.2 Participants and Sampling

Elderly participants were chosen in the East China cities of Suzhou, Hefei and Xiamen in urbanized areas. Participants were chosen amongst the elderly who are out in parks, shopping centres, and community centres. Sample size varied between projects. For the first project which explained in detail in the Chapter 4, sample size was defined as 150 (Suzhou city). The second project (Chapter 5) had a bigger sample size (n=300; 150 in Suzhou and 150 in Hefei). The third project had the largest sample size which included 1200 elderly in Suzhou, 1200 in Hefei and 1066 in Hefei city. For the main project 3466 participants answered the questionnaire. Non-probability sampling (convenience sampling) was adopted as the sampling technique because questionnaires were distributed to elderly who are willing to be surveyed in the parks or around the research sites (Chapter 6). Convenience sampling is a non-probabilistic sampling technique applicable to qualitative or quantitative studies, although it is most frequently used in quantitative research (Suen et al., 2014). All questionnaire work was undertaken in participants' native language (written simplified Chinese).

3.5.3 Data Collection, Input and Analysis

For each individual study first, descriptive statistical analyses were performed on the sample groups to obtain a clear understanding of the population. Chi-square analysis was performed to report on the knowledge, attitude and practices of the elderly (Akerlof et al., 2010). Data coding and entry was first performed in Excel and for analysis all questionnaire data were initially imported in IBM SPSS Statistics 25. Climate change research related to knowledge, and perception studies used regression modeling often (Wang et al., 2015, Robinson, 2017, Rahman et al., 2021). Due to the nature of the data for the regression models (yes and no questions, where only 'yes' answers are taken into account), binary regression analyses were conducted in order to assess the strength of direction of the relationship (relationship of likelihood) between identified cofounders age, gender, education and occupation (Park, 2015, Connelly, 2020, Whitmarsh, 2005). It is important here to note that analysis on regressions can produce models from the data, which can be used to predict the dependent variables from one or more known independent variables (Fidel, 2000). Although chi-square tests identify where significant relationships exist between two variables, regression analysis examines the interrelationships between large numbers of variables. Also, it is important to note that in the analysis, in some cases, significant relationships identified in the chi-square results are not consistent in the regression models.

3.5.4 Ethical Considerations

There were several types of ethical issues, which the researcher had to take into consideration for this thesis to be completed. Collecting written consent in China from a focus group, in our case 'the elderly' shows a cultural conflict. It would be almost impossible to get these forms signed in China. During survey studies and data collection, most of the elderly were hesitant to sign any kind of form (the elderly refuse to give any kind of personal information), yet they were still willing to answer the questions without signing the consent form. Thus, we had to adapt and seek the verbal consent of the elderly. Elderly without signing any kind of form was willing to take part in our study, yet all of the participants were informed in advance about the purposes of the research and they gave their informed consent prior their participation to the survey. No personal data was obtained such as name address or phone number. The consent form presented to the elderly is attached in the 'Appendix D'.

3.6 Summary

This chapter presented the methodology of the thesis and the appropriateness of utilizing a quantitative study design. Moreover, the study allowed for the examination of relationships between socio-demographical data and knowledge, attitude and practices of elderly on climate change views. The chapter also described the population under investigation, sampling frame, and data collection and analysis methods used. Following chapters 4, 5, 6 are individual studies presenting all of the study methods and results as in individual chapters.The Chapter 4 will introduce the communication research undertaken in Suzhou city, illustrating the methods that helped with communicating climate change with elderly Chinese.

Chapter 4 COMMUNICATING CLIMATE CHANGE WITH ELDELRY CHINESE: TOOL VISUALISATION

This chapter introduces the communication methods that could be used for climate change communication with Chinese elderly.

4.1 Introduction

As outlined in the Chapter 1 and Chapter 2, climate change impacts on health will affect many regions in coming years and put the lives of billions of people at risk (Costello et al., 2009, Watts et al., 2015). Even though climate change is a topic of great importance to society, it is a topic of great complexity and studies have indicated that there are many problems related to its communication (Filho, 2009, Leiserowitz et al., 2011). Its mitigation and adaption will only be successful if the information provided clearly articulates the risks of climate change impacts and health impacts on the society (Ockwell et al., 2009).

The way in which the communication is framed can significantly alter the results from the respondents (Spence and Pidgeon, 2010). In order to help people to understand how these impacts will be harmful, the communication of the risks and impacts of climate change is a significant research topic in its own right. Thus, research needs to find ways to better communicate the impact of climate change, so that public awareness can be created. To create this awareness communication tools may be created to help different segments of population (Carmichael and Brulle, 2017).

Internationally, many studies were undertaken in climate change communication in the past (Pearce et al., 2015, Semenza et al., 2008, Wilson, 2000). Climate change related studies have been undertaken on climate change related issues in China such as food security, water security and quality and temperature impacts (Frumkin et al., 2008, McMichael et al., 2006). Some studies have also been conducted on the heat wave impacts on elderly health (Huang et al., 2010, Zhang et al., 2017), however how to better communicate climate change problems with the elderly is not a common concern in China. China with an increasing ageing population, will be exposed to the risk of climate change health impacts, and the elderly will bear a greater proportion of these impacts (Kan, 2011, Yao-Dong et al., 2013). This chapter aims to further the research on ways to communicate climate change with the elderly in China.

Climate Change Communication

Globally, numerous studies have been undertaken on communication of climate change with different groups of the population, as well as with the elderly (Janković and Schultz, 2017, Levine and Kline, 2017). Communication research undertaken in the UK shows that media tools have a heavy influence on public opinion (Hart and Feldman, 2016). While most of the studies undertaken in countries such as US, Canada, Malta are on perceptions of the public to climate change (Akerlof et al., 2010), few studies are undertaken on finding effective ways to communicate climate change in China. One exception is research on behalf of the China Center for Climate Change Communication by Li (2015). Using a national telephone survey of 4,169 Chinese adults aged among 18-70 and a combined urban and rural sample, Li (2015) found that respondents in China generally obtained information related to climate change impacts through mass media such as TV, radio or newspapers (Li, 2015).

However, Li (2015) also found that the respondents were more interested in social news, then political and environmental news, and many Chinese find climate change related issues as distant problems.

4.2 Methodology

4.2.1 Communication Tools: Preparation and Representation

To understand ways to better communicate climate change with the elderly in China a focus group approach was applied. The focus groups were undertaken in Suzhou (80 km west of Shanghai) city in East China. The primary intention was to survey people with age greater than 60 years old, however, to increase participation, people between ages 57-59 was also included as participants. Potential respondents were approached randomly in sites, outside, around Suzhou.

Three communication tools, an infographic, a video and a text-graph were tested (Please see APPENDIX E. COMMUNICATION TOOLS presented in Chinese versions).

Each of the communication tool contained the same information related climate change weather impacts and health impacts. 50 participants were shown the infographic, 50 were shown a video, and other 50 were shown a text-graph.

The information presented in the tools included pictures related to climate change impacts and related health impacts. These impacts were flooding, drought, heatwaves, storms and air quality interactions. Pictures of elderly people in hospital, people affected by flooding and drought were included in the video tool.

The respondents were asked to look at the tools for 2 minutes. Each participant was then asked questions on climate change weather impacts and climate change health impacts.

4.2.2 Survey Design

To assess public response to the communication tools a brief questionnaire was created. The overall purpose of the survey was to investigate the effectiveness of the communication tools used by delivering information on weather impacts of climate change and relative health impacts. A semi-structured questionnaire was designed and presented to each participant after the tools were shown. The participants were asked on their perceptions on the issue of climate change, weather impacts of climate change and climate change health impacts. 150 elderly citizens from Suzhou city completed the questionnaire.

In the first section of the survey, demographic questions were included in order to assess whether the responses amounted to a cross sectional social representation appropriate for a fair and reliable analysis. These questions were designed to gather information without compromising anonymity. The second section of the survey included questions on the weather impacts of climate change (flooding, drought, storms, extreme heat, and air quality interactions). The third section of the survey consisted questions on the health impacts of climate change (heart disease, lung disease, infectious diseases, injuries and mental disease). In the last question survey respondents were asked to rank these health impacts according to their perception on which health impact is going to be more effective in Suzhou in coming decades.

4.2.3 Data Analysis

Descriptive statistics are presented as relative frequencies. Comparisons between groups were conducted using the analysis of variance. Finally, the logistic regression method was used to estimate the effect of information frame while controlling for other covariates. A type I error of 5% was adopted for all analyses.

4.3 Results

4.3.1 Demographic Characteristics of Participants

Table 4.1 presents the demographic and socio-economic characteristics of the respondents. High percentages of participants were aged 65-69 years old (28%). The majority of respondents were born in Suzhou (70%). Most of the respondents had high school education level (42%). 54% of the respondents were still living with their children, grandchildren. 36% of the respondents had an income level between 5000-7000RMB a month.

Table 4.1: Demographic characteristics of the elderly including age, education, living alone or with children, born in Suzhou or not, and income level. Frequencies and percentages are presented, and number of participants is given for each tool.

Characteristic	Frequency (%)	Infographic(n)	Video(n)	Text(n)
Age				
<60	24 (16)	10	6	7
60-64	24 (16)	8	6	10
65-69	42 (28)	14	17	11
70-74	31 (20)	8	12	11
75-79	18 (12)	5	7	6
80 and older	11 (7)	5	2	4
Born in Suzhou				
Yes	104 (70)	31	37	37
No	46 (30)	19	13	13
Education Level				
No formal schooling	6 (4)	3	1	4
Primary school	13 (9)	3	6	3
Middle school	33 (22)	10	13	9
High school	63 (42)	18	18	25
Entered but not completed	10(7)	1	6	2
University	23 (15)	15	4	3
Lives with children				
Yes	81 (54)	22	37	21
No	65 (43)	27	13	25
Have no children	3 (2)			2
Income				
<2500	9 (6)	4	3	2
2500-4999	23 (15)	6	6	11
5000-7499	55 (37)	13	19	21
>7500	33 (22)	16	9	7
Prefer not to say	25 (17)	8	11	4

4.3.2 Regression Analysis

For a binary response taking the values 0=no and 1=yes the expected value is simply the probability, p, that the variable takes the value one (Valsamis et al., 2019, Bland and Altman, 2000, Andrade, 2015), i.e., likelihood of saying yes to one of the weather impacts of climate change (flooding, drought, storms, extreme heat, air quality interactions) or health impacts of climate change (heart disease, lung disease, infectious diseases, injuries, mental illnesses).

4.3.3 Variations on Climate Change Weather Impacts

Table 4.2 presents the results of effectiveness of the tool at delivering knowledge for certain climate change impacts. Using the text-graph tool as the reference category, it is estimated that given the infographic the odds of saying 'yes' to flooding as an effective weather impact in Suzhou was 1.23 times higher than when they were shown the text-graph tool. When given the video tool, the chances of saying 'yes' to flood factor was 1.63 times higher compared to text-graph tool. When given the drought option the chances for infographics was 3.5 times higher than the text-graph tool. For the video tool the chances of saying 'yes' to drought factor was 0.78 times lower than text-graph tool. When given the infographic tool chances of choosing storms were 3.14 higher than when given the text-graph tool, and for video tool odds of choosing storms factor was 1.19 times higher than when given the text-graph tool (Table 4.2).

When asked about extreme heat and air quality interactions, chances of choosing these options were more likely than when they were given video, or text-graph tool. For the options drought, storms, extreme heat and air quality interactions when participants were shown infographic, the participants were more likely to choose these options. Likelihood ratio of infographic tool was found higher than video or text-graph tool for climate change weather impacts (drought, storms, air quality interactions).

Table 4.2: Variations on climate change weather impacts including impacts of weather presented as flooding, drought, storms, extreme heat and air quality interactions presented with likelihood (odds) ratios in comparison with text-graph tool.

	Infographic vs Text-graph			**Video vs Text-graph**		
	OR. *	**95% C.I.****	**p value*****	**OR**	**95% C.I.**	**p value**
Flooding	1.23	(0.50, 3.01)	0.649	1.63	(0.68, 3.90)	0.272
Drought	**3.50**	(1.15, 10.63)	0.027	0.78	(0.19, 3.10)	0.727
Storms	**3.14**	(1.10, 8.94)	0.032	1.19	(0.37, 3.84)	0.766
Extreme heat	1.88	(0.75, 4.69)	0.174	0.65	(0.22, 1.87)	0.427
Air quality interactions	**2.47**	(1.10, 5.54)	0.028	**0.31**	(0.13, 0.77)	0.012

**C.I. = confidence interval; *OR. = odds ratio; ***p<0.05 is considered as significant.

4.3.4 Variations on Climate Change Health Impacts

Comparing the infographic and video with the text-graph tool, it is estimated that given the infographic the odds of saying ‘yes’ to heart diseases as an effective health impact in Suzhou were 1.28 times higher than when they were shown the text-graph tool and asked on flood factor. When given the video tool, the chances of saying “yes” to heart disease factor were 0.76 times less likely compared to text-graph tool. Given lung disease option the chances for infographics was 1.86 times higher than the text-graph tool. When given the infographic tool chances of choosing infectious diseases were 2.08 times higher than when given the text-graph tool, and for video tool odds of choosing were 2.66 times higher than when given the text-graph tool. When asked about injuries, the chances of a participant choosing this option were more likely than when they were given video tool (Table 4.3). For the options heart disease, and lung disease participants were more responsive to the infographic, whereas when given the video ‘infectious diseases’ and ‘injuries’ options were more likely to be chosen, although the results here remained insignificant.

Table 4.3: Variations on health impacts and effectiveness of tools including climate change health impacts: hearth disease, lung disease, infectious diseases, injuries and mental illness. Likelihood ratios are presented as OR. (odds ratio).

	Infographic vs Text-graph			Video vs Text-graph		
	OR. *	**95% C.I.****	**p value***	**OR.**	**95% C.I.**	**p value**
Heart disease	1.28	(0.57, 2.84)	0.542	0.76	(0.33, 2.84)	0.530
Lung disease	1.86	(0.80, 4.29)	0.144	0.52	(0.23, 1.16)	0.111
Infectious diseases	2.08	(0.36, 11.94)	0.409	2.66	(0.49, 14.44)	0.255
Injuries	0.37	(0.06, 2.03)	0.255	0.78	(0.19,3.10)	0.727
Mental diseases	0	0	0.99	0	0	0.99

**C.I. = confidence interval; *OR. = odds ratio; ***p<0.05 is considered as significant.

4.3.5 Variations on Ranking the Health Impacts

Comparing each tool with the third tool (text-graph), and ranking the diseases in order of importance (1=strongest, 5=weakest) here it is estimated that when given the infographic as a communication tool the odds of ranking heart disease as 1 in Suzhou were 1.06 times higher than when they were shown the text-graph tool. When given the video tool, the chances of giving strongest rank to heart disease factor were 1.52 times more likely compared to text-graph tool. When given lung disease option the chances for infographics was 1.14 times higher than the text-graph tool. For the video tool the chances of giving strongest rank to lung diseases were 2.33 times higher than text-graph tool. For the options heart disease, lung disease and infectious diseases participants were more attracted by the tool video, whereas when given the video ‘injuries’ and ‘mental diseases’ options were more likely to be chosen (Table 4.4).

Table 4.4: Variations on ranking the importance of health impacts in between tools.

	Infographic vs Text-graph		Video vs Text-graph	
	OR. *	**p value****	**OR**	**p value**
Heart disease	1.06	0.873	1.52	0.266
Lung disease	1.14	0.728	**2.33**	0.026
Infectious diseases	1.16	0.678	1.97	0.069
Injuries	**2.20**	0.036	1.23	0.563
Mental diseases	**2.23**	0.041	1.83	0.179

*OR. = odds ratio; **p<0.05 is considered as significant.

4.4 Discussion

Communicating climate change to diverse audiences is now researchers focus (Berhe, 2020). These results provided a first look at three different communication tools, an infographic, a video and a text-graph as a means of communicating the impact of climate change to the Chinese elderly. Overall, for the elderly, analysis showed that pictures or visuals are more effective than any kind of written means, graphs etc. The results of the survey found that respondents who were given infographic tool were more likely to give 'yes' answers for the climate change weather impacts (drought, storms, extreme heat and air quality interactions), compared to text-graph tool, and the video tool.

For the options heart disease, and lung disease participants were more likely to respond these after observing the tool infographic, whereas when given the video 'infectious diseases' and 'injuries' options were more likely to be chosen yet likelihood level remained less than infographic tool. Table 4.4 provided statistical correlations between the health impacts of climate change and tools, this question was designed in a way the participants were asked to rank the climate change health impacts in the future they expect to see in Suzhou city.

Overall, the survey results indicate that elderly know that climate change poses a large risk to public health but that they lack the information and resources needed to lessen the risks (Martens, 1998, Skanavis et al., 2019). The elderly were not hesitant to explore the communication methods provided to them and were willing to talk on what they know about climate change. They were easy to communicate with once they were approached without any kind of written work, they were comfortable to be shown the infographic or the video, but they were intimidated by questionnaires, so it is better to follow up questions verbally once they are being communicated, this also supports the baseline tool, why the text tool was compared to other two tools video and infographic.

When the elderly was asked about their income at first, most of them resisted on answering, this might be related to culture or maybe respondents found it irrelevant to the subject (Section 4.3.1). A majority of participants held high school education. Most elderly lived with their children, which is a cultural outcome in China, as majority of the elderly stays with their children to look after the grandkids. The elderly also stated that in China they are familiar with the air quality interactions and the impacts of it on respiratory conditions (Kan et al., 2012).

Finally, a third challenge in communication was the physical ability of the elderly to hear well or to see well, once the tools were shown. The age interval covers mainly between 60-80 years old, depending on their condition, the ability to receive information varied. Some respondents needed help in the completion of the questionnaire because some of them had difficulty of reading or hearing. Here while they were assisted with the questionnaire completion, they were not resistant to receive help from the project members. Most elderly were friendly which enable the team members to complete the project easier. Nonetheless, this project on communication tools did provide useful information and helped defining the effectiveness of the tools.

4.5 Conclusion

This study has conducted initial analysis on communication tools which can be used when communicating climate change with elderly Chinese. Literature shows that studies related to communication of climate change in China are limited and it is even more limited when elderly population is the target.

When communication is the concern, it is understood that most participants were not familiar with the scientific terms; they needed to be communicated with simplified language in climate change related issues. The tools helped the elderly to understand the core of the project and the questionnaire was very helpful to carry out more information on health impacts and weather impacts of climate change. However, with this study it was only possible to reach a limited number of the elderly population; hence the responsibility belongs to the authorities to build communication channels with the vulnerable elderly population on climate change health and weather impacts.

From the regression analysis it is understood that while communicating climate change infographic and video tools could be used however the elderly are resistant to text-graph tool. It is suggested that governmental organizations working in the area of health or environmental protection should construct communication tools (pictures, videos, and infographics) to help the vulnerable segments of the population to be informed and prepared about climate change impacts (Cumiskey et al., 2019, Lickiss and Cumiskey, 2019). More communication studies should be undertaken on climate change to create awareness and help elderly cope with climate change health and weather impacts.

CHAPTER 5 PAPER 2

UNDERSTANDING CLIMATE CHANGE: KNOWLEDGE, ATTITUDES AND PRACTICES OF CHINESE ELDERLY ON CLIMATE CHANGE IN EAST CHINA

Submitted to Regional Environmental Change.

Note: This chapter is in submitted manuscript format. Table and figure numbering in this chapter is as the exact numbering in the submitted version of the submitted paper and it follows the journal numbering. Sub numbering and table and figure numbering is not included in the ‘Table of Contents’ and in the ‘List of Tables and Figures’ for this chapter.

Chapter 5 PAPER 2 UNDERSTANDING CLIMATE CHANGE: KNOWLEDGE, ATTITUDES AND PRACTICES OF CHINESE ELDERLY ON CLIMATE CHANGE IN EAST CHINA

Pelin Kınay, kinay.pelin@xjtlu.edu.cn, University of Liverpool, United Kingdom,
Andrew P Morse, A.P.Morse@liverpool.ac.uk, University of Liverpool, United Kingdom,
Philip L Staddon, pstaddon@glos.ac.uk, University of Gloucestershire, United Kingdom,
Karyn Morrissey, K.Morrissey@exeter.ac.uk, University of Exeter, United Kingdom,
Elmer Villanueva, Elmer.Villanueva@xjtlu.edu.cn, Xi'an Jiaotong-Liverpool University, China,
Shanzheng Zhang, Shanzheng.Zhang13@alumni.xjtlu.edu.cn, Xi'an Jiaotong-Liverpool University, China,
Jingjing Liu, Jingjing.Liu13@aluni.xjtlu.edu.cn, Xi'an Jiaotong-Liverpool University, China.

ABSTRACT

This study aimed to evaluate the climate change and health related knowledge, attitudes and practices (KAP) of the elderly population (60 years plus) in Hefei and Suzhou cities in China. This cross-sectional study included 150 participants in each city. Data regarding demographic characteristics, KAP, and climate change perceptions were collected using a semi-structured questionnaire. When asked about the potential impacts of climate change, 79% of participants stated that climate change affected their lifestyle. Participants were most concerned about storms (52%), food shortages (33%) and drought (26%). The main health risks cited included water contamination (32%), air pollution related diseases (38%) and lung disease (43%). Logistic regression models were used to analyze the data in order to understand the links between socio-demographical factors and KAP of the participants. These findings provide insights for potential adaptation strategies targeting the elderly. It is recommended that government should take responsibility in creating awareness strategies to improve the coping capacity of the elderly in China to climate change and its health impacts, and further develop climate change adaptation strategies.

Key words: Climate change, elderly, China, knowledge, attitude, practices.

I. Introduction

Climate change will impact many generations through different pathways. Little research has been undertaken explicitly on the elderly health (Portier et al., 2013, Thow and de Blois, 2008, Kok and Jäger, 2009). The elderly health is particularly vulnerable to climate change impacts due to decreased mobility and previous health history (Filiberto et al., 2009, Schneider et al., 2017). Thus, elderly population will especially suffer from climate change impacts (Haq, 2017).

Climate change concerns could show similarities from location to location, and experiences of population can be similar when regional level is concerned (Rhoades et al., 2017). In China, no in-depth study was undertaken regarding knowledge, attitudes or practices of the Chinese elderly on climate change (Chen et al., 2015, Kan et al., 2012, Yang et al., 2013, Zeng et al., 2010). There is currently very limited data in the literature regarding the knowledge, attitude and practices of the elderly (Berrang-Ford et al., 2011). This study addresses this gap by examining the current knowledge, attitude and practices of the elderly population in two study sites in Eastern China. Using regression models further analysis examines the KAP of the participants by socio-demographic characteristics.

Previous research has indicated the important role that both location and socio-demographic characteristics play on KAP to climate change among the elderly. A clear understanding of the social and behavioral risk factors, and knowledge gaps, related to exposure to climate change are essential when providing guidelines and recommendations for more effective understanding on impacts of climate change on elderly Chinese. In this section it is aimed to outline the socio-demographic factors that might impact on elderly population of

KAP. To date there is scarce information on KAP and sociodemographic factor association especially with the elderly population on climate change concerns in China.

A study in to Zomba district in Africa by the FAO found that education is very important when helping communities adapt climate change (Hara, 2010). Previous study examines adaptation among older people in rural and urban regions in China found that elderly behavior alters in response to extreme weather as a factor exacerbated by climate change (Zhang et al., 2016). However, this study does not allocate any results on socio demographic factors and KAP indications. Another study undertaken among vulnerable communities in Bangladesh reveals on education found that people with higher educational level were more knowledgeable about climate change (Kabir et al., 2016a).

The present study aims to evaluate the climate change and health related knowledge, attitudes and practices (KAP) of the elderly population (60 years plus) in Hefei and Suzhou cities of China (n=300). This cross-sectional study includes 150 participants in each city. Data regarding demographic characteristics, KAP, and climate change perceptions were collected using a semi- structured questionnaire. It is recommended that government should take responsibility in creating awareness strategies to improve the coping capacity of the elderly in China to climate change and its health impacts, and develop climate change adaptation strategies.

II. Methodology

Sample Selection

For this study people aged greater than 60 were targeted. The study was carried out in two cities: Suzhou and Hefei. These sites were chosen based on the similarities and differences between these two cities including the climate hazards, local customs and social condition. Hefei is the provincial capital of Anhui Province, a former manufacturing city with economic transition. Heavy manufacturing causes heavy pollution in this city. Suzhou, the economic center of Jiangsu Province, ranks number one in terms of city development in China.

Environmentally, Suzhou is a city surrounded by channels, where people live by the water so that this may influence their perceptions regarding climate change impacts. The relatively good social development level across both cities guarantees the citizens' awareness of their living quality. The participants were surveyed across public areas including parks and community centers where many old people gathered for exercising, relaxing, playing chess and dancing (n=300). However, due to the continuous precipitation in Hefei, shopping malls and nursing houses were also visited. In order to increase participation rates, a small notebook and pen were provided to each participant as a thank-you.

Survey Development

A literature review on climate change was undertaken to help in order to construct the questionnaire (Kinay et al., 2019). Several existing questionnaires were taken as reference and examined in order to better structure the questions (van Loenhout et al., 2016, Broto and Bulkeley, 2013, Furgal and Seguin, 2006). The final questionnaire had four distinct sections: social demographics, knowledge of climate change, attitudes to climate change and practices on adaptation. Excluding the demographic questions, the questionnaire included 11 climate change related questions.

Data Analysis

Relative frequencies and percentages are presented for demographics of the participants. Comparisons between groups were conducted using analysis of variance. Finally, binary logistic regression models (Park, 2015, Valsamis et al., 2019, Austin and Merlo, 2017) were constructed to estimate the effect of information frame while controlling for other covariates. A type I error of 5% was adopted for all analyses.

III. Data Presentation and Results

Demographic Characteristics of Participants

There was no significant difference in gender participation between cities. However, the average age in Hefei was found older than in Suzhou. The reason for age difference may be as a result of the characteristics of the sample sites. In Suzhou, most questionnaires were completed in parks, but for Hefei, nursing center was also included due to the heavy precipitation (the elderly in nursing center were much older).

The education level of the respondents also varied between both cities, with Hefei's education level distributed more evenly than Suzhou. The majority of participants had middle school education level, Suzhou 39%, Hefei 26%. There is no significance found among occupations between cities (Table 1).

Table 1: Demographic characteristics of the participants.

Demography	Suzhou	Hefei	p-value
Sex, n (%)			0.297
Female	60(40%)	71(47.3%)	
Male	73(48.7%)	67(44.7%)	
Age, years, mean (SD)	64.98(8.470)	68.82(10.612)	0.001
Education level, n (%)			0.001
No schooling	7(4.8%)	19(12.8%)	
Primary school	26(17.7%)	32(21.6%)	
Middle school	57(38.8%)	38(25.7%)	
High school	42(28.6%)	28(18.9%)	
College	15(10.2%)	31(20.9%)	
Postgraduate	0(0%)	0(0%)	
Occupation, n (%)			0.276
Agriculture	25(17.2%)	30(24.0%)	
Mining	9(6.2%)	11(8.8%)	
Manufacturing	36(24.8%)	21(16.8%)	
Energy sector	1(0.7%)	3(2.4%)	
Traffic officer	11(7.6%)	7(5.6%)	
Medical	3(2.1%)	9(7.2%)	
Business, finance	20(13.8%)	13(10.4%)	
Retail	16(11%)	11(8.8%)	
Construction worker	18(12.4%)	16(12.8%)	
Education sector	6(4.1%)	4(3.2%)	

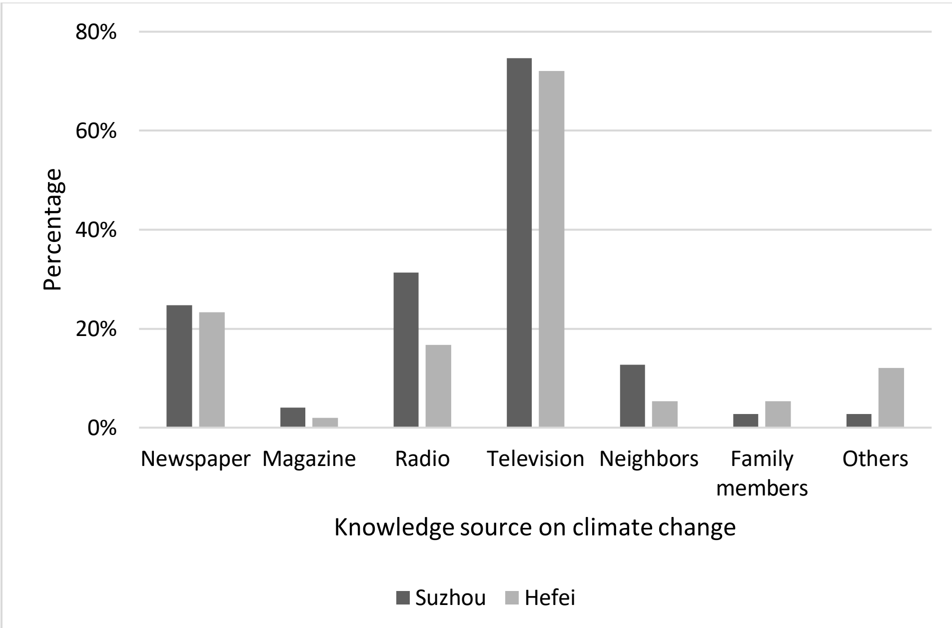
Knowledge of Participants Regarding Climate Change

Section 2 of the survey focused on respondents' awareness of climate change and the ways they get relevant information on climate change. The majority of respondents had heard about 'climate change', accounted as 81% in Suzhou and 83% in Hefei. When participants were asked to explain what climate change meant, 95% of participants referred to it as 'weather changes' (Table 2). Respondents had learnt about climate change through television (75% in Suzhou, 72% in Hefei), and other means of learning about climate change included radio and newspapers (25% in Suzhou, 24% in Hefei) (Figure 1).

Table 2: Knowledge of the participants regarding climate change.

Question	Suzhou	Hefei	p-value
Heard about climate change			0.558
Yes	121(80.7%)	124(82.7%)	
No	21(14%)	25(16.7%)	
Knowledge source			
Newspaper	37(24.7%)	35(23.3%)	0.787
Magazine	6(4%)	3(2%)	0.310
Radio	47(31.3%)	25(16.7%)	0.003
Television	112(74.7%)	108(72%)	0.602
Neighbors	19(12.7%)	8(5.3%)	0.026
Family members	4(2.7%)	8(5.3%)	0.239
Others (internet, cellphone)	4(2.7%)	18(12%)	0.002

Figure 1: Knowledge source: The participants were asked about their source of knowledge about climate change in Suzhou and Hefei cities whether they heard about it from the newspaper, magazine, radio, television, neighbors, family members or others.



Participants' Perceptions of Climate Change

When asked about what climate change will mean for local weather, respondents in both cities thought that storms would be more severe in the future (49% in Suzhou, 54% in Hefei). Respondents also believed that the cities would experience increased drought (25% in Suzhou, 27% in Hefei) and extreme heat (21% in Suzhou, 22% in Hefei) events. Precipitation increase (15% in Suzhou, 17% in Hefei) and floods (11% in Suzhou, 15% in Hefei) were also among the climate change impacts that the respondents thought would increase in severity in Suzhou and Hefei (Table 3).

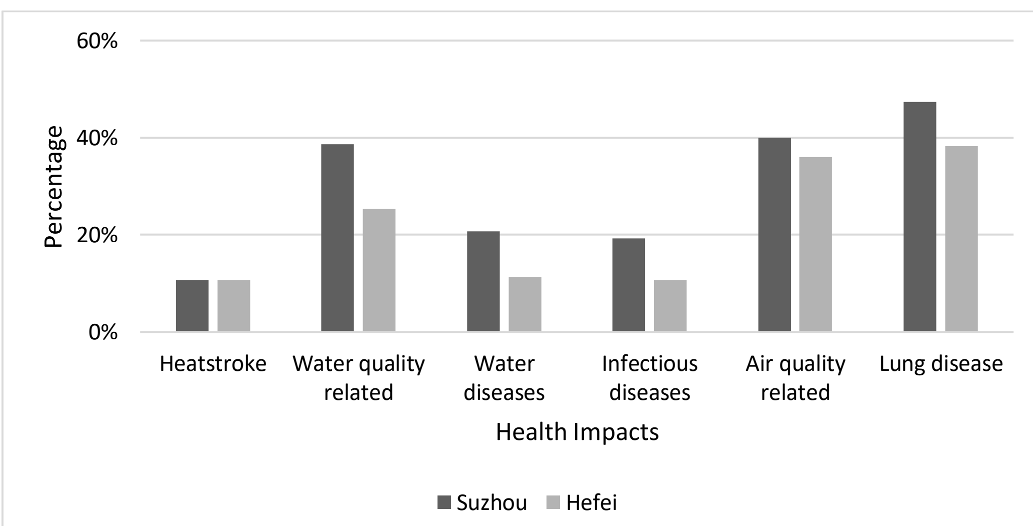
Table 3: Perceptions of the participants on climate change.

Question	Suzhou	Hefei	p-value
How climate change manifests?			
Extreme heat	32(21.3%)	33(22%)	0.889
Rainfalls	22(14.7%)	25(16.7%)	0.634
Storms	74(49.3%)	81(54%)	0.419
Floods	17(11.3%)	23(15.3%)	0.308
Drought	37(24.7%)	41(27.3%)	0.599
Other	8(5.3%)	8(5.3%)	1.000
Don't know	7(4.7%)	18(12%)	0.022
Concerned of Climate Change?			0.164
Yes	115(76.7%)	119(79.3%)	
No	12(8%)	19(12.7%)	
Don’t know	20(13.3%)	12(8%)	
How do you think climate change will affect your health?			
Heat stroke	16(10.7%)	16(10.7%)	1.000
Water quality related	58(38.7%)	38(25.3%)	0.013
Water borne diseases	31(20.7%)	17(11.3%)	0.027
Infectious diseases	29(19.3%)	16(10.7%)	0.036
Air quality related	60(40%)	55(36.7%)	0.553
Respiratory diseases	71(47.3%)	58(38.7%)	0.130
Sunburn	23(15.3%)	18(12%)	0.401
Cancer	11(7.3%)	6(4%)	0.212
Stress	18(12%)	15(10%)	0.580
Other	4(2.7%)	9(6%)	0.156
Climate change affects your lifestyle?			0.044
Yes	113(75.3%)	124(82.7%)	
No	14(9.3%)	4(2.7%)	
Don’t know	17(11.3%)	20(13.3%)	
Are you vulnerable to climate change?			0.992
Yes	93(62%)	97(64.7%)	
No	22(14.7%)	22(14.7%)	
Don’t know	28(18.7%)	29(19.3%)	
Do you have enough information to prepare for the impacts of climate change?			0.405
Yes	56(37.3%)	47(31.3%)	
No	33(22%)	40(26.7%)	
Don’t know	53(35.3%)	60(40%)	
What kind of trouble have you meet when you take measures to resist climate change?			
Lack of knowledge	44(29.3%)	49(32.7%)	0.533
Lack of skills	32(21.3%)	36(24%)	0.511
Lack of motivation	5(3.3%)	11(7.3%)	0.123
Lack of time	6(4%)	9(6%)	0.427
Lack of resources	27(18%)	33(22%)	0.386
Lack of assistance	16(10.7%)	6(4%)	0.027
No use of resistance to climate change	17(11.3%)	22(14.7%)	0.391
Climate change is not emerging	8(5.3%)	8(5.3%)	1.000

Government will solve it	25(16.7%)	17(11.3%)	0.183
Others	1(0.7%)	2(1.3%)	0.562
Extreme weather assistance from government?			0.066
Yes	48(32%)	35(23.3%)	
No	94(62.7%)	111(74%)	

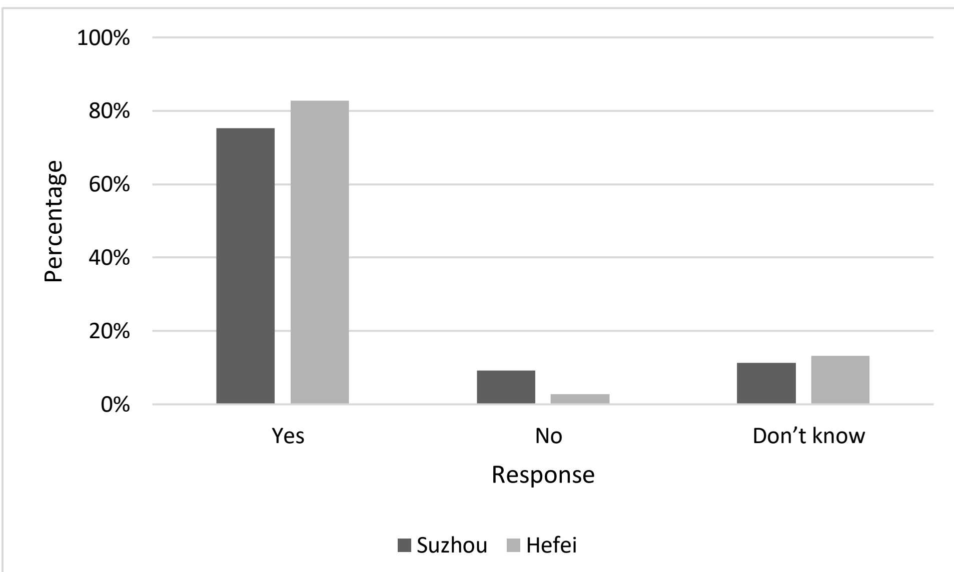
Respondents in both cities noted that they understood that there are health risks associated with climate change, particularly air quality related diseases and respiratory diseases (air quality related diseases 40% for Suzhou, 37% for Hefei, respiratory diseases 47% for Suzhou, 39% for Hefei). Respondents in Suzhou were more concerned about water quality 39%, water borne diseases 21%, and infectious diseases 19%, compared to people in Hefei. 11% of the respondents in both cities believed that heat stroke as a result of climate change would also impact their health in future (11%) (Figure 2).

Figure 2: Perceived health risks of climate change: The participants were asked about perceived health impacts of climate change with impacts of heatstroke, water quality related impacts, water diseases, infectious diseases, air quality related diseases and lung diseases in Suzhou and Hefei cities.



Most participants agreed that climate change would affect their lifestyle (75% Suzhou, 82% Hefei), with over 60% of respondents believing that they will be vulnerable to climate change (62% in Suzhou, 65% in Hefei) (Figure 3). However, only a small percentage of respondents believed they had enough information to cope with the impacts of climate change, and the main difficulties they foresaw in coping with climate change included a lack of knowledge, skills and financial barriers.

Figure 3: Climate change and lifestyle: Participants when asked the question 'Do you think climate change would affect your lifestyle?', responded as 'yes', 'no' or 'I don't know' in Suzhou and Hefei cities.



Practices of Participants in Extreme Weather

Participants were given the options such as drinking more water, opening the windows, staying at home, and using air conditioner as practices to adapt to the impacts of climate change. During heat waves, most people chose to drink more water (83% Suzhou, 78% Hefei). In terms of frequently opening windows and taking baths, staying in shades and using public air conditioners, more people in Suzhou preferred these methods than Hefei. Only 32% in Suzhou and 23% of the elderly people in Hefei stated that they received help from government during extreme events (Table 4).

Table 4: Practices in extreme heat.

Question	Suzhou	Hefei	p-value
In extreme heat what are your practices?			
Drink more water	125(83.3%)	117(78.0%)	0.242
Open the windows	74(49.3%)	50(33.3%)	0.005
Stay in shade	50(33.3%)	26(17.3%)	0.001
Stay in home	63(42.0%)	67(44.7%)	0.641
Use air conditioner	57(38.0%)	49(32.7%)	0.334
Lower your activity	47(31.3%)	35(23.3%)	0.120
Wear less clothes	31(20.7%)	22(14.7%)	0.173
Use sun protector	13(8.7%)	13(8.7%)	0.376
Bath often	12(8.0%)	4(2.7%)	0.040
Use public air conditioner	27(18.0%)	11(7.3%)	0.005
Take medicines	45(30.0%)	32(21.3%)	0.086

Binary Regression Analysis Measuring Variations with Socio-demographic Factors

a. Variations in Knowledge Linked to Socio-demographic Factors

Using a logistic model, the association between knowledge of climate change and survey respondents' socio-demographic indicators were analyzed. Knowledge of climate change among the elderly respondents was significantly associated with education level in the model. Participants with middle school education were 11.33 times more likely to know about climate change than participants with no school education (95% CI 3.04-42.18) (Table 5). However, while there was a positive significant relationship between high school education and knowledge of climate change among participants, the association 9.38 was less than that of respondents with middle school education relative to participants with no school education (95% CI 2.20-39.90). Other independent covariates remained insignificant (Table 5).

Table 5: Variations in knowledge linked to socio-demographic factors.

Have you heard about climate change?					
		OR. ***	95% C.I. *		p value**
			lower	upper	
Gender	Male (Ref.****)	1.00	-	-	-
	Female	0.89	0.36	2.20	0.790
Education Overall p=0.005	No schooling (Ref.)	1.00	-	-	-
	Primary school	7.20	2.07	25.02	**<0.001**
	Middle school	11.33	3.04	42.18	**<0.001**
	High school	9.38	2.20	39.90	**<0.001**
	College	NA	0.00	NA	1.000
Industry Overall p=0.680	Agriculture (Ref.)	1.00	-	-	-
	Mining	0.84	0.20	3.60	0.810
	Manufacturing	2.55	0.65	9.92	0.180
	Energy	NA	0.00	NA	1.000
	Traffic officers	3.08	0.31	31.04	0.340
	Medical	1.03	0.14	7.74	0.980
	Business/finance	1.05	0.22	4.93	0.950
	Retail	7.08	0.81	61.73	0.080
	Construction worker	1.49	0.36	6.20	0.580
	Education sector	3.43	0.31	37.86	0.310
Location	Hefei (Ref.)	1.00	-	-	-
	Suzhou	0.61	0.25	1.47	0.270

*C.I. = confidence interval; **p < 0.05 considered as significant; ***OR. = odds ratio; **** Ref. =reference category; *****NA. = Not applicable.

b. Variations in Attitudes Linked to Socio-demographic Factors

With regard to respondents’ attitudes to climate change and its impact on health, gender, education and industry remained insignificant. However, the location variable had a significant association. Participants from the water surrounded city of Suzhou were 2.35 times more likely to think that water quality related diseases will form a threat in society as climate changes. Participants from Suzhou city were also 3.42 times more likely to think that climate change will create water borne diseases that could impact the health of the elderly (Table 6).

Table 6: Variations in attitudes linked to socio-demographic factors.

How do you think climate change will affect your health?													
		Water quality related Overall Education p=0.149, Industry p=0.805				**Water borne diseases** Overall Education p=0.030, Industry p=0.801				**Infectious diseases** Overall Education p=0.396, Industry p=0.659			
		OR. ***	95% C.I.*		P** value	OR.	95% C.I.		p value	OR.	95% C.I.		p value
			lower	upper			lower	upper			lower	upper	
Gender	**Male (Ref.****)**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**
	Female	0.86	0.45	1.61	0.629	0.67	0.29	1.54	0.347	1.27	0.54	2.98	0.587
Education	**No schooling (Ref.)**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**
	Primary school	1.50	0.43	5.21	0.521	3.24	0.35	29.64	0.298	2.57	0.27	24.35	0.412
	Middle school	0.85	0.24	2.98	0.797	0.79	0.08	7.93	0.842	3.66	0.40	33.69	0.253
	High school	1.09	0.30	3.99	0.898	3.01	0.31	28.73	0.339	4.36	0.45	42.32	0.204
	College	2.74	0.71	10.66	0.145	4.84	0.48	48.64	0.180	7.87	0.75	82.42	0.085
Industry	**Agriculture (Ref.)**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**
	Mining	1.74	0.48	6.32	0.400	3.59	0.65	19.83	0.142	0.64	0.11	3.87	0.631
	Manufacturing	1.58	0.58	4.32	0.375	1.33	0.31	5.66	0.699	0.35	0.08	1.51	0.159
	Energy	1.48	0.12	17.65	0.755	0.00	0.00	NA	0.999	0.00	0.00	NA	0.999
	Traffic officers	2.77	0.73	10.48	0.133	4.89	0.89	27.01	0.069	1.86	0.40	8.67	0.432
	Medical	4.03	0.95	17.06	0.058	1.79	0.23	13.80	0.576	0.91	0.13	6.33	0.923
	Business/finance	1.55	0.47	5.10	0.471	2.04	0.41	10.10	0.384	0.70	0.16	3.06	0.641
	Retail	1.65	0.53	5.14	0.390	1.91	0.41	8.83	0.407	1.11	0.28	4.41	0.884
	Construction worker	1.16	0.37	3.65	0.801	1.66	0.35	7.92	0.525	1.28	0.32	5.15	0.729
	Education sector	1.72	0.39	7.59	0.475	1.73	0.24	12.34	0.585	1.98	0.37	10.73	0.427
Location	**Hefei (Ref.)**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**	**1.00**	**-**	**-**	**-**
	Suzhou	2.35	1.28	4.31	**0.006**	3.42	1.49	7.83	**0.004**	2.54	1.12	5.76	**0.025**

*C.I. = confidence interval; **p < 0.05 considered as significant; ***OR. = odds ratio; ****Ref. =reference category.

c. Variations in Practices Linked to Socio-demographic Factors

Examining health related practices, when given the option 'open the windows' participants who worked previously in mining, and medical sectors were more likely to perform this practice (OR 3.60; 95% CI 1.09-11.93, OR 5.12; 95% CI 1.22-21.55, respectively). Participants of Suzhou city were 2.07 times more likely to open windows and 2.30 times more likely to stay under shade than participants of Hefei city (Table 7).

Table 7: Variations in practices linked to socio-demographic factors.

In extreme heat what are your practices?									
		Open the windows Overall Education p=0.278, Industry p=0.314				**Stay in shade** Overall Education p=0.728, Industry p=0.656			
		OR.	95% C.I.*		P**value	OR. ***	95% C.I.		P value
			lower	upper			lower	upper	
Gender	**Male (Ref.****)**	**1.00**	-	-	-	**1.00**	-	-	-
	Female	0.92	0.51	1.69	0.793	1.23	0.63	2.41	0.546
Education	**No schooling (Ref.)**	**1.00**	-	-	-	**1.00**	-	-	-
	Primary school	0.78	0.26	2.40	0.671	0.60	0.19	1.90	0.382
	Middle school	0.60	0.19	1.83	0.367	0.63	0.20	2.00	0.436
	High school	0.46	0.14	1.50	0.197	0.46	0.13	1.62	0.227
	College	0.27	0.07	1.01	0.052	0.41	0.10	1.69	0.216
Industry	**Agriculture (Ref.)**	**1.00**	-	-	-	**1.00**	-	-	-
	Mining	3.60	1.09	11.93	**0.036**	0.68	0.18	2.59	0.568
	Manufacturing	2.58	0.99	6.77	0.053	1.39	0.53	3.66	0.509
	Energy	1.41	0.12	16.93	0.787	1.21	0.10	14.78	0.880
	Traffic officers	3.01	0.81	11.08	0.098	1.48	0.39	5.68	0.566
	Medical	5.12	1.22	21.55	**0.026**	0.64	0.11	3.59	0.611
	Business/finance	3.55	1.12	11.24	**0.031**	0.41	0.10	1.59	0.196
	Retail	2.35	0.79	6.99	0.123	0.71	0.22	2.29	0.567
	Construction worker	3.67	1.27	10.67	**0.017**	1.17	0.39	3.54	0.782
	Education sector	1.27	0.27	6.05	0.763	0.24	0.03	2.16	0.203
Location	**Hefei (Ref.)**	**1.00**	-	-	-	**1.00**	-	-	-
	Suzhou	2.07	1.18	3.64	**0.012**	2.30	1.22	4.33	**0.010**

*C.I. = confidence interval; **p < 0.05 considered as significant; ***OR. = odds ratio; ****Ref. =reference category.

When given the option 'bath often' female participants were 9.22 times more likely to bath often in extreme heat than male participants. Participants who worked in energy sector were 53.06 times more likely to bath often during extreme heat (Table 8).

Table 8: Variations in practices linked to socio-demographic factors (Cont'd).

In extreme heat what are your practices?										
		Bath often Overall Education p=0.825, Industry p=0.611				**Use public air conditioner Overall** Education p=0.498, Industry p=0.504			
		OR.	95% C.I. *		P** value	OR. ***	95% C.I.		p value
			lower	upper			lower	upper	
Gender	**Male (Ref.)**	**1.00**	-	-	-	**1.00**	-	-	-
	Female	9.22	1.16	72.95	**0.035**	1.72	0.67	4.39	0.261
Education	**No schooling (Ref.****)**	**1.00**	-	-	-	**1.00**	-	-	-
	Primary school	NA	0.00	NA	0.998	0.79	0.00	NA*****	1.000
	Middle school	NA	0.00	NA	0.998	NA	0.00	NA	0.998
	High school	NA	0.00	NA	0.998	NA	0.00	NA	0.998
	College	0.94	0.00	NA	1.000	NA	0.00	NA	0.998
Industry	**Agriculture (Ref.)**	**1.00**	-	-	-	**1.00**	-	-	-
	Mining	0.00	0.00	NA	0.998	1.47	0.17	12.39	0.725
	Manufacturing	1.07	0.06	20.38	0.966	2.13	0.37	12.20	0.397
	Energy	53.06	1.27	NA	**0.037**	0.00	0.00	NA	0.999
	Traffic officers	4.75	0.19	118.71	0.343	0.63	0.05	8.23	0.723
	Medical	0.00	0.00	NA	0.999	1.61	0.11	23.31	0.727
	Business/finance	2.88	0.22	38.02	0.421	5.49	0.96	31.31	0.055
	Retail	1.18	0.06	22.40	0.910	4.23	0.69	26.09	0.120
	Construction worker	13.86	0.78	246.51	0.073	1.13	0.13	10.12	0.915
	Education sector	4.43	0.19	105.38	0.358	4.49	0.41	48.62	0.217
Location	**Hefei (Ref.)**	**1.00**	-	-	-	**1.00**	-	-	-
	Suzhou	5.74	0.78	42.04	0.085	1.54	0.62	3.77	0.350

*C.I. = confidence interval; **p < 0.05 considered as significant; ***OR. = odds ratio; ****Ref. =reference category; *****NA. = Not applicable.

IV. Discussions

This paper examined the knowledge, attitude and practice of the elderly people to the risks associated with climate change to their health. It is found that the elderly in both cities thought that climate change would impact their life in a negative way, indicating that the elderly is already concerned about (a) the impacts of climate change and (b) that they accept that they are vulnerable to climate change. There was a significant difference in terms of age and education level (p=0.001) between respondents in Suzhou and Hefei. The difference in education levels may directly influence participants' knowledge on climate change as well as their practices. Research repeatedly demonstrates that people with higher education levels are able to understand climate related issues better and adapt to new skills faster (Hara, 2010). Occupation will also make influence on the people's perception of climate change. For instance, people who earn their life as farmers and fishers are more vulnerable to climate change, as climate change impacts the soil and water (Pettengell, 2010). However, in this current study, no significant difference in occupation was observed (p=0.276) between both cities.

In section 2, the knowledge level of participants was presented with the focus on respondents' awareness of climate change and the ways in which they obtain information on climate change. Over 80% of the respondents had previously heard about climate change, with most respondents interpreted the meaning of climate change as "variation of weather", "changes in rain patterns" or "changes in temperature". Research undertaken by MACC (Mainstreaming Adaptation to Climate Change) project in 2006 in Caribbean (in five countries: Barbados, Belize, Dominica, Jamaica and St. Vincent and the Grenadines) regarding climate change awareness (Rawlins et al., 2007) found that most people associated changes in weather patterns with climate change. A similar study in the USA, found that many Americans have shallow knowledge about climate change (Leiserowitz et al., 2011).

For the elderly, their ability to accept new knowledge may be lower than younger age groups (Paul and Stegbauer, 2005). When it comes to obtain knowledge on climate change, television is the most common means for acquiring information related to climate change in both cities. This finding is consistent with previous research on knowledge accumulation among the elderly which states that compared to other means of communication (radio, internet) television is more easy to operate and delivers information better than other written means of communication such as newspapers (considering the elderly may have visual impairment) (Li, 2015).

With regard to attitudes to climate change, respondents reported that they knew about the impacts of climate change and stated that they are concerned about these impacts; however, they further noted that they lacked detailed information related the impacts of climate change. When it comes to health risks caused by climate change, the first three risks the participants were most concerned about were lung problem (respiratory problem), air quality and water quality. Increased respiratory problems are one of the most documented impacts of climate change on human health (Xing et al., 2016, D’Amato et al., 2013). It is evident that some meteorological factors also impacted respiratory health of the elderly (Bernstein and Rice, 2013).

Research found that elderly is specifically vulnerable to extreme heat compared to other segments of population (Li et al., 2016). Participants in this study adapted to extreme heat by drinking more water, followed by opening windows, using air conditioning and staying indoors. Opening windows was preferred more because using air conditioners would raise some economic concerns. Most of participants had not received help from community or the government during periods of extreme heat. With regard to personal practices to cope during extreme heat events demographic and socio-economic differences were observed. For example, when given the option 'bath often' female participants were more likely to bath often in extreme heat than male participants (Alber, 2011, Fuchs, 2018, Jost et al., 2016).

Attitude and knowledge related dependent variables were also tested with independent predictors. Participants with middle school education were found more likely to know about climate change than participants with no school education. Other independent covariates remained insignificant. Here, the data provide insight about how the future work and implementations will be regarding the risk awareness improvement projects, and the policy adjustments regarding climatic issues threatening the public, and the vulnerable elderly population.

It is suggested that the policymakers and decision makers should take necessary precautions warning the elderly on how to protect themselves against the impacts of climate change. Efforts to reduce environmental risks and improve environmental conditions could help improve elderly health or help to eliminate dangers resulting from climatic changes. Government help and more financial help for elderly would be useful in climate emergencies (Zeng et al., 2010).

V. Conclusions

This study presented information on the climate change health perspectives of the elderly. With the demographical analysis it was found that the education level of the respondents varied in cities. Hefei's education level distributed more even than Suzhou. There was no significance found among occupations. In both cities the age level was greater than 57. The knowledge statistics showed that most elderly heard of 'climate change', both in Hefei and Suzhou, but when respondents were given an explanation on climate change, most people (95%) referred it as 'weather changes'. It is understood that more than 70% of the participants learned about climate change through television.

Among the many impacts presented in the questionnaire, around half of respondents were most aware of health impacts of storms in both cities, but unawareness of the participants in Hefei was found higher than in Suzhou. It is important to note that climate change may lack salience as a health issue in the two cities studied. The elderly being so vulnerable to changing factors around them, there is no to-date study exists that really asks elderly how they perceive climate change and what they do about lessening the impacts.

This study helps connecting with the elderly and provides some quantitative data on elderly knowledge, attitude and practices. It is highly recommended that governments should further develop awareness strategies in order to improve the coping capacity of the elderly with climate change and its health impacts and develop response strategies.

Issues associated with surveying elderly population included respondents having hearing and eyesight disabilities. It was also difficult to convey scientific information using simplified language; however, reviewing previous survey instruments overcame much of these issues. The results of this study can provide example for the future researchers undertaking further experiments in this field. Now elderly is focused for most researchers around the world, especially in climate change related areas (Arnberger et al., 2017, Chindapol et al., 2017, Haines et al., 2006).

Future research will need to provide methods of adapting to climate change and provide techniques on how to better implement these methods, especially for the specific group of elderly population. Particularly at regional levels; improving characterization of climate–health relationships on vulnerable groups is a must. While results showed a fair amount of knowledge among the general elderly population concerning climate change, the responses points to an area that needs addressing. More research should be undertaken regarding the elderly perceptions and practices for adaptive measurements. Community and government should help the elderly and give them more chance to know more about climate change and also support them in protecting themselves from emergency and catastrophe within their power. Collecting long term secondary data over climate change health impacts must be researchers focus.

Chapter 6 CLIMATE CHANGE ADAPTATION AND THE HEALTH OF THE ELDERLY: AN ANALYSIS IN THREE CHINESE CITIES

6.1 Introduction

A deep understanding of the social and behavioural risk factors, and knowledge gaps, related to exposure to climate change impacts are important when developing guidelines and recommendations for more effective risk prevention in the future. To-date, the level of knowledge, the practices and perceptions of the elderly towards climate change impacts and relative health impacts has not been sufficiently assessed in China (Zhang et al., 2016). For the purpose of this thesis, a KAP survey was conducted to get a better understanding of elderly participants' knowledge of climate change health impacts, their attitudes to climate change events and practices of protection in the Eastern Chinese cities of Suzhou, Hefei and Xiamen. Further evaluations on associations between sociodemographic determinants and KAP factors showed that this work could be useful in assisting local government by providing information for the development of tailored climate change policies.

Specifically, the research questions addressed in this chapter are:

RQ1: What is the belief of elderly regarding climate change health risks? How does this differ between cities?

RQ2: In what specific ways do the elderly think that climate change will harm their health?

RQ3: What are the adaptive measures taken by the elderly to prevent the health risks associated with climate change?

RQ4: Are age, gender, education and occupation of the elderly determinant factors on their knowledge, attitudes and practices? (Binary regression models)

RQ5: What actions, if any, do these findings suggest for public health officials?

6.2 Data & Methods

The KAP survey was conducted in three cities, Suzhou, Hefei and Xiamen in East China. Using a structured questionnaire, the knowledge, attitudes and practices related to climate change impacts and health were assessed for the elderly population. The study area in each city was restricted to urban zones (Chapter 3, 3.2). To assess the status of, and factors associated with elderly knowledge, attitudes, and practices (KAP) related to climate change impacts regression models were constructed. Completed questionnaires were coded using Excel. Outcome variables were knowledge, attitude and practice questions as follow:

- 'Have you heard of climate change?' (Knowledge)
- 'How would you define climate change impacts?' (Knowledge)
- 'Do you think climate patterns changed in last 20 years?' (Knowledge)
- 'Which one of the below impacts you noticed changes?' (Knowledge)
- 'Which of the following ways climate change threatens your health?' (Knowledge)
- 'Do you think climate change threatens your health?' (Attitude)
- 'Do you think your government is doing enough to inform-warn you about weather changes and its health impacts?' (Attitude)

- 'For each of the below health impacts what would you do to manage your health?' (Practices)
    - Heat stroke and exhaustion
    - Respiratory diseases
    - Infectious diseases
    - Injuries

In terms of the descriptive statistics used, the alpha level was set at 0.05 to determine statistical significance. Four independent variables, including: (1) respondents' age, (2) respondents' gender, (3) respondents' educational level, and (4) occupation was statistically analyzed using chi-square tests. A binary logistic regression model was used to identify possible factors (age, gender, education, occupation) associated with residents' knowledge, attitude and practices. First, all site regressions were run together using binary logistic regression models (Suzhou, Hefei, Xiamen sites), then separate city regressions were provided as cities provided different characteristics. In a binary response regression model, classical residuals are difficult to define and interpret due to the discrete nature of the response variable (Ali et al., 2018). As such the coefficients are presented as odds ratios (OR) value with a 95% confidence interval (95% CI). All analysis was performed using IBM SPSS Statistics 25. First, cross tabular analysis with regression models including all residential locations will be presented following the chi-square analysis with KAP questions. Additional regression analysis of the response measures by age, gender education and occupation for individual sites (Suzhou, Hefei, Xiamen) are provided in the 'Appendix B'.

6.3 Descriptive & Chi-Square Analysis

Characteristics of the Participants

Table 6.1 presents the descriptive statistics for each of the three sites. Across each of the three cities, males accounted for 53% of the sample in total. 26% of participants were aged between 65-69 years old, 36% of participants had ‘less than high school’ education and 60% of the sample selected ‘other’ in job categories, with 13% selecting ‘engineering’.

Table 6.1: Demographic characteristics of the respondents at all sites including participants gender, age, education and occupation, tested with sites variable.

	Total n=3466	Suzhou n=1200	Hefei n=1200	Xiamen n=1066	*p value
	n (%)	n (%)	n (%)	n (%)	
Gender					p<0.001
Male	1843 (53.2)	673 (56.1)	574 (47.8)	596 (55.9)	
Female	1623 (46.8)	527 (43.9)	626 (52.2)	470 (44.1)	
Age					p<0.001
55-59	534 (15.4)	227 (18.9)	128 (10.7)	179 (16.7)	
60-64	753 (21.7)	217 (18.1)	294 (24.5)	242 (22.7)	
65-69	895 (25.8)	305 (25.4)	337 (28.1)	253 (23.7)	
70-74	768 (22.2)	288 (24.0)	246 (20.5)	234 (22.0)	
75 and older	516 (14.9)	163 (13.6)	195 (16.3)	158 (14.8)	
Education					p<0.001
Less than high school	1030 (36.2)	483 (40.9)	233 (31.0)	314 (34.4)	
High school	566 (19.9)	247 (20.9)	124 (16.5)	195 (21.4)	
Some university	445 (15.7)	168 (14.2)	126(16.8)	151 (16.6)	
University graduate	251 (8.8)	109 (9.2)	41 (5.5)	101 (11.1)	
Postgraduate	25 (0.9)	14 (1.2)	6 (0.8)	5 (0.5)	
No schooling	526 (18.5)	159 (13.5)	221 (29.4)	146 (16.0)	
Occupation					p<0.001
Business, consulting, management	231 (9.6)	143 (12.2)	38 (7.2)	50 (7.0)	
Accounting, banking, finance	145 (6.0)	94 (8.0)	14 (2.7)	37 (5.2)	
Design	54 (2.2)	16 (1.4)	8 (1.5)	30 (4.2)	
Engineering	305 (12.6)	122 (10.4)	21 (4.0)	162 (22.6)	
Healthcare	76 (3.1)	27 (2.3)	10 (1.9)	39 (5.4)	
Law	23 (1.0)	7 (0.6)	7 (1.3)	9 (1.3)	
Sales and marketing	115 (4.8)	38 (3.2)	8 (1.5)	69 (9.6)	
Other	1466 (60.7)	724 (61.8)	421 (79.9)	321 (44.8)	

*p<0.05 is considered as significant, n=number of the participants (%) = percentage.

6.3.1 Knowledge of the Participants

With regard to knowledge of climate change, the majority of participants (73%) had heard about climate change (Table 6.2).

When participants were asked to define climate change participants referred to heatwaves (56%), drought (40%), storms (36%) and flooding (33%). A majority of respondents (86%) said the climate patterns changed in the last 20 years; with more heat (90%), more droughts (47%) and more storms (44%) reported (Table 6.2)

Asking the participants to relate the impact of climate change to their health, 46% noted heat stroke and 33% noted respiratory problems.

Suzhou

A majority of the elderly in Suzhou knew about climate change (74%). When they were asked to define climate change 58% of the participants of Suzhou city defined climate change with more occurrence in heatwaves. When they were asked about change in climate patterns over the past years, 86% of the elderly in Suzhou responded as “yes” they have observed some changes. The elderly referred to ‘heatstroke’ as one of the most threatening health impact of climate change which accounted as 50% (Table 6.2).

Hefei

65% of the elderly in Hefei heard about climate change. 57% defined climate change as heatwaves and 37% chose drought as a defining factor of climate change. The elderly in Hefei thought that climate patterns changed in the last years (89%). Heatstroke was one of the most threatening health impact of climate change which accounted as 39% (Table 6.2).

Xiamen

80% of the elderly in Xiamen heard about climate change. 59% defined climate change as heatwaves and 40% chose storms as a defining factor of climate change. The elderly in Xiamen also thought that climate patterns changed in the last years (83%). The elderly in Xiamen also referred to ‘heatstroke’ as one of the most threatening health impact of climate change which accounted as 48% (Table 6.2).

Table 6.2: Knowledge related questions and Chi-square results for each site.

	Total n=3466	Suzhou n=1200	Hefei n=1200	Xiamen n=1066	*p value
KNOWLEDGE QUESTIONS	n (%)	n (%)	n (%)	n (%)	
Q1. Have you heard about climate change?					p<0.001
Yes	2502 (72.9)	889 (74.5)	768 (64.9)	845 (80.1)	
No	930 (27.1)	305 (25.5)	415 (35.1)	210 (19.9)	
Q2. How would you define climate change?					
Flooding	1136 (32.8)	602 (50.2)	190 (15.8)	344 (32.3)	p<0.001
Drought	1350 (38.9)	577 (48.1)	442 (36.8)	331 (31.1)	p<0.001
Storms	1244 (35.9)	565 (47.1)	245 (20.4)	434 (40.7)	p<0.001
Wildfires	569 (16.4)	316 (26.3)	114 (9.5)	139 (13.0)	p<0.001
Heatwaves	1933 (55.8)	693 (57.8)	687 (57.3)	553 (51.9)	p<0.001
Q3. Do you think climate patterns changed in last 20 years?					p<0.001
Yes	2338 (85.9)	864 (86.4)	717 (88.6)	757 (83.0)	
No	383 (14.1)	136 (13.6)	92 (11.4)	155 (17.0)	
Q4. Which one of the following impacts you noticed changes?					
More storms	1005 (43.7)	519 (58.4)	194 (25.6)	292 (44.6)	p<0.001
More floods	773 (33.8)	469 (53.6)	136 (17.9)	168 (25.8)	p<0.001
More droughts	1082 (47.0)	484 (54.9)	403 (52.8)	195 (29.7)	p<0.001
More heat	2271 (90.5)	861(90.2)	708 (92.7)	702 (88.7)	p<0.001
More cold	506 (22.7)	303 (35.0)	117 (15.5)	86 (14.2)	p<0.001
Q6. Which of the following ways climate change threatens your health?					
Heat stroke-exhaustion	1582 (45.6)	603 (50.3)	471 (39.3)	508 (47.7)	p<0.001
Respiratory problems	1160 (33.5)	569 (47.4)	358 (29.8)	233 (21.9)	p<0.001
Infectious diseases	634 (18.3)	340 (28.3)	176 (14.7)	118 (11.1)	p<0.001
Injuries	516 (14.9)	295 (24.6)	115 (9.6)	106 (9.9)	p<0.001

*p<0.05 is considered as significant.

6.3.2 Attitudes of the Participants

Geographically, when asked about the relationship between human health and climate change 76%, 60% and 64% of respondents in Suzhou, Hefei and Xiamen respectively thought that climate change threatens their health (Table 6.3).

Pooling the responses from the three cities, 45% of participants thought that the government is doing enough to protect or warn them from the negative impacts of climate change on their health.

Suzhou

In Suzhou city 76% of the elderly thought that climate change threatens their health. 56% believed that government had no help in climate change warning (Table 6.3).

Hefei

60% of the participants in Hefei city thought that climate change has a strong negative impact on human health. Different than Suzhou city, participants in Hefei believed that government helped them in extreme events which accounted as 54% (Table 6.3).

Xiamen

64% of the participants thought that climate change has a strong negative impact on human health. Majority of the participants reported that government is doing enough to protect-warn the elderly from the health impacts of climate change (55%) (Table 6.3).

Table 6.3: Attitude related questions and Chi-Square results for each site.

	Total n=3466 n (%)	Suzhou n=1200 n (%)	Hefei n=1200 n (%)	Xiamen n=1066 n (%)	p value*
ATTITUDE QUESTIONS					
Q5. Do you think climate change threatens your health?					p<0.001
Yes	1880 (67.4)	776 (76.5)	533 (60.1)	571 (64.4)	
No	908 (32.6)	239 (23.5)	354 (39.9)	315 (35.6)	
Q8. Do you think your government is doing enough to protect-warn you from the health impacts of climate change?					p<0.001
Yes	1180 (45.4)	302 (30.2)	418 (54.3)	460 (55.5)	
No	1014 (39.0)	563 (56.4)	252 (32.7)	199 (24.0)	
I am not sure	404 (15.6)	134 (13.4)	100 (13.0)	170 (20.5)	

*p<0.05 is considered as significant.

6.3.3 Practices of the Participants

Regarding personal practices to protect themselves from health impacts of climate change respondents reported that, during moments of heat stroke or exhaustion most of the participants reported drinking more water (44%) or staying indoors (34%), while 23% used air conditioning to prevent physiological injuries, and most elderly preferred avoiding going out in stormy weather (25%) (Table 6.4).

Suzhou

During extreme events and in case of heat stroke and exhaustion elderly reported that they would prefer to consume more water (60%). In case of respiratory hardships, 39% reported that they would rather avoid exposure to pollutants. 35% of the elderly would disinfect the hot zones in their compounds for infectious diseases. To prevent injuries, 48% of Suzhou participants would prefer to stay indoors (Table 6.4).

Hefei

30% of the elderly in Hefei city would also prefer to drink more water to protect themselves from heat stroke. In case of respiratory problems the elderly prefer to use masks for protection (22%). For infectious diseases the elderly prefer to get vaccinated (14%). 11% of the elderly would avoid staying under the sun to prevent injuries such as sunburn (Table 6.4).

Xiamen

When in the danger of a heat stroke, the elderly preferred to drink more water (41%). 13% of the participants in Xiamen preferred to use air purifiers (cleaners) if they have respiratory hardships. 11% preferred to get vaccinated if there is a risk of infectious diseases. Like Hefei participants 14% of the elderly in Xiamen would also stay indoors to protect themselves from injuries (Table 6.4).

Table 6.4: Practice related questions and Chi-Square results per site.

	Total n=3466 n (%)	Suzhou n=1200 n (%)	Hefei n=1200 n (%)	Xiamen n=1066 n (%)	*p value
PRACTICE QUESTIONS					
Q7. For each of the below how do you manage your health?					
Heat stroke or exhaustion					p<0.001
Drink more water	1520 (43.9)	721 (60.1)	362 (30.2)	437 (41.0)	p<0.001
Stay in the shade	1148 (33.1)	544 (45.3)	322 (26.8)	282 (26.5)	p<0.001
Stay indoors	1178 (34.0)	541 (45.1)	340 (28.3)	297 (27.9)	p<0.001
Use AC	804 (23.2)	371 (30.9)	227 (18.9)	206 (19.3)	p<0.001
Respiratory problems					p<0.001
Use masks	790 (22.8)	402 (33.5)	259 (21.6)	129 (12.1)	p<0.001
Use air purifiers	815 (23.5)	432 (36.0)	246 (20.5)	137 (12.9)	p<0.001
Avoid exposure with pollutants	832 (24.0)	468 (39.0)	232 (19.3)	132 (12.4)	p<0.001
Infectious diseases					p<0.001
Get vaccinated	697 (20.1)	409 (34.1)	173 (14.4)	115 (10.8)	p<0.001
Stay at home if you have signs of infection	677 (19.5)	413 (34.4)	165 (13.8)	99 (9.3)	p<0.001
Disinfect the hot zones in your residence	660 (19.0)	421 (35.1)	154 (12.8)	85 (8.0)	p<0.001
Wash your hands often	602 (17.4)	404 (33.7)	125 (10.4)	73 (6.8)	p<0.001
Injuries					p<0.001
Avoid going out in stormy weather	864 (24.9)	581 (48.4)	129 (10.8)	154 (14.4)	p<0.001
Avoid staying in the sun	834 (24.1)	571(47.6)	136 (11.3)	127 (11.9)	p<0.001
Ready a first aid kit for physical injuries	553 (16.0)	368 (30.7)	117 (9.8)	68 (6.4)	p<0.001
Use sun protection if working outside	462 (13.3)	347 (28.9)	96 (8.0)	19 (1.8)	p<0.001

*p<0.05 is considered as significant.

6.4 Regression Analysis: All Models

A binary logistic regression method was used to analyze the associations between baseline variables such as age, gender, education, occupation and site and knowledge, attitude and practices pooling all the data from the three sites (n=3466). For the purpose of all the models the variables were grouped in 5 sets, each containing age, gender, education, occupation and site independent predictors in addition to the identification and specific outcome variables of the set. A sequence table for all analysis was constructed based on questionnaire question categorization on knowledge, attitude and practice related feedbacks of the participants (Table 6.5). During all regression analysis MODEL 1 will refer to Suzhou city regressions, MODEL 2 will refer to Hefei regressions and MODEL 3 refers to Xiamen based regressions (Presented in APPENDIX B). ALL MODELS refers to all city regressions analyzed together, and this model also includes site variable. Selected parameters were presented below and some others are included in the appendices (APPENDIX B) (Table 6.5).

Table 6.5: Analysis sequence for regressions with questions (How the analysis was constructed according to the question sequence in the survey).

KNOWLEDGE RELATED QUESTIONS	RESPONSE
Q1. Have you heard about climate change?	Yes
Q2. How would you define climate change?	Flooding Drought Storms Wildfires Heatwaves
Q3. Do you think climate patterns changed in last 20 years?	Yes
Q4. Which one of the following impacts you noticed changes?	More storms More floods More drought More heat More cold
Q6. Which of the following ways climate change threatens your health? (Choose any.)	Heat stroke-exhaustion Respiratory problems Infectious diseases Injuries
ATTITUDE RELATED QUESTIONS	**RESPONSE**
Q5. Do you think climate change threatens your health?	Yes
Q8. Do you think your government is doing enough to protect-warn you from the health impacts of climate change?	Yes
PRACTICE RELATED QUESTIONS	**RESPONSE**
Q7. For each of the below how do you manage your health?	
Heat-stroke or exhaustion	Drink more water Stay in the shade Stay indoors Use AC
Respiratory problems	Use masks Use air purifiers Avoid exposure with pollutants
Infectious diseases	Get vaccinated (in case of malaria, dengue) Stay at home if you have signs of infection Disinfect the hot zones in your residence Wash your hands often
Injuries	Avoid going out in stormy weather Avoid staying under the sun Ready a first aid kit for physical injuries Use sun protection if working outside

6.4.1 Knowledge

Question 1: Have you heard of climate change? (All Models)

Overall age, gender, and education of the participants were associated with the model (p=0.000, p=0.002, and p=0.000, respectively) (Table 6.6). Individual level predictors showed that participants aged ’60-64’ years old were less likely to know about climate change than participants of age category ’59 or younger’ (OR 0.81; 95% CI 0.56-1.17). Female participants were 0.72 times less likely to know about climate change than male participants (95% CI 0.59-0.89). Participants who worked in law sector were 5.15 times more likely to know about climate change than participants who worked in business sector (95% CI 0.65-40.75). Participants of Xiamen city were 1.62 times more likely to know about climate change than participants of Suzhou city (95% CI 1.25-2.08).

Table 6.6: Regressions analysis and knowledge on climate change with variables age, gender, education, occupation and site (ALL MODELS).

Have you heard about climate change?					
ALL MODELS		*OR. **	*95% C.I. ***		*p value*****
			lower	*upper*	
Age Overall p<0.001 (p=0.000)	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**
	60-64	0.81	0.56	1.17	0.256
	65-69	0.57	0.40	0.81	0.002
	70-74	0.58	0.41	0.83	0.003
	75+	0.39	0.26	0.56	0.000
Gender Overall p<0.01 (p=0.002)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.72	0.59	0.89	0.002
Education p<0.001 (p=0.000)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	1.34	0.99	1.82	0.062
	Some university	1.62	1.14	2.29	0.007
	Graduate	**2.28**	**1.44**	**3.60**	**0.000**
	Post graduate	1.82	0.52	6.31	0.347
	No education	0.35	0.27	0.45	0.000
Occupation Overall p>0.05 (p=0.771)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	1.06	0.60	1.89	0.839
	Design	1.59	0.65	3.89	0.306
	Engineering	0.97	0.61	1.53	0.885
	Healthcare	0.98	0.48	2.00	0.963
	Law	5.15	0.65	40.75	0.120
	Sales	0.93	0.50	1.71	0.807
	Others	1.08	0.75	1.56	0.678
Site Overall p<0.01 (p=0.001)	***Suzhou (Ref.)***	***1.00***	**-**	**-**	**-**
	Hefei	**1.32**	**1.01**	**1.71**	**0.040**
	Xiamen	1.62	1.25	2.08	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Question 3: Do you think climate patterns changed in last 20 years? (ALL MODELS)

Age, gender, education and occupation independent variables had no impact on the model (p=0.397, p=0.412, p=0.307, p=0.304, respectively). Examining the relationship between sites indicated that people from Hefei were 1.94 times more likely to think that climate patterns changed in the last 20 years than participants of Suzhou (95% CI 1.23-3.05) (Table 6.7).

Table 6.7: Regressions on 'Do you think climate patterns changed in last 20 years?' (ALL MODELS).

Do you think climate patterns changed in last 20 years?					
ALL MODELS		*OR. **	*95% C.I.***		*p value**** *
			lower	*upper*	
Age Overall p>0.05 (p=0.397)	***≤ 59 (Ref.) **** ***	***1.00***	-	-	-
	60-64	0.97	0.61	1.56	0.910
	65-69	1.03	0.65	1.65	0.889
	70-74	0.82	0.52	1.28	0.381
	75+	0.68	0.41	1.13	0.139
Gender Overall p>0.05 (p=0.412)	***Male (Ref.)***	***1.00***	-	-	-
	Female	0.88	0.66	1.19	0.412
Education Overall p>0.05 (p=0.307)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	0.99	0.68	1.44	0.952
	Some university	**1.74**	**1.05**	**2.90**	**0.033**
	Graduate	1.28	0.77	2.14	0.348
	Post graduate	0.75	0.21	2.69	0.664
	No education	1.18	0.75	1.85	0.473
Occupation Overall p>0.05 (p=0.304)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	0.83	0.35	1.97	0.669
	Design	1.13	0.30	4.21	0.860
	Engineering	0.61	0.31	1.21	0.158
	Healthcare	1.46	0.39	5.42	0.570
	Law	1.27	0.15	10.56	0.827
	Sales	0.52	0.23	1.17	0.113
	Others	0.56	0.31	1.03	0.060
Site Overall p<0.05 (p=0.017)	***Suzhou (Ref.)***	***1.00***	-	-	-
	Hefei	**1.94**	**1.23**	**3.05**	**0.004**
	Xiamen	1.12	0.81	1.55	0.503

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

6.4.2 Attitude

Question 5: Do you think climate change threatens your health?

The age of the participants was significantly associated with participants' thought on climate change threatens their health (p=0.045). Gender had no significant association with the dependent variable (p=0.885). Overall education and occupation had a significant association with the dependent variable (p=0.000, and p=0.000, respectively). People with some university education were more likely to think that climate change will harm their health than people with less than high school degree (OR 1.68; 95% CI 1.15-2.47). Participants who worked in healthcare sector were 1.87 times more likely to think that climate change will affect their health than the participants who worked in business sector (95% CI 0.67-5.19). A test between sites revealed that there is no significant difference between cities when asked about whether climate change impacts participants' health (Table 6.8).

Table 6.8: Regression model on 'Do you think climate change threatens your health?' analyzed with age, gender, education and occupation (ALL MODELS).

Do you think climate change threatens your health?					
ALL MODELS		*OR. **	*95% C.I. ***		*p value****
			lower	*upper*	
Age Overall p<0.05 (p=0.045)	***≤ 59 (Ref.) ****	***1.00***	-	-	-
	60-64	0.62	0.43	0.90	0.011
	65-69	0.72	0.50	1.05	0.085
	70-74	0.58	0.40	0.84	0.003
	75+	0.66	0.43	0.99	0.045
Gender Overall p>0.05 (p=0.885)	***Male (Ref.)***	***1.00***	-	-	-
	Female	1.02	0.81	1.27	0.885
Education Overall p<0.001 (p=0.000)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	0.87	0.65	1.18	0.381
	Some university	**1.68**	**1.15**	**2.47**	**0.007**
	Graduate	0.57	0.40	0.81	0.002
	Post graduate	0.88	0.31	2.50	0.807
	No education	1.08	0.77	1.52	0.659
Occupation Overall p<0.001 (p=0.000)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	1.16	0.58	2.35	0.670
	Design	0.86	0.34	2.16	0.745
	Engineering	0.42	0.25	0.69	0.001
	Healthcare	1.87	0.67	5.19	0.232
	Law	0.47	0.15	1.42	0.181
	Sales	0.83	0.42	1.66	0.599
	Others	0.49	0.31	0.77	0.002
Site Overall p>0.05 (p=0.416)	***Suzhou (Ref.)***	***1.00***	-	-	-
	Hefei	1.23	0.90	1.68	0.186
	Xiamen	1.04	0.81	1.35	0.750

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Question 8: Do you think your government is doing enough to protect or warn you from the health impacts of climate change? (ALL MODELS)

When asked the question ‘Do you think your government is doing enough to protect or warn you from the health impacts of climate change?’ age, gender, education and occupation variables were not associated with the model (p=0.079, p=0.314, p=0.099, p=0.277, respectively) (Table 6.9).

Table 6.9: Regressions on government assistance analyzed with age, gender, education and occupation (ALL MODELS).

Do you think your government is doing enough to protect or warn you from the health impacts of climate change?					
ALL MODELS		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.079)	***≤ 59 (Ref.) ****	***1.00***	-	-	-
	60-64	0.82	0.60	1.11	0.193
	65-69	0.80	0.59	1.08	0.148
	70-74	0.81	0.60	1.09	0.162
	75+	0.60	0.42	0.85	0.004
Gender Overall p>0.05 (p=0.314)	***Male (Ref.)***	***1.00***	-	-	-
	Female	0.90	0.74	1.10	0.314
Education Overall p>0.05 (p=0.099)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	1.00	0.77	1.30	0.993
	Some university	1.18	0.88	1.58	0.264
	Graduate	0.95	0.68	1.33	0.758
	Post graduate	1.78	0.60	5.26	0.299
	No education	**1.50**	**1.10**	**2.03**	**0.009**
Occupation Overall p>0.05 (p=0.277)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	1.35	0.81	2.24	0.251
	Design	0.57	0.29	1.14	0.111
	Engineering	0.78	0.52	1.17	0.230
	Healthcare	1.04	0.56	1.93	0.906
	Law	0.72	0.27	1.95	0.520
	Sales	0.83	0.49	1.39	0.483
	Others	0.85	0.61	1.19	0.350
Site Overall p<0.001 (p=0.000)	***Suzhou (Ref.)***	***1.00***	-	-	-
	Hefei	0.33	0.25	0.43	0.000
	Xiamen	0.35	0.28	0.44	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

6.4.3 Practices

Question 7: For each of the below impacts what would you do to manage your health?

For each climate change health impact, multiple options were given for the elderly participants to select. For practices during heat stroke or exhaustion, participants were given the options of drinking more water, staying in the shade, staying indoors and using air conditioners. For practices in order to prevent any case of respiratory discomfort, participants were given the options of using masks, using air purifiers and avoiding exposure with pollutants. In order to prevent any infectious disease participants were offered to choose the options of getting vaccinated, staying at home if they have signs of infection, disinfecting the hot zones in their residence for example if they are living close by channels or lakes. Whereas for injuries, participants were given the options avoiding going out in stormy weather, avoiding staying under the sun, readying a first aid kit and using sun protection if working outside.

Heat Stroke or Exhaustion

Age, education and occupation factors were significantly associated with the dependent variable when participants were given the option 'drink more water' (p=0.000, p=0.000, p=0.002, respectively). When given the option 'stay in the shade', only the occupation independent variable was associated (p=0.007) (Table 6.10).

When given the option 'stay indoors' all independent indicators showed association with the dependent variable (age p=0.039, gender p=0.023, education p=0.000 and occupation p=0.002, respectively). Given the option 'use air conditioner' age, and education variables were associated with the model (age p=0.003, gender p=0.647, education p=0.000, respectively) (Table 6.11).

Table 6.10: Regressions on practices of elderly during extreme weather events in case of heat stroke or exhaustion with practices; drinking more water, staying in shade (ALL MODELS).

PRACTICES OF ELDERLY									
HEAT STROKE OR EXHAUSTION									
ALL MODELS		DRINK MORE WATER *Overall p-values for Age p=0.000, Gender p=0.969, Education p=0.000, Occupation p=0.000, Site p=0.001*				STAY IN THE SHADE *Overall p-values for Age p=0.128, Gender p=0.652, Education p=0.086, Occupation p=0.007, Site p=0.000*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.78	0.59	1.03	0.078	1.06	0.81	1.39	0.681
	65-69	0.68	0.52	0.89	0.006	1.00	0.77	1.30	0.993
	70-74	0.73	0.55	0.96	0.023	1.14	0.87	1.50	0.330
	75+	0.50	0.36	0.68	0.000	0.78	0.58	1.07	0.123
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.00	0.84	1.18	0.969	0.96	0.81	1.14	0.652
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.97	0.76	1.24	0.805	0.75	0.59	0.96	0.024
	Some university	1.11	0.85	1.44	0.452	1.10	0.85	1.42	0.479
	Graduate	1.35	0.98	1.87	0.063	0.98	0.72	1.34	0.919
	Post graduate	1.02	0.43	2.44	0.961	1.06	0.46	2.43	0.894
	No education	0.64	0.51	0.82	0.000	0.82	0.65	1.05	0.114
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	1.74	1.08	2.81	0.024	0.84	0.54	1.30	0.430
	Design	1.37	0.73	2.58	0.332	0.97	0.53	1.78	0.919
	Engineering	0.92	0.64	1.32	0.640	0.65	0.46	0.94	0.020
	Healthcare	1.72	0.96	3.08	0.070	0.81	0.47	1.39	0.445
	Law	1.99	0.74	5.35	0.170	1.62	0.65	4.04	0.299
	Sales	0.86	0.53	1.38	0.523	0.49	0.30	0.81	0.005
	Others	0.83	0.61	1.11	0.212	0.63	0.47	0.84	0.002
Site	***Suzhou (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Hefei	0.70	0.56	0.88	0.002	1.00	0.80	1.24	0.984
	Xiamen	0.72	0.59	0.89	0.002	0.68	0.56	0.83	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Table 6.11: Regressions on practices of elderly during extreme weather events in case of heat stroke or exhaustion with practices; staying indoors and using air conditioner (ALL MODELS) (Cont'd).

PRACTICES OF ELDERLY									
HEAT STROKE OR EXHAUSTION									
ALL MODELS		STAY INDOORS *Overall p-values for Age p=0.039, Gender p=0.023, Education p=0.000, Occupation p=0.002, Site p=0.001*				USE AIR CONDITIONER *Overall p-values for Age p=0.003, Gender p=0.647, Education p=0.000, Occupation p=0.057, Site p=0.000*			
		*OR. **	*95% C.I.** lower*	*upper*	*p value*****	*OR.*	*95% C.I. lower*	*upper*	*p value*
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.78	0.59	1.02	0.074	0.78	0.58	1.05	0.095
	65-69	0.73	0.56	0.95	0.022	0.62	0.46	0.83	0.001
	70-74	0.81	0.62	1.07	0.138	0.58	0.43	0.79	0.000
	75+	0.62	0.45	0.85	0.003	0.67	0.47	0.93	0.019
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.22	1.03	1.45	0.023	1.05	0.86	1.27	0.647
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.75	0.59	0.96	0.023	0.69	0.52	0.91	0.008
	Some university	1.33	1.03	1.73	0.029	0.98	0.73	1.30	0.882
	Graduate	1.17	0.86	1.60	0.309	1.48	1.07	2.05	0.017
	Post graduate	0.69	0.29	1.63	0.397	0.65	0.25	1.70	0.378
	No education	0.69	0.54	0.88	0.003	0.46	0.34	0.62	0.000
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	1.01	0.65	1.57	0.962	2.24	1.39	3.63	0.001
	Design	0.85	0.46	1.56	0.595	1.12	0.52	2.44	0.770
	Engineering	0.59	0.41	0.85	0.004	1.62	1.07	2.45	0.024
	Healthcare	0.73	0.43	1.25	0.255	1.35	0.72	2.53	0.349
	Law	0.93	0.38	2.26	0.877	2.53	0.98	6.51	0.054
	Sales	0.54	0.33	0.88	0.014	1.43	0.82	2.50	0.204
	Others	0.58	0.43	0.78	0.000	1.52	1.07	2.16	0.019
Site	***Suzhou (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Hefei	0.94	0.75	1.18	0.591	0.70	0.54	0.91	0.007
	Xiamen	0.67	0.55	0.83	0.000	0.58	0.46	0.73	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Respiratory Problems

Age, education and occupation variables were associated when given the option ‘use masks’ in order to prevent any respiratory problems (p=0.000, p=0.000, p=0.000, respectively). People aged between 70-74 years old were more likely to use masks to prevent respiratory problems that may be exacerbated by climate change (OR 1.75; 95% CI 1.29-2.39). Participants with some university education and people from law sector were more likely to use masks (OR 1.77; 95% CI 1.34-2.33, OR 0.90; 95% CI 0.36-2.24, respectively). When given the option ‘using air purifiers’ age, education and occupation independent variables were again associated with this kind of practice (p=0.001, p=0.000, p=0.000, respectively). When given the option ‘avoiding exposure with pollutants’, age education and occupation of the participants were associated with this practice (p=0.002, p=0.000, P=0.040, respectively). Hefei respondents were more likely to perform these practices than Suzhou respondents (OR 1.20; 95% CI 0.96-1.52) (Table 6.12).

Table 6.12: Regressions on practices of elderly during extreme weather events in case of respiratory problems with practices; using masks, using air purifiers, avoiding exposure with pollutants (ALL MODELS).

ALL MODELS		USE MASKS ***Overall p-values for Age p=0.000, Gender p=0.392, Education p=0.000, Occupation p=0.000, Site p=0.000***				USE AIR PURIFIERS ***Overall p-values for Age p=0.001, Gender p=0.800, Education p=0.000, Occupation p=0.000, Site p=0.000***				AVOID EXPOSURE WITH POLLUTANTS ***Overall p-values for Age p=0.002, Gender p=0.370, Education p=0.000, Occupation p=0.040, Site p=0.001***			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.)****	**1.00**	-	-	-	**1.00**	-	-	-	**1.00**	-	-	-
	60-64	1.41	1.02	1.93	0.036	0.79	0.59	1.07	0.135	0.58	0.43	0.79	0.000
	65-69	1.50	1.10	2.04	0.010	0.85	0.64	1.14	0.288	0.63	0.47	0.84	0.001
	70-74	1.75	1.29	2.39	0.000	1.02	0.76	1.37	0.899	0.70	0.52	0.93	0.014
	75+	0.92	0.64	1.32	0.650	0.52	0.36	0.73	0.000	0.57	0.41	0.79	0.001
Gender	***Male (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-	**1.00**	-	-	-
	Female	1.09	0.90	1.31	0.392	1.02	0.85	1.24	0.800	1.09	0.90	1.31	0.370
Education	***Less than high school (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-	**1.00**	-	-	-
	High school	0.65	0.48	0.87	0.003	0.57	0.43	0.77	0.000	0.78	0.60	1.02	0.074
	Some university	1.77	1.34	2.33	0.000	1.59	1.21	2.10	0.001	1.41	1.07	1.84	0.014
	Graduate	0.83	0.58	1.19	0.316	1.22	0.87	1.71	0.258	0.91	0.65	1.28	0.580
	Post graduate	1.37	0.57	3.28	0.477	0.92	0.37	2.27	0.855	0.50	0.19	1.30	0.156
	No education	1.26	0.97	1.63	0.086	1.29	1.00	1.68	0.054	0.69	0.52	0.90	0.006
Occupation	***Business (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-	**1.00**	-	-	-
	Finance	0.35	0.22	0.57	0.000	0.89	0.56	1.39	0.597	0.92	0.58	1.44	0.702
	Design	0.62	0.33	1.18	0.145	0.95	0.51	1.79	0.881	1.03	0.54	1.98	0.918
	Engineering	0.36	0.24	0.54	0.000	0.33	0.22	0.49	0.000	0.65	0.44	0.96	0.029
	Healthcare	0.46	0.25	0.84	0.012	0.59	0.33	1.06	0.077	0.81	0.45	1.46	0.487
	Law	0.90	0.36	2.24	0.825	1.28	0.51	3.21	0.596	1.86	0.73	4.69	0.191
	Sales	0.33	0.18	0.58	0.000	0.36	0.20	0.63	0.000	0.52	0.30	0.91	0.023
	Others	0.35	0.26	0.48	0.000	0.39	0.29	0.53	0.000	0.70	0.52	0.95	0.023
Site	***Suzhou (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-	**1.00**	-	-	-
	Hefei	1.20	0.96	1.52	0.114	1.12	0.89	1.41	0.332	0.95	0.75	1.19	0.650
	Xiamen	0.39	0.30	0.49	0.000	0.37	0.29	0.47	0.000	0.32	0.25	0.41	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Infectious Diseases

When given the option ‘get vaccinated’, ‘stay at home’ and ‘disinfect the hot zones in your residence’; age, education and occupation of the participants were associated with the model ($p=0.001$, $p=0.000$, $p=0.000$, respectively). When participants were given the option ‘wash your hands often’ only the age and occupation factors were associated ($p=0.000$, $p=0.046$, respectively). For all options given, Xiamen participants were less likely to perform these practices than Suzhou participants (See Table 6.13-14).

Table 6.13: Regressions on practices of elderly during extreme weather events in case of infectious diseases with practices; getting vaccinated and staying at home in signs of infection (ALL MODELS).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
ALL MODELS		**GET VACCINATED** *Overall p-values for Age p=0.001, Gender p=0.954, Education p=0.000, Occupation p=0.000, Site p=0.000*				**STAY AT HOME IF YOU HAVE SIGNS OF INFECTION** *Overall p-values for Age p=0.001, Gender p=0.330, Education p=0.000, Occupation p=0.000, Site p=0.000*			
		OR. *	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.)****	**1.00**	-	-	-	**1.00**	-	-	-
	60-64	0.74	0.54	1.01	0.058	1.16	0.84	1.61	0.369
	65-69	0.83	0.62	1.13	0.236	1.27	0.93	1.74	0.135
	70-74	1.05	0.78	1.43	0.733	1.41	1.03	1.93	0.034
	75+	0.55	0.38	0.79	0.001	0.69	0.47	1.01	0.058
Gender	***Male (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	Female	1.01	0.83	1.22	0.954	1.10	0.90	1.35	0.330
Education	***Less than high school (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	High school	0.60	0.45	0.82	0.001	0.49	0.36	0.67	0.000
	Some university	1.92	1.45	2.54	0.000	1.57	1.18	2.09	0.002
	Graduate	0.98	0.69	1.40	0.919	1.55	1.10	2.19	0.013
	Post graduate	0.81	0.32	2.06	0.661	1.17	0.48	2.87	0.730
	No education	1.14	0.86	1.51	0.359	1.01	0.77	1.34	0.927
Occupation	***Business (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	Finance	0.83	0.53	1.32	0.440	0.38	0.23	0.63	0.000
	Design	0.83	0.44	1.59	0.574	1.31	0.69	2.48	0.416
	Engineering	0.43	0.29	0.64	0.000	0.47	0.32	0.71	0.000
	Healthcare	0.76	0.42	1.36	0.348	0.64	0.35	1.17	0.146
	Law	1.89	0.74	4.84	0.181	1.42	0.57	3.55	0.449
	Sales	0.29	0.16	0.54	0.000	0.33	0.17	0.62	0.001
	Others	0.38	0.28	0.52	0.000	0.40	0.29	0.54	0.000
Site	***Suzhou (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	Hefei	0.79	0.62	1.01	0.066	0.74	0.58	0.94	0.014
	Xiamen	0.33	0.25	0.42	0.000	0.25	0.19	0.33	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significa

Table 6.14: Regressions on practices of elderly during extreme weather events in case of infectious diseases with practices; disinfecting hot zones in the residence, and washing hands often (ALL MODELS) (Cont'd).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
ALL MODELS		**DISINFECT THE HOT ZONES IN YOUR RESIDENCE**				**WASH YOUR HANDS OFTEN**			
		Overall p-values for Age p=0.001, Gender p=0.690, Education p=0.000, Occupation p=0.000, Site p=0.000				*Overall p-values for Age p=0.000, Gender p=0.892, Education p=0.081, Occupation p=0.046, Site p=0.000*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*Upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) **** **	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.69	0.50	0.95	0.023	0.44	0.32	0.60	0.000
	65-69	0.81	0.60	1.10	0.177	0.42	0.31	0.57	0.000
	70-74	0.83	0.61	1.13	0.242	0.34	0.25	0.46	0.000
	75+	0.47	0.32	0.68	0.000	0.30	0.21	0.44	0.000
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.04	0.85	1.27	0.690	0.99	0.80	1.21	0.892
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.65	0.48	0.88	0.005	0.79	0.59	1.07	0.124
	Some university	1.62	1.22	2.17	0.001	1.16	0.86	1.56	0.340
	Graduate	1.13	0.79	1.62	0.513	0.88	0.60	1.28	0.490
	Post graduate	0.88	0.35	2.23	0.786	0.63	0.23	1.71	0.363
	No education	1.11	0.83	1.47	0.486	0.73	0.53	0.99	0.045
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.67	0.42	1.07	0.096	1.09	0.67	1.77	0.722
	Design	1.35	0.71	2.60	0.362	1.08	0.51	2.28	0.851
	Engineering	0.50	0.33	0.75	0.001	0.81	0.53	1.23	0.321
	Healthcare	0.96	0.53	1.74	0.883	1.01	0.53	1.91	0.983
	Law	1.78	0.70	4.54	0.224	1.97	0.75	5.20	0.170
	Sales	0.42	0.23	0.77	0.005	0.96	0.54	1.70	0.878
	Others	0.43	0.32	0.59	0.000	0.68	0.49	0.94	0.021
Site	***Suzhou (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Hefei	0.66	0.52	0.85	0.001	0.60	0.47	0.78	0.000
	Xiamen	0.21	0.16	0.28	0.000	0.20	0.15	0.26	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Injuries

Age, education and occupation was associated with the all-sites model for all the practices regarding injuries. Participants residing in Xiamen were less likely to 'avoid going out in stormy weather', 'avoid staying under the sun', 'readying a first aid kit for injuries' and 'using sun protection if working outside' (See Table 6.15-16).

Table 6.15: Regressions on practices of elderly in events of injuries with practices; avoiding going out in stormy weather and avoiding staying under the sun (ALL MODELS).

		PRACTICES OF ELDERLY							
		INJURIES							
ALL MODELS		**AVOID GOING OUT IN STORMY WEATHER** *Overall p-values for Age p=0.001, Gender p=0.980, Education p=0.000, Occupation p=0.000, Site p=0.000*				**AVOID STAYING UNDER THE SUN** *Overall p-values for Age p=0.001, Gender p=0.076, Education p=0.000, Occupation p=0.000, Site p=0.000*			
		**OR.*	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.68	0.51	0.92	0.012	0.66	0.49	0.89	0.007
	65-69	0.71	0.54	0.95	0.021	0.72	0.54	0.96	0.024
	70-74	0.79	0.59	1.06	0.115	0.81	0.61	1.09	0.170
	75+	0.48	0.34	0.68	0.000	0.49	0.35	0.70	0.000
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.00	0.83	1.21	0.980	1.19	0.98	1.44	0.076
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.96	0.73	1.25	0.746	0.94	0.72	1.23	0.660
	Some university	1.57	1.19	2.08	0.001	1.53	1.15	2.03	0.003
	Graduate	1.54	1.11	2.14	0.009	2.14	1.53	2.98	0.000
	Post graduate	1.23	0.51	2.97	0.645	1.19	0.49	2.90	0.699
	No education	0.80	0.60	1.06	0.114	0.84	0.64	1.12	0.236
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.82	0.52	1.30	0.401	0.88	0.55	1.41	0.600
	Design	1.10	0.58	2.10	0.764	1.33	0.69	2.56	0.387
	Engineering	0.81	0.56	1.19	0.286	0.75	0.51	1.10	0.137
	Healthcare	0.86	0.48	1.52	0.594	1.07	0.60	1.92	0.808
	Law	1.75	0.70	4.38	0.234	1.37	0.54	3.45	0.509
	Sales	0.59	0.35	1.01	0.053	0.67	0.39	1.15	0.151
	Others	0.52	0.38	0.71	0.000	0.54	0.39	0.73	0.000
Site	***Suzhou (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Hefei	0.33	0.25	0.42	0.000	0.37	0.29	0.47	0.000
	Xiamen	0.23	0.18	0.29	0.000	0.18	0.14	0.24	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Table 6.16: Regressions on practices of elderly in events of injuries with practices; readying a first aid kit for injuries and using sun protection while working outside (Cont'd).

PRACTICES OF ELDERLY									
INJURIES									
ALL MODELS		READY A FIRST AID KIT FOR INJURIES *Overall p-values for Age p=0.000, Gender p=0.436, Education p=0.000, Occupation p=0.000, Site p=0.000*				USE SUN PROTECTION IF WORKING OUTSIDE *Overall p-values for Age p=0.000, Gender p=0.662, Education p=0.044, Occupation p=0.000, Site p=0.000*			
		*OR. **	*95% C.I.***		*p value*** **	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.70	0.50	0.98	0.037	0.53	0.37	0.76	0.000
	65-69	0.68	0.49	0.94	0.019	0.45	0.32	0.64	0.000
	70-74	0.90	0.65	1.24	0.508	0.55	0.39	0.78	0.001
	75+	0.40	0.26	0.60	0.000	0.30	0.20	0.47	0.000
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	0.92	0.74	1.14	0.436	0.95	0.75	1.20	0.662
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.46	0.33	0.65	0.000	0.58	0.41	0.82	0.002
	Some university	1.52	1.13	2.06	0.006	0.94	0.67	1.32	0.723
	Graduate	0.84	0.56	1.24	0.371	0.81	0.53	1.24	0.327
	Post graduate	0.59	0.21	1.69	0.328	1.11	0.42	2.92	0.837
	No education	1.11	0.81	1.51	0.519	0.77	0.55	1.08	0.134
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.78	0.48	1.27	0.322	0.73	0.43	1.24	0.248
	Design	1.26	0.64	2.48	0.507	1.68	0.75	3.78	0.208
	Engineering	0.42	0.27	0.64	0.000	0.48	0.30	0.79	0.004
	Healthcare	0.71	0.37	1.36	0.299	1.35	0.67	2.71	0.405
	Law	1.80	0.70	4.59	0.222	2.19	0.78	6.17	0.138
	Sales	0.40	0.21	0.76	0.006	0.66	0.33	1.32	0.241
	Others	0.35	0.26	0.49	0.000	0.52	0.37	0.74	0.000
Site	***Suzhou (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Hefei	0.56	0.42	0.73	0.000	0.51	0.39	0.68	0.000
	Xiamen	0.19	0.14	0.26	0.000	0.06	0.03	0.09	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

6.4.4 Summary of Regression Modelling for All Models

Age

The association between age dependent categorical variable and independent variables indicated that 'age' overall is a significant predictor of the model ($p<0.01$). Generally, the older the participants the less the likelihood of an association being observed. In the case of independent variables *'Do you think your government is doing enough to protect or warn you from the health impacts of climate change?' and 'Do you think climate patterns changed in last 20 years?' the* age dependent variable was not associated with the model ($p=0.079$, $p=0.397$, respectively). There is a negative, and a highly significant relationship between knowledge on climate change and age. The older the participants, the less likely they are to know about climate change and other variables such as defining climate change with weather impacts; flooding, drought, heatwaves, and wildfires also showed the same pattern during regression analysis.

Gender

Table 6.6 indicates that gender was associated with knowledge ($p=0.002$). However, gender was not associated with the independent variable '*Do you think climate patterns changed in last 20 years?*' ($p=0.412$). In most of the models, gender was not a strong predictor of the model ($p>0.05$).

Education

The education level of the participants was a strong predictor for KAP. When participants were asked about their knowledge on climate change, university graduates were more likely to know about climate change than people with less than high school degree. Thus, complexity of the questions asked had a positive relationship with degree of education. Respondents who held higher degrees were likely to have greatest knowledge in climate change. In most of the models presented above, education was highly associated with dependent variables. Yet despite increased acceptance of the health threat of climate change, participants with higher level of education were significantly less likely to think that climate change threatens their health.

Occupation

The occupation of the respondent was significantly associated with the question *'Do you think climate change threatens your health?*'. People who worked in healthcare sector were leading predictors of the model.

Residential Location

The residential location of participants provided important insight on the role of residency and KAP. For the question *'Have you heard of climate change?'* respondents of Xiamen were more likely to know about climate change than Suzhou. When asked about how participants would define climate change, while Xiamen participants were more likely to define climate change with storms and floods, Hefei participants were more likely to define climate change with drought and heatwave events. This was supported by the question *'Which climate patterns you noticed changes in last 20 years?'* when Xiamen participants described the changes as 'more storms and more floods' and Hefei participants described the changes in climate patterns in last 20 years as 'more heat', 'more droughts' and 'more cold'.

6.5 Discussion

Chapter 6 focused on elderly knowledge, attitudes, and practices, and the associations between their age, education, gender and occupation. When knowledge of the participants is the concern, the elderly has heard about climate change, yet most only have a basic understanding of what it is. The elderly understand that it is associated with changes in 'weather patterns', air temperatures and other changes in the environment such as colder or hotter weather. However, they are not able to express comprehensively that climate change is a change in climate resulting from excess carbon dioxide levels resulting from greenhouse gas effect, simply because these are very technical terms and elderly do not have all the means to reach the scientific information actually learn the scientific explanation of climate change. Climate change is not a part of elderly's everyday language (Lickiss and Cumiskey, 2019, Lackner et al., 2019). Still elderly stated that they observed changes in their communities that are noticeable and are impacting the environment. In most cases even though they do not possess comprehensive knowledge on climate change they are able to identify some of these changes as impacts of climate change. It is important to note that knowledge gaps identified in the study must be addressed in order to ensure elderly and vulnerable communities have comprehensive knowledge of climate change.

A recent study done in Thailand found association between participants' knowledge about climate change and the level of education ($p<0.01$). Their attitudes towards climate change were associated with residence status (urban/rural) and internet use ($p<0.05$); climate change related practices were associated with educational level (Rahman et al., 2021).

Without adequate education and awareness among elderly there will continue to be a disconnect between what is occurring in their communities. It is critically important for individuals to have more knowledge on climate change so that they can better understand the role they can play in preventing or lessening its impact (Bi et al., 2020, Knutti, 2019, Lackner et al., 2019). Some important areas to cover include; what is climate change, how it is caused, how it is affecting/can affect the elderly in China in near future.

The elderly is willing to take actions to prevent or lessen the impact of climate change by performing changes in daily life such as drinking more water in extreme heat events, or staying indoors. Elderly also reported on insufficient government help in this study. It is therefore important that government, community organizations and community leaders make more visible the current actions (more facilities for elderly to gather) that are being implemented to prevent or lessen the impact of climate change (more facilities for elderly to gather) (Sumi et al., 2010, Bicknell et al., 2009, Zahran et al., 2008).

This thesis focuses on older people and older people are also disproportionately at risk from climate change. There is a difference between the vulnerability of those in different ages (age definitions in terms of years of age may vary for different countries), but there are still potentially far-reaching health implications for all elderly people (Lackner et al., 2019, Filiberto et al., 2009). Physical weakness and declining income levels mean that the elderly is more affected by extreme weather (hot and cold) and they also face higher mortality risks in extreme weather events. Reduced mobility, changes in physiology and more limited access to resources undermine the adaptive capacity of the elderly. Some groups of people are inherently more vulnerable to climate change than others. The very old or very young, the sick, and the physically or mentally challenged are vulnerable.

According to the literature, limited as it is, elderly people are insufficiently involved in adaptation and mitigation planning and initiatives (Kokoye et al., 2019). Thus, adaptation efforts should seek to build the adaptive capacity of older people, taking greater account of their specific susceptibilities and capabilities (Kumar, 2019). Older people are more vulnerable to extreme weather (both hot and cold), which is projected to increase. Older people will be more affected than youth, because of their greater physical weakness and the associated decline in incomes that can be common in old age (Erdreich, 2009). The elderly will be disproportionately affected by climate change, because they face higher mortality risks in extreme weather events, and are more vulnerable to the effects of temperature extremes.

When gender is the concern, studies are numerous around the globe (Otsuka and Fan, 2021, Dalby et al., 2019, Kirton and Larionova, 2018, Fuchs, 2018). Women express slightly greater concern about climate change than do men, and this gender divide is not accounted for by differences in key values and beliefs or in the social roles that men and women differentially perform in society (Alston, 2014). Women, who typically spend more time and effort on care-giving to parents, children, and the sick than men do, are more vulnerable because that care-giving exposes them more to the impacts of climate change (Chidakwa et al., 2020). Research has found that women have a higher risk perception than men, and thus also recognize climate change as a more serious problem than men do (Alston, 2014). It has only been recognized fairly recently that women will be disproportionately affected by climate change compared to men, because of widespread entrenched gender inequalities (McCright, 2010).

When location is the concern the risk and adaptation strategies to climate change may also vary. Although location concerns will be discussed in detail in Chapter 7, the increasing severity of tropical storms may pose risks for older adults living in coastal areas because of intensity of storms or the risk of sea-level rise. In this thesis, Xiamen was one of the study sites and the elderly who lived in Xiamen area reported they were more likely to define climate change with storms and floods which supports the risk they have more often been exposed (Ebikeme et al., 2019, Lin et al., 2018). Elderly in Hefei reported more on droughts and air pollution and elderly in Suzhou was more concerned about river flooding resulted from environmental surroundings (channels).

A study noted on the main industrial sectors in hot countries that are directly affected by increasing average heat are agriculture, fisheries, forestry, and construction work with indirect effects in the tourism, health, and finance/insurance sectors (Nilsson and Kjellstrom, 2010). Participants of Chapter 6 study being the elderly, although most of the participants were already retired, thesis results revealed that people in health sector know more about climate change and its health impacts. More detailed discussion will be presented for the whole thesis in Chapter 7 in light with research questions.

6.6 Conclusion

Climate change and KAP practices are widely studied; however, studies examining the links between KAP and sociodemographic factors are scarce (Plotnikoff et al., 2004, Shove, 2010, Saxena et al., 2018). This chapter presented an analysis of the sociodemographic factors associated with the knowledge, attitude and practice to climate change in the elderly in Eastern China. Specifically, this chapter examined the association between age, gender, education and the occupation of the elderly regarding their climate change knowledge, attitude and practices. The relationship between dependent and independent variables were not always found to be equal in each city, given the fact that age, gender, education and occupation variables being tested for each dependent variable. This should be affected by many factors considering the environment, exposure, and other factors considered when analyzing through climate change knowledge, attitude and practices.

This chapter found that age is a significant explanatory variable in most of the models, and the relationship was found as negative. Gender, education and occupation were rarely associated with most of the models. However, the Suzhou Model showed strong association with the education level and occupation of the participants. These points will be discussed in Chapter 7 in detail and links will be provided for recommendations and future research taking into consideration these results. Then a conclusion section will be introduced.

Chapter 7 DISCUSSION & CONCLUSION

7.1 Discussions

This thesis synthesized the findings on the KAP to climate change of the elderly from three cities in Eastern China. That said, it urges appropriate caution in interpreting our findings due to limitations in the methods. While each of the surveys used was methodologically sound, synthesizing their findings to answer a set of overarching research questions is inherently limited by differences in measures, research questions and local context. We have presented a range of detailed results, but will limit our discussion to the big picture findings that emerge from the data also due to limited literature. It is appropriate here to discuss the results in the line of research questions.

RQ1: What is the belief of the elderly regarding climate change health risks? How does this differ between cities?

To date not much research has focused on the impact of climate change on the elderly in China (Zeng et al., 2010), with the studies that have been undertaken have focused on temperature changes or broader environmental changes and effects on public health in general (Guo et al., 2012, Guo et al., 2013). For example, studies focusing on heatwaves and their impacts using mortality values did not attribute these impacts to climate change (Cheng et al., 2018, Wang et al., 2019, Yang et al., 2019). A comparative study of environmental knowledge, attitudes and behaviors among university students in China found that students possessed low levels of environmental knowledge (He et al., 2011). Whereas Xiao conducted a study on nurse's knowledge and attitude regarding potential health impacts of climate change on public health found that 76% of nurses were aware that climate change would impact public health (Xiao et al., 2016). Although increasing attention has been devoted to effective climate change communication little of this has focused specifically on older audiences (Huntington, 2007). Given the increased vulnerability of the elderly to climate change (Füssel, 2007), communicating clearly and effectively with the elderly population about climate change is very important. Climate change communication, designed for and directed to older people, should be tailored not only to the existing knowledge of the elderly, but also to their concerns and values (Nisbet, 2009) as indicated in Chapter 4.

This research found significant conflict and misunderstanding between the terms 'climate change' and 'weather change' amongst the elderly. In order to address climate change impacts to the elderly, simple, consistent words need to be used to carry the information. With regard to their source of knowledge on climate change knowledge, this study found that respondents reported that television was their main source of information on climate change (Chapter 5). A recent study showed that the Chinese respondents use TV as their most important information seeking channel, consider the science institutes as the most trusted information source, and have low attention to the environmental related news content (Li, 2015). Thus, the media should focus also on how to better communicate environmental concerns with the elderly population.

The communication tools developed and presented in Chapter 4 helped the elderly to understand the core of the project and the questionnaire was very helpful to carry out more information on health impacts and weather impacts of climate change. Some studies focused on climate change communication through apps, or web media. However web media may not the best way to engage with elderly populations (Chou et al., 2013) as they may not use web related tools as efficiently when compared to younger people. Another study was undertaken on the establishment of an environmentally oriented applications for mobile phones, focused on climate change, with the intention of raising the knowledge and altering the attitude and behavior towards this crucial environmental issue, based on internet support (Skanavis et al., 2019). The study found that the elderly participants were not capable of using these sorts of technological communication tools. In our study a video, an infographic and a text-graph tool were used to communicate climate change with the elderly respondents.

The regression analysis showed that when communicating climate change infographic and video tools could be effective, however text-graph tool was harder to be understood by the elderly (Chapter 4, Section 4.5). Thus, governmental organizations working in the area of health or environmental protection should create appealing communication tools with a simple message (pictures, videos, and infographics) to help the elderly population to be informed and be prepared about climate change impacts.

Offering practical steps for individuals and groups to have an impact on climate change are critical (Markus et al., 2018). In particular, widespread awareness and concern about the health effects of climate change provide an appropriate springboard on which to initiate public engagement about climate change (Levine and Kline, 2017). Effective climate change communication should adopt similar discourses to engage the public in terms with which they identify (Nerlich et al., 2010). Elderly awareness in this field must be inspected and nationwide communication methods should be adopted.

The majority of respondents of this study believed that climate change poses important risks to human health and well-being now or in decades to come. Over 50% of the elderly in three cities know about climate change, or at least heard about it and can relate with the terms explained by the interviewers. However, the most commonly perceived threats to health and well-being differed across the three cities. For example, the elderly in Hefei saw droughts and heatwaves as one of the most harmful climate change impacts (37%, 57% respectively). Whereas, the elderly in Xiamen reported on storms (40%) as one of the most threatening factors. While Suzhou participants were genuinely worried about heatwaves. These differences may be underpinned by different climatic conditions in each area and their geographical location. For example, although sea-level rise had not been included as an impact of climate change in this study, a number of elderly respondents in Xiamen reported the risk they perceive from living in a coastal area. Cultural differences, local and regional climate conditions, and personal experiences may also have played a role in these differences. Many regions of the Hefei have experienced drought conditions over the past decade which may influence perceptions (Yuan et al., 2015, Qu et al., 2020, Chandio et al., 2020). Xiamen is unique in this respect as it has the capacity to supply demand for potable water by desalinating sea water (Zhu et al., 2019).

To collect more information, standardized questions about health impacts should be developed so that future surveys can more meaningfully explore these perceptions within and between regions and nations, and particularly address potential differences between developed and developing countries.

It is important to note, however, that climate change may lack salience as a health issue in the three cities studied. When asked questions, many respondents gave answers consistent with beliefs in climate change as a threat to human health. Conversely, however some referred it as weather change which gives a clue about how the elderly think about climate change. When they were asked about the difference between the two terms, most elderly were confused and needed detailed information with examples.

The low level of information on climate change among the Chinese elderly evidenced by this study is not unexpected. Climate change receives relatively low attention in China amongst the public and when it does, the human health consequences are rarely mentioned (Boyce and Lewis, 2009, Tolan, 2007, Liu and Zhao, 2017). Rather, news representations and entertainment programming representations of climate change impacts tend to focus on attributes of the environment such as polar ice and glaciers, and non-human species such as polar bears and pine trees (Nisbet, 2009). Moreover, until relatively recently, public health officials have been largely much more hesitant to talk about climate change as a health risk in China and in the world (Han et al., 2012). Much of the recent public health communication activity about climate change appears to be targeted internally—from leaders in the public health community to members of the public health community at large—rather than aimed at the public. For instance, in Canada, a study shows that while 69% of the participants provide information related to health conditions that may be exacerbated by climate change, only 10% mention climate change specifically (Akerlof et al., 2010). The same appears to exist in China, and this study among elderly may prove the complications and lack of knowledge for health officials and future researchers. Finally communication of climate change issues must be credible, transparent and consistent with the wider policy framework (Evans et al., 2018).

RQ2: In what specific ways do the elderly think that climate change will harm their health?

This study found that there were no substantial differences among the three cities with regard to questions used to assess perceptions of elderly on how their health will be impacted by climate change. Suzhou participants thought that climate change impacts will manifest as heatstroke (50%), and in two other sites elderly also voted as heatstroke as the harming factor of climate change on their health. When specifically analysed, however, three city participants also reported on respiratory/breathing problems, and infectious diseases. Yet these findings indicate that the Chinese elderly accept the claim that climate change can harm human health in specific ways, even if they are not based on an accurate scientific understanding. Future educational efforts may need to focus on increasing knowledge of these specific risks and ensuring that the more elderly and the public is aware of climate change health hazards, symptoms and preventative measures (Hoogendoorn et al., 2020, Bi et al., 2020).

More respondents in Hefei and Suzhou cities reported that they see themselves and the people in their community as being vulnerable to at least moderate harm from climate change. However, in Xiamen, most elderly families were concerned about the risk to their grandchildren. When it comes to heath related impacts of climate change in China, participants reported they believed that they would experience more heat stress and this would impact their health (Chapter 6, Section 6.3.1). In China, heatwaves are considered a major impact of climate change especially in Eastern parts of China (Yang et al., 2019). A study (Li et al., 2016) on mortality also reported that ageing population could substantially enhance the burden of heat-related health risks in a warming climate because of their higher susceptibility to extreme heat health impacts. Research in China noted that asking the participants to relate the impact of climate change to their health, the majority reported heat stroke and 33% noted respiratory problem and this finding is similar with the findings in Chapter 5, Section 5.3.3 (Tong et al., 2016). Examining the help that governments give to the elderly during extreme weather, elderly responses varied. However, for example, in Suzhou city most participants thought that government was passive in taking actions (56% reported no assistance from government in Suzhou. For Hefei 33%, for Xiamen 24%). Government action is necessary when helping the elderly adapt climate change (Zhang et al., 2016).

A large literature in the field of health and risk communication points to an individual's sense of risk as the most powerful motivator of behavioural change (Whitmarsh, 2008, Filiberto et al., 2009). This theory suggests that the closer to home a threat is, the more likely individuals will be to recognize and take precautions towards it. This may be particularly relevant in encouraging public adoption of adaptation measures to avoid increased climate health risks. Literature in politics, political sciences finds that perceptions of national threats such as climate change are sufficient drivers of policymaking and policy support (Sears and Funk, 1991). Thus, climate change adaptation needs to focus on the importance of perceived personal consequences as opposed to the national or even regional health consequences of climate change.

Prompted by their commitment to the United Nations Framework Convention on Climate Change, public health officials globally have only begun in the last decade to focus on vulnerabilities of specific communities to climate change. However, there has been little communication of this assessment to the public.

RQ3: What are the adaptive measures taken by the elderly to prevent the health risks associated with climate change?

It is important to note that climate change is not solely a 'scientific' problem; it consists of social, political, cultural, and moral aspects as well (O'Brien and Wolf, 2010, Adger et al., 2017). The causes, impacts and solutions cannot be separated from human societies and economies, their values and lifestyles (Whitmarsh, 2005). Responses to risk and uncertainty, environmental values, and concerns about social equity are among the moral dimensions to be addressed in climate change policies (O'Brien, 2010). As such it is essential that climate change research investigate individual and community level factors that may increase the risks of adverse health outcomes of climate change as means to inform prevention measures. A number of studies have explored risk factors following major heatwaves and preventive measures that people would follow. For instance, in France, (Poumadere et al., 2005) found that during the 2003 heat wave living in a upper floor apartment and low ventilation rates were associated with higher mortality rates. A study undertaken in South Australia reported that people were more likely to drink more water and open the windows in extreme heat events (Nitschke et al., 2013).

In terms of practices, the elderly participants of my study also reported that to protect themselves from the health impacts of climate change during moments of heat stroke or exhaustion, the majority of the elderly reported that they would consume more water. Results from one study in China showed that the majority of the participants reported that they changed their behaviors in order to cope with extreme heat, with the most commonly adopted adaptive behaviors for rural older people involved wearing lightweight clothes (93%), reducing time outdoors (73%) and staying indoors (72%) (Zhang et al., 2016). For older urban residents, the most commonly adopted adaptive behaviors were staying indoors (84%), wearing light clothes

(79%), and reducing physical activities (58%) (Zhang et al., 2016). In my study responses of the elderly also showed that they would prefer to stay indoors in events of climate extremes (34%). Still, in China for elderly wellbeing, it is important to strengthen heatwave awareness and access to appropriate heat resilient shelters for older people (Gamble et al., 2016). Strengthening health services and community support mechanisms to ensure that older people receive targeted medical support during heatwaves is also another step that should be taken by governments.

RQ4: Are age, gender, education and occupation of the elderly determinant factors on their knowledge, attitudes and practices? (Binary regression models)

When building strategies to protect elderly from the impacts of climate change location, age, gender, education and occupation must be specifically considered (WHO, 2014). Studies undertaken in Europe and United States indicate that mortality rates during extreme heat vary with age, and gender (Berry et al., 2008, Filiberto et al., 2009). This variation in mortality rates shows an increase with older age (Yang et al., 2019). Older people suffer from impaired physiological responses and often are unable to increase their cardiac output sufficiently during extremely hot weather (Kenney et al., 2014).

Studies looking at gender and climate change associations are numerous globally (Onta and Resurreccion, 2011, Alber, 2011, Poortinga et al., 2019, Fuchs, 2018). The gender-specific differences in adaptive capacity must be fully acknowledged and considered paying special attention to the design and implementation of response strategies (Nelson, 2011). Women and men – in their respective social roles – are differently affected by the effects of climate change (Arora-Jonsson, 2011). Reasons to be found in different responsibilities for care work and income generating work, independency on natural resources because of lacking access to environmental services, or in knowledge and capacities to cope with the effects because of differences in the access to education and information systems (Roehr, 2007). If these mechanisms and measures are developed in a non-gender-sensitive way they again do not take into account the different responsibilities across genders (Vincent et al., 2010). Research has found that women have a higher risk perception than men, and thus also recognize climate change as a more serious problem than men do (Alston, 2014). However in South of England, female participants are significantly less likely to know about climate change, and the older the participants are the less likely to know about climate change (Whitmarsh, 2005). Thus, when gender is considered as a factor associated with climate change KAP, considering climate change knowledge, the findings from this thesis also shown that female participants were less likely to know about climate change than male participants (OR 0.72; 95% CI 0.59-0.89). Examples with gender also provide different results such as men's trust in technical solutions, while women vote stronger for lifestyle changes and reduction of energy consumption (Whitmarsh, 2005).

As noted in Chapter 2, vulnerability is a concept that has been used in various disciplines (Alwang et al., 2001, Thomas et al., 2019). Determining how men and women are vulnerable to climate change and their associated adaptive capacity provides an explanation as to how they are differently impacted (Nelson, 2011). Climate change impacts, including droughts, extreme weather events, sea-level rise, ocean acidification, and flooding, affect women and men differently (Flannery, 2010). Statistics on casualties of climate-related hazards and natural disasters show that women are among the most impacted (Arora-Jonsson, 2011).

Depending on where they live, some older adults can be more vulnerable to climate change-related health effects than others (Filiberto et al., 2009). For example, the increasing severity of tropical storms (Pugatch, 2019) may pose risks for older adults living in coastal areas in the United States and in China (Balbus and Malina, 2009, Liang et al., 2017). The elderly who lived in Xiamen area reported they were more likely to define climate change with storms and floods which supports the risk they have more often been exposed. For older adults residing in cities, factors such as the urban heat island effect, urban sprawl, and neighborhood safety may also present risks (Stone et al., 2010). In Xiamen, area for instance, sea-level rise risk is evident and this threats elderly wellbeing as well as the whole populations' (Ebikeme et al., 2019).

While the majority of respondents to this study were retired, links between occupation/previous occupation were found. The main industrial sectors in hot countries that are directly affected by increasing average heat exposures include agriculture, fisheries, forestry, and construction work with indirect affects in the tourism, health, and finance/insurance sectors (Nilsson and Kjellstrom, 2010). In this study respondents who worked in health sector previously for example, were more likely to think that climate change will impact their heath than elderly who worked in other sectors. Another recent study in Ghana in evaluating climate change knowledge and awareness of climate-related health risks among health experts and the public showed that both groups were likely to report climate change-related health concerns, however, differences exist in public and experts' perceptions of climate change health linkage (Hussey and Arku, 2019). As an example, community members were less likely to link climate change to health risks compared with health experts ($OR=0.02$, $p \leq 0.000$) (Hussey and Arku, 2019).

Studies undertaken in the central Philippines, Nepal and United States (Portland, Orlando and Houston) and 22 European countries and Israel previously reported that climate change awareness most strongly depended on the respondent's level of education (Combest-Friedman et al., 2012, Mishra et al., 2015, Semenza et al., 2008, Poortinga et al., 2019). With regard to education and knowledge of climate change, it is expected that people with higher education level will more likely to hear about climate change (Bangay and Blum, 2010), in some cases people with lower education level were found to be more responsive. In a study undertaken in Bangladesh on KAP of vulnerable communities on climate change age, educational qualification, and occupation were significantly associated with the knowledge about climate change ($p<0.001$) and people with higher educational level or who live near a school were more knowledgeable about climate change and its impact on health (Kabir et al., 2016a). However, this difference might be a result of the target population. For the elderly population, consideration of knowledge of climate change might depend on their experience of having lived many years, rather than their educational level (Frumkin et al., 2012). A study undertaken in Xiamen showed that the resident's knowledge on climate change and its risk was still at a relatively low level on average (Lin et al., 2018). In contrast, the results showed 80% of elderly in Xiamen knew about climate change and this might be because of the respondents' high level of education. Among effects of climate change, temperature rise can be easily identified by people, while sea-level rise is less known by residents. Although in my study sea-level rise has not been included as a climate change impact some elderly in Xiamen reported the risk they perceive living in a coastal area.

RQ5: ***What actions, if any, do these findings suggest for public health officials?***

In China and globally large numbers of people are already willing to accept that climate change has impact on human health (Morefield et al., 2018, Arriagada et al., 2020, Li et al., 2020). At the same time, the impact of climate change on public health is increasingly widely recognized by public health officials. However, to date there has been little evidence on whether the use of a climate change public health frame in engaging the public on adaptation to these risks would be more effective in China. This raises an important issue that should be addressed in additional research. Little social science research exists to date on the ways in which people are thinking about the health risks from climate change. The development of uniform measures of climate health beliefs, risk perceptions and adaptation actions will provide a yardstick by which comparisons can be more easily made at all levels and by teams of researchers working independently, with the end goal of the development of more effective public health outreach campaigns on climate change at all levels—local, regional, national and international.

A public health approach to climate change may also have more relevance at local governmental levels. framing or at least aligning environmental policy with public health have been used in China as a means to reduce emissions (Holdaway, 2013, Green and Stern, 2017), while in the USA, health co-benefits are publicly communicated as a key selling point in the climate change debate in an attempt to pursue climate action despite the politically toxic nature of the climate change debate (Jacob, 2015).

However, more fine-grained information about the mental models they use in processing this information will also need to be obtained using techniques such as those established by other scientists (DeBono et al., 2012, Morgan et al., 2002). In-depth interviews with both members of the scientific community and the public on climate change health risks and adaptation responses will be needed in order to learn what types of information will be most valuable to audiences in affecting behavioral changes to reduce their risks from climate change as individuals and communities (Kause et al., 2020, Schäfer and Painter, 2021, Robbins, 2020). Surveys, done in other nations that obtain richer narrative data may also provide a window to greater understanding of the ways that the public intersects with this issue.

7.2 Limitations and Delimitations of the Study

The findings of this study have to be seen in light of some limitations. Firstly, the reliance on self-reported measures of behavior represents a significant methodological limitation in this study. Although using surveys of knowledge, perceptions and behavior is less time-intensive and intrusive than conducting observational measurements, surveys may not accurately reflect actual behaviors taken. The quantitative research method involved semi-structured questionnaires with closed questions. Also, the respondents have limited options of responses, based on the selection made by the researcher, yet some comments of the elderly were also recorded. Future research can improve on this study by including more objective measures of KAP.

Secondly, the target population, the elderly was very hard to approach because most of them just wanted to relax or exercise and they did not really want to get involved with surveys. Furthermore, the response rate was considerably lower in Xiamen simply because the local security was very tight during the time of the survey because of the BRICS summit happening in the city, so that research team was stopped by security reaching parks or public spaces.

As an advantage, the little or no prior research on this specific topic could be considered. Since the literature in China on elderly views on climate change health impacts are limited, with this thesis a literature review was also produced and published. For future research, discovering new literature can be considered as an important opportunity to identify new gaps in the prior literature and to present the need for further development in the area of study.

7.3 Research Summary and Conclusion

Older people are already profoundly affected by the impacts of climate change (Benevolenza and DeRigne, 2018). These impacts are set to increase due to the combination of increased stress factors from climate change leading to mortality, poor health and global population ageing and air pollution (Chapter 2). Adaptation and mitigation choices made now will affect the impact of climate change throughout the 21st century (King, 2004). Adverse health impacts of climate change can be minimized or avoided with appropriate mitigation and adaptation strategies (Ireland and Clausen, 2019). Adaptation refers to actions being taken to lessen the impact on health and the environment due to changes that cannot be prevented through mitigation (Aguiar et al., 2018). Some adaptation activities will directly improve human health through changes in public health and health care infrastructure (Watts et al., 2015).

Scientific research has identified human-induced climate change as a serious threat to human societies and the non-human world. Yet, climate change is an issue with major political, economic, socio-cultural, psychological, and ethical implications, which must be understood if policymakers and wider society are to respond effectively to this issue. This study asked the elderly questions on their knowledge, attitudes and practices (KAP) in relation to climate change; and the elderly stated which adaptive measures they would take in order to lessen the impacts of extreme events exacerbated by climate change (Chapter 5). The aim of this thesis is to examine the contextual determinants and dimensions of elderly Chinese populations' understanding of, and response to, climate change in order to inform the design of more effective public communication strategies and workable adaptation policies.

This study uses a mixed-methodology approach in three cities of East China (Suzhou, Hefei, Xiamen) to explore the perceptions of and behavioral responses to climate change of Chinese elderly (Chapter 6). Associated with effective communication, one factor given particular attention here is knowledge and understanding of climate change. By focusing on the relationship between knowledge and adaptation, this study represents an original approach to understanding how the elderly conceives and responds to climate change (Chapter 6, 6.3.3). The findings from this research suggest that elderly acknowledges that they are vulnerable to climate change, and study results inform that elderly in China are worried about climate change health (respiratory diseases and heat stroke-exhaustion) and weather impacts (heatwaves, droughts, storms) of climate change. At the same time, the results highlight the elderly's tendency to associate climate change with other health issues, notably heat stroke and respiratory diseases. This study asked the elderly questions on their knowledge, attitudes and practices (KAP) in relation to climate change; and the elderly stated which adaptive measures they would take in order to lessen the impacts of extreme events exacerbated by climate change. Part of the survey work across the three cities involved ethnographic work to understand what measures have already been taken by the government, what kind of facilities have been offered to elderly, and what are the local circumstances for elderly wellbeing in extreme conditions. The insights from the data analysis can be used to identify solutions for elderly wellbeing under climate change scenarios. The thesis concludes by recommending that information about climate change must be tailored to the needs, existing knowledge, and values of particularly vulnerable focus groups such as the elderly.

7.4 Future Research

The research described in this thesis focused on residents in East China, and primarily in three cities Suzhou, Hefei and Xiamen. Based on the findings of this study and the limitations noted above, seven areas were proposed in which further research might build on the findings from this study.

1. Future research should extend this type of in-depth analysis of public understanding and response to climate change to a representative nation-wide study. Such nation-wide research can provide more data for policymakers.
2. This study only focused on quantitative measures, qualitative measures such as interviews should be undertaken by future researchers working in this field. These interviews could be carried out with health officials or policymakers as well.
3. Future research might also determine how and why perceived threat from climate change by elderly influences their actions, as well as a number of dimensions of understanding.
4. More fundamentally, further research should try to address the need for a grounded theory approach to understanding perceptions of, and behavioral response to, climate change. Similarly, future research on perceptions of climate change might consider relating the findings from this and other studies.
5. The dimensions of uncertainty exposed through analysis of survey data in this research deserve further investigation amongst other populations. For example, cross-national research might compare the way in which uncertainty is constructed and mobilized amongst different cultures or focus groups. Comparisons might also be made between policymakers, scientists, businesses, and journalists; or between different environmental issues.

6. This study focused on the elderly response to climate change primarily adaptation rather than mitigation. Further studies might address the extent to which the elderly considers adaptation to be preferable to mitigation, or their perceptions of responsibility and self-efficacy in relation to adaptation. This information would need to be considered in the development of a comprehensive climate change strategy.
7. Finally, an obvious path to take in relation to further research is to implement and test the recommendations put forward in this chapter. For example, attention might be focused on an evaluation of participatory approaches to climate change policy-making.

In conclusion, this thesis brought together a broad literature for local and global contexts. While communicating climate change with elderly, infographic and video tools could be used however elderly is resistant to text-graph tool. Further communication studies should be undertaken by researchers and climate change communication should be prioritized with the elderly. Climate change among the elderly although they know the term, they usually referred to it as weather change and this could also be considered as a communication issue.

Most of the participants had heard about climate change through television. Media can be an excellent tool to communicate climate change with the elderly through videos or infographics presented. Better public understanding and adaptation to climate change will most effectively be achieved through communication schemes that demonstrate the efficacy of personal action and result in local benefits. Local governments and researchers must focus on risk communication and perception; and cultural, behavioral, and socio-demographic influences on adaptation to climate change with vulnerable populations. The insights from the data analysis can be used to identify solutions for the elderly wellbeing under climate change scenarios.

REFERENCES

ADGER, W. N., BUTLER, C. & WALKER-SPRINGETT, K. 2017. Moral reasoning in adaptation to climate change. *Environmental Politics,* 26**,** 371-390.

AGUIAR, F. C., BENTZ, J., SILVA, J. M., FONSECA, A. L., SWART, R., SANTOS, F. D. & PENHA-LOPES, G. 2018. Adaptation to climate change at local level in Europe: an overview. *Environmental Science & Policy,* 86**,** 38-63.

AHERN, M., KOVATS, R. S., WILKINSON, P., FEW, R. & MATTHIES, F. 2005. Global health impacts of floods: epidemiologic evidence. *Epidemiologic Reviews,* 27**,** 36-46.

AKERLOF, K., DEBONO, R., BERRY, P., LEISEROWITZ, A., ROSER-RENOUF, C., CLARKE, K.-L., ROGAEVA, A., NISBET, M. C., WEATHERS, M. R. & MAIBACH, E. W. 2010. Public perceptions of climate change as a human health risk: surveys of the United States, Canada and Malta. *International journal of environmental research and public health,* 7**,** 2559-2606.

AL-AMIN, A. Q., NAGY, G. J., AZEITEIRO, U. M., WIESBÖCK, L., AYAL, D. Y., MORGAN, E. A., MUGABE, P., APARICIO-EFFEN, M., FUDJUMDJUM, H. & CHIAPPETTA JABBOUR, C. J. 2018. A Comparative Analysis of Climate-Risk and Extreme Event-Related Impacts on Well-Being and Health: Policy Implications. *International Journal of Environmental Research and Public Health,* 15**,** 331.

ALBER, G. 2011. Gender, cities and climate change. *Unpublished thematic report prepared for the Global Report on Human Settlements*.

ALI, Z., ADAM, F. & BAHARUM, A. Modeling quality of life of end stage renal disease patients in Kelantan using binary logistic regression. AIP Conference Proceedings, 2018. AIP Publishing, 020030.

ALSTON, M. Gender mainstreaming and climate change. Women's Studies International Forum, 2014. Elsevier, 287-294.

ALWANG, J., SIEGEL, P. B. & JORGENSEN, S. L. 2001. Vulnerability: a view from different disciplines. Social protection discussion paper series.

ANDERSON, A. 2011. Sources, media, and modes of climate change communication: the role of celebrities. *Wiley interdisciplinary reviews: climate change,* 2**,** 535-546.

ANDRADE, C. 2015. Understanding relative risk, odds ratio, and related terms: as simple as it can get. *The Journal of clinical psychiatry,* 76**,** 857-861.

ARCEO, E., HANNA, R. & OLIVA, P. 2016. Does the effect of pollution on infant mortality differ between developing and developed countries? Evidence from Mexico City. *Econ. J. ,* 126**,** 257-280.

ARNBERGER, A., ALLEX, B., EDER, R., EBENBERGER, M., WANKA, A., KOLLAND, F., WALLNER, P. & HUTTER, H.-P. 2017. Elderly resident’s uses of and preferences for urban green spaces during heat periods. *Urban Forestry & Urban Greening,* 21**,** 102-115.

ARORA-JONSSON, S. 2011. Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change,* 21**,** 744-751.

ARRIAGADA, N. B., BOWMAN, D. M., PALMER, A. J. & JOHNSTON, F. H. 2020. Climate change, wildfires, heatwaves and health impacts in Australia. *Extreme Weather Events and Human Health.* Springer.

AUSTIN, P. C. & MERLO, J. 2017. Intermediate and advanced topics in multilevel logistic regression analysis. *Statistics in medicine,* 36**,** 3257-3277.

BABCICKY, P. & SEEBAUER, S. 2017. The two faces of social capital in private flood mitigation: opposing effects on risk perception, self-efficacy and coping capacity. *Journal of Risk Research,* 20**,** 1017-1037.

BALBUS, J. M. & MALINA, C. 2009. Identifying vulnerable subpopulations for climate change health effects in the United States. *Journal of occupational and environmental medicine,* 51**,** 33-37.

BANGAY, C. & BLUM, N. 2010. Education responses to climate change and quality: Two parts of the same agenda? *International Journal of Educational Development,* 30**,** 359-368.

BARATA, M., LIGETI, E., DE SIMONE, G., DICKINSON, T., JACK, D., PENNEY, J., RAHMAN, M. & ZIMMERMAN, R. 2011. Climate change and human health in cities. *Climate Change and Cities First Assessment Report of the Urban Climate Change Research Network.* Cambridge University Press.

BARRIOPEDRO, D., GOUVEIA, C. M., TRIGO, R. M. & WANG, L. 2012. The 2009/10 drought in China: possible causes and impacts on vegetation. *J. Hydrometeorol.,* 13**,** 1251-1267.

BASU, R. & SAMET, J. M. 2002. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. *Epidemiologic Reviews,* 24**,** 190-202.

BENEVOLENZA, M. A. & DERIGNE, L. 2018. The impact of climate change and natural disasters on vulnerable populations: A systematic review of literature. *Journal of Human Behavior in the Social Environment***,** 1-16.

BERHE, A. A. 2020. Communicating climate change science to diverse audiences. *Standing up for a Sustainable World.* Edward Elgar Publishing.

BERNSTEIN, A. S. & RICE, M. B. 2013. Lungs in a warming world: climate change and respiratory health. *CHEST Journal,* 143**,** 1455-1459.

BERRANG-FORD, L., FORD, J. D. & PATERSON, J. 2011. Are we adapting to climate change? *Global Environmental Change,* 21**,** 25-33.

BERRY, P., MCBEAN, G. & SEGUIN, J. 2008. Vulnerabilities to natural hazards and extreme weather. *Human Health in a Changing Climate: A Canadian Assessment of Vulnerabilities and Adaptive Capacity. Ottawa (ON): Health Canada***,** 51.

BHATTACHARYYA, K. 1997. Key informants, pile sorts, or surveys? Comparing behavioral research methods for the study of acute respiratory infections in West Bengal. *The anthropology of infectious diseases: Theory and practice on medical anthropology and international health***,** 211-238.

BI, P., SHI, X.-M. & LIU, Q.-Y. 2020. Climate change and population health research in China: Knowledge gaps and further directions. *Advances in Climate Change Research,* 11**,** 273-278.

BICKNELL, J., DODMAN, D. & SATTERTHWAITE, D. 2009. *Adapting cities to climate change : understanding and addressing the development challenges,* London ; Sterling, VA, Earthscan.

BIENIEK-TOBASCO, A., MCCORMICK, S., RIMAL, R. N., HARRINGTON, C. B., SHAFER, M. & SHAIKH, H. 2019. Communicating climate change through documentary film: Imagery, emotion, and efficacy. *Climatic change,* 154**,** 1-18.

BLAND, J. M. & ALTMAN, D. G. 2000. The odds ratio. *Bmj,* 320**,** 1468.

BOOTH-KEWLEY, S., LARSON, G. E. & MIYOSHI, D. K. 2007. Social desirability effects on computerized and paper-and-pencil questionnaires. *Computers in human behavior,* 23**,** 463-477.

BOYCE, T. & LEWIS, J. 2009. *Climate change and the media*, Peter Lang.

BROTO, V. C. & BULKELEY, H. 2013. A survey of urban climate change experiments in 100 cities. *Global environmental change,* 23**,** 92-102.

BUSHELL, S., BUISSON, G. S., WORKMAN, M. & COLLEY, T. 2017. Strategic narratives in climate change: Towards a unifying narrative to address the action gap on climate change. *Energy Research & Social Science,* 28**,** 39-49.

CARMICHAEL, J. T. & BRULLE, R. J. 2017. Elite cues, media coverage, and public concern: an integrated path analysis of public opinion on climate change, 2001–2013. *Environmental Politics,* 26**,** 232-252.

CHANDIO, A. A., JIANG, Y., REHMAN, A. & RAUF, A. 2020. Short and long-run impacts of climate change on agriculture: an empirical evidence from China. *International Journal of Climate Change Strategies and Management*.

CHEN, B. & LIU, Y. 2017. Redesigning and retrofitting existing communities toward lifetime neighbourhoods *Innovation in Aging,* 1**,** 456-456.

CHEN, K., BI, J., CHEN, J., CHEN, X., HUANG, L. & ZHOU, L. 2015. Influence of heat wave definitions to the added effect of heat waves on daily mortality in Nanjing, China. *Science of The Total Environment,* 506**,** 18-25.

CHEN, K., HORTON, R. M., BADER, D. A., LESK, C., JIANG, L., JONES, B., ZHOU, L., CHEN, X., BI, J. & KINNEY, P. L. 2017. Impact of climate change on heat-related mortality in Jiangsu Province, China. *Environmental pollution,* 224**,** 317-325.

CHENG, J., XU, Z., BAMBRICK, H., SU, H., TONG, S. & HU, W. 2018. Heatwave and elderly mortality: An evaluation of death burden and health costs considering short-term mortality displacement. *Environment international,* 115**,** 334-342.

CHIDAKWA, P., MABHENA, C., MUCHERERA, B., CHIKUNI, J. & MUDAVANHU, C. 2020. Women's Vulnerability to Climate Change: Gender-skewed Implications on Agro-based Livelihoods in Rural Zvishavane, Zimbabwe. *Indian Journal of Gender Studies,* 27**,** 259-281.

CHINDAPOL, S., BLAIR, J., OSMOND, P. & PRASAD, D. 2017. A suitable thermal stress index for the elderly in summer tropical climates. *Procedia Engineering,* 180**,** 932-943.

CHOU, W. H., LAI, Y.-T. & LIU, K.-H. 2013. User requirements of social media for the elderly: a case study in Taiwan. *Behaviour & Information Technology,* 32**,** 920-937.

CLELAND, J. 1973. A critique of KAP studies and some suggestions for their improvement. *Studies in Family Planning,* 4**,** 42-47.

COMBEST-FRIEDMAN, C., CHRISTIE, P. & MILES, E. 2012. Household perceptions of coastal hazards and climate change in the Central Philippines. *Journal of environmental management,* 112**,** 137-148.

CONNELLY, L. 2020. Logistic regression. *Medsurg Nursing,* 29**,** 353-354.

CORVALAN, C., HALES, S. & MCMICHAEL, A. J. 2005. *Ecosystems and human well-being: health synthesis*, World Health Organization.

COSTELLO, A., ABBAS, M., ALLEN, A., BALL, S., BELL, S., BELLAMY, R., FRIEL, S., GROCE, N., JOHNSON, A. & KETT, M. 2009. Managing the health effects of climate change. *Lancet,* 373**,** 1693-1733.

CUMISKEY, L., LICKISS, M., ŠAKIĆ TROGRLIĆ, R. & ALI, J. 2019. Interdisciplinary pressure cooker: environmental risk communication skills for the next generation. *Geoscience Communications,* 2**,** 173-186.

CURRIE, J. & NEIDELL, M. 2005. Air pollution and infant health: what can we learn from California's recent experience? *Q. J. Econ,* 120**,** 1003-1030.

CURRIE, J., NEIDELL, M. & SCHMIEDER, J. F. 2009. Air pollution and infant health: lessons from New Jersey. *Journal of Health Economics,* 28**,** 688-703.

D'AMATO, G., BAENA-CAGNANI, C. E., CECCHI, L., ANNESI-MAESANO, I., NUNES, C., ANSOTEGUI, I., D'AMATO, M., LICCARDI, G., SOFIA, M. & CANONICA, W. G. 2013. Climate change, air pollution and extreme events leading to increasing prevalence of allergic respiratory diseases. *Multidisciplinary Respiratory Medicine,* 8**,** 12.

DALBY, S., HORTON, S. & MAHON, R. 2019. Achieving the sustainable development goals : global governance challenges. *Routledge studies in sustainable development.* London ; New York: Routledge, Taylor & Francis Group, Earthscan from Routledge,.

DAVÍDKOVOVÁ, H., PLAVCOVÁ, E., KYNČL, J. & KYSELý, J. 2014. Impacts of hot and cold spells differ for acute and chronic ischaemic heart diseases. *BMC Public Health,* 14**,** 480.

DE'DONATO, F. K., LEONE, M., NOCE, D., DAVOLI, M. & MICHELOZZI, P. 2013. The impact of the February 2012 cold spell on health in Italy using surveillance data. *PloS ONE,* 8.

DE'ER, Z. & YOUYE, L. 2010. A long lasting and extensive drought event over China during 1876-1878. *Adv. Clim. Change Res.,* 2**,** 009.

DEBONO, R., VINCENTI, K. & CALLEJA, N. 2012. Risk communication: climate change as a human-health threat, a survey of public perceptions in Malta. *The European Journal of Public Health,* 22**,** 144-149.

DEMIRKESEN, A. C. & EVRENDILEK, F. 2017. Compositing climate change vulnerability of a Mediterranean region using spatiotemporally dynamic proxies for ecological and socioeconomic impacts and stabilities. *Environmental Monitoring and Assessment,* 189**,** 29.

DENG, S.-Z., JALALUDIN, B. B., ANTÓ, J. M., HESS, J. J. & HUANG, C.-R. 2020. Climate change, air pollution, and allergic respiratory diseases: a call to action for health professionals. *Chinese Medical Journal,* 133**,** 1552.

DEPOUX, A., HÉMONO, M., PUIG-MALET, S., PÉDRON, R. & FLAHAULT, A. 2017. Communicating climate change and health in the media. *Public health reviews,* 38**,** 1-4.

DING, Y., REN, G., ZHAO, Z., XU, Y., LUO, Y., LI, Q. & ZHANG, J. 2007. Detection, causes and projection of climate change over China: an overview of recent progress. *Adv. Atmos. Sci.,* 24**,** 954-971.

DU, W., FITZGERALD, G. J., CLARK, M. & HOU, X.-Y. 2010. Health impacts of floods. *Prehospital and Disaster Medicine,* 25**,** 265-272.

EASTERLING, D. R., EVANS, J., GROISMAN, P. Y., KARL, T. R., KUNKEL, K. E. & AMBENJE, P. 2000. Observed variability and trends in extreme climate events: a brief review. *Bulletin of the American Meteorological Society,* 81**,** 417-425.

EBIKEME, C., GATZWEILER, F., ONI, T., LIU, J., OYUELA, A. & SIRI, J. 2019. Xiamen Call for Action: Building the Brain of the City—Universal Principles of Urban Health. *Journal of Urban Health***,** 1-3.

EPSTEIN, P. R. 2001. Climate change and emerging infectious diseases. *Microbes and infection,* 3**,** 747-754.

ERDREICH, S. F. 2009. *Adaptation and climate change,* Detroit, Greenhaven Press.

EVANS, H.-C., DYLL, L. & TEER-TOMASELLI, R. 2018. Communicating Climate Change: Theories and Perspectives. *Handbook of Climate Change Communication: Vol. 1.* Springer.

FANG, J., LIU, W., YANG, S., BROWN, S., NICHOLLS, R. J., HINKEL, J., SHI, X. & SHI, P. 2017. Spatial-temporal changes of coastal and marine disasters risks and impacts in Mainland China. *Ocean Coast Manag.,* 139**,** 125-140.

FIDEL, A. 2000. Discovering statistics using SPSS for windows. Sage Publications, London, UK.

FILHO, W. 2009. Communicating climate change: challenges ahead and action needed. *International Journal of Climate Change Strategies and Management,* 1**,** 6-18.

FILIBERTO, D., WETHINGTON, E., PILLEMER, K., WELLS, N., WYSOCKI, M. & PARISE, J. T. 2009. Older people and climate change: vulnerability and health effects. *Generations,* 33**,** 19-25.

FLANNERY, T. 2010. *The Weather Makers: The history & future impact of climate change*, Text Publishing.

FRUMKIN, H., FRIED, L. & MOODY, R. 2012. Aging, climate change, and legacy thinking. *American journal of public health,* 102**,** 1434-1438.

FRUMKIN, H., HESS, J., LUBER, G., MALILAY, J. & MCGEEHIN, M. 2008. Climate change: the public health response. *American Journal of Public Health,* 98**,** 435-445.

FUCHS, S. 2018. Globalization, agriculture and food in the Caribbean: climate change, gender and geography. Taylor & Francis.

FURGAL, C. & SEGUIN, J. 2006. Climate change, health, and vulnerability in Canadian northern Aboriginal communities. *Environmental Health Perspectives,* 114**,** 1964.

FÜSSEL, H.-M. 2007. Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change,* 17**,** 155-167.

FÜSSEL, H.-M. & KLEIN, R. J. 2006. Climate change vulnerability assessments: an evolution of conceptual thinking. *Clim. Change,* 75**,** 301-329.

GALEA, S., NANDI, A. & VLAHOV, D. 2005. The epidemiology of post-traumatic stress disorder after disasters. *Epidemiologic Reviews,* 27**,** 78-91.

GAMBLE, J. L., BALBUS, J., BERGER, M., BOUYE, K., CAMPBELL, V., CHIEF, K., CONLON, K., CRIMMINS, A., FLANAGAN, B. & GONZALEZ-MADDUX, C. 2016. Ch. 9: Populations of concern. US Global Change Research Program, Washington, DC.

GAO, M., GUTTIKUNDA, S. K., CARMICHAEL, G. R., WANG, Y., LIU, Z., STANIER, C. O., SAIDE, P. E. & YU, M. 2015. Health impacts and economic losses assessment of the 2013 severe haze event in Beijing area. *Science of the Total Environment,* 511**,** 553-561.

GAUTAM, K. & VAN DER HOEK, E. 2003. Literature study on environmental impact of floods. *DC1-233-13*.

GE, Y., DOU, W. & LIU, N. 2017. Planning Resilient and Sustainable Cities: Identifying and Targeting Social Vulnerability to Climate Change. *Sustainability,* 9**,** 1394.

GREEN, E. C. 2001. Can qualitative research produce reliable quantitative findings? *Field Methods,* 13**,** 3-19.
GREEN, F. & STERN, N. 2017. China's changing economy: implications for its carbon dioxide emissions. *Climate policy,* 17**,** 423-442.
GUO, S., WANG, J., XIONG, L., YING, A. & LI, D. 2002. A macro-scale and semi-distributed monthly water balance model to predict climate change impacts in China. *J. Hydrol.,* 268**,** 1-15.
GUO, Y., JIANG, F., PENG, L., ZHANG, J., GENG, F., XU, J., ZHEN, C., SHEN, X. & TONG, S. 2012. The association between cold spells and pediatric outpatient visits for asthma in Shanghai, China. *PLoS ONE,* 7.
GUO, Y., LI, S., ZHANG, Y., ARMSTRONG, B., JAAKKOLA, J., TONG, S. & PAN, X. 2013. Extremely cold and hot temperatures increase the risk of ischaemic heart disease mortality: epidemiological evidence from China. *Heart* 99**,** 195.
GUOJU, X., WEIXIANG, L., QIANG, X., ZHAOJUN, S. & JING, W. 2005. Effects of temperature increase and elevated CO 2 concentration, with supplemental irrigation, on the yield of rain-fed spring wheat in a semiarid region of China. *Agricultural Water Management,* 74**,** 243-255.
HAINES, A., KOVATS, R. S., CAMPBELL-LENDRUM, D. & CORVALÁN, C. 2006. Climate change and human health: impacts, vulnerability and public health. *Public Health,* 120**,** 585-596.
HAN, X., HAN, Z. Y. & CHEN, J. H. Study on urban public facilities and basic design points in ageing society of Mainland China: based on an elderly-care survey in Nanjing. Advanced Materials Research, 2012. Trans Tech Publ, 5949-5953.
HAQ, G. 2017. Growing Old in a Changing Climate. *Public policy & aging report,* 27**,** 8-12.
HARA, K. N. 2010. An assessment on the knowledge, attitudes and practices among communities on climate change.
HARLAN, S. L. & RUDDELL, D. M. 2011. Climate change and health in cities: impacts of heat and air pollution and potential co-benefits from mitigation and adaptation. *Current Opinion in Environmental Sustainability,* 3**,** 126-134.
HART, P. S. & FELDMAN, L. 2016. The Impact of Climate Change–Related Imagery and Text on Public Opinion and Behavior Change. *Science Communication,* 38**,** 415-441.
HAUSMANN-MUELA, S., RIBERA, J. M. & NYAMONGO, I. 2003. Health-seeking behaviour and the health system response. *Disease Control Piroirities Project working paper No14*.
HE, X., HONG, T., LIU, L. & TIEFENBACHER, J. 2011. A comparative study of environmental knowledge, attitudes and behaviors among university students in China. *International Research in Geographical and Environmental Education,* 20**,** 91-104.
HELTBERG, R., SIEGEL, P. B. & JORGENSEN, S. L. 2009. Addressing human vulnerability to climate change: toward a 'no-regrets' approach. *Glob. Environ. Chang.,* 19**,** 89-99.
HILLEN, M. A., GUTHEIL, C. M., STROUT, T. D., SMETS, E. & HAN, P. K. 2017. Tolerance of uncertainty: conceptual analysis, integrative model, and implications for healthcare. *Social Science & Medicine,* 180**,** 62-75.
HOLDAWAY, J. 2013. Environment and health research in China: the state of the field. *China Q.***,** 255.
HOOGENDOORN, G., SÜTTERLIN, B. & SIEGRIST, M. 2020. The climate change beliefs fallacy: The influence of climate change beliefs on the perceived consequences of climate change. *Journal of Risk Research,* 23**,** 1577-1589.
HOPKINSON, N., HART, N., JENKINS, G., KAMINSKI, N., ROSENFELD, M., SMYTH, A. & WILKINSON, A. 2017. Climate change and lung health: the challenge for a new president. *Thorax,* 72**,** 295-296.
HU, G. 2017. China's cost of handling climate change. *The Cost of Development in China.* Springer.
HUANG, W., KAN, H. & KOVATS, S. 2010. The impact of the 2003 heat wave on mortality in Shanghai, China. *Science of the Total Environment,* 408**,** 2418-2420.
HUGHES, S., CHU, E. K. & MASON, S. G. 2018. *Climate change in cities*, Springer.
HUNTINGTON, H. P. 2007. Creating a climate for change: communicating climate change and facilitating social change. *Ecoscience,* 14**,** 545-547.

HUSSEY, L. K. & ARKU, G. 2019. Conceptualizations of climate-related health risks among health experts and the public in Ghana. *Social Science & Medicine*.
IRELAND, P. & CLAUSEN, D. 2019. Local action that changes the world: Fresh perspectives on climate change mitigation and adaptation from Australia. *Managing Global Warming.* Elsevier.
ISLAM, R. & WALKERDEN, G. 2015. How do links between households and NGOs promote disaster resilience and recovery?: A case study of linking social networks on the Bangladeshi coast. *Natural hazards,* 78**,** 1707-1727.
JACOB, D. J. & WINNER, D. A. 2009. Effect of climate change on air quality. *Atmospheric Environment,* 43**,** 51-63.
JACOB, J. A. 2015. EPA releases final clean power plan. *Jama,* 314**,** 1216-1216.
JANKOVIĆ, V. & SCHULTZ, D. M. 2017. Atmosfear: communicating the effects of climate change on extreme weather. *Weather, Climate, and Society,* 9**,** 27-37.
JONKMAN, S. N. 2005. Global perspectives on loss of human life caused by floods. *Nat. Hazards,* 34**,** 151-175.
JONKMAN, S. N. & KELMAN, I. 2005. An analysis of the causes and circumstances of flood disaster deaths. *Disasters,* 29**,** 75-97.
JOST, C., KYAZZE, F., NAAB, J., NEELORMI, S., KINYANGI, J., ZOUGMORE, R., AGGARWAL, P., BHATTA, G., CHAUDHURY, M. & TAPIO-BISTROM, M.-L. 2016. Understanding gender dimensions of agriculture and climate change in smallholder farming communities. *Climate and Development,* 8**,** 133-144.
KABIR, M. I., RAHMAN, M. B., SMITH, W., LUSHA, M. A. F., AZIM, S. & MILTON, A. H. 2016a. Knowledge and perception about climate change and human health: Findings from a baseline survey among vulnerable communities in Bangladesh. *BMC Public Health,* 16**,** 266.
KABIR, M. I., RAHMAN, M. B., SMITH, W., LUSHA, M. A. F., AZIM, S. & MILTON, A. H. 2016b. Knowledge and perception about climate change and human health: findings from a baseline survey among vulnerable communities in Bangladesh. *BMC public health,* 16**,** 1-10.
KAN, H. 2011. Climate change and human health in China. *Environmental Health Perspectives,* 119**,** A60.
KAN, H., CHEN, R. & TONG, S. 2012. Ambient air pollution, climate change, and population health in China. *Environment International,* 42**,** 10-19.
KANG, R., XUN, H., ZHANG, Y., WANG, W., WANG, X., JIANG, B. & MA, W. 2015. Impacts of Different Grades of Tropical Cyclones on Infectious Diarrhea in Guangdong, 2005-2011. *PloS one,* 10**,** e0131423.
KANG, S., HAO, X., DU, T., TONG, L., SU, X., LU, H., LI, X., HUO, Z., LI, S. & DING, R. 2017. Improving agricultural water productivity to ensure food security in China under changing environment: from research to practice. *Agric Water Manag.,* 179**,** 5-17.
KARAMI, S., SHOBEIRI, S. M. & JAFARI, H. 2017. Assessment of knowledge, attitudes, and practices (KAP) towards climate change education (CCE) among lower secondary teachers in Tehran, Iran. *International Journal of Climate Change Strategies and Management*.
KAUSE, A., BRUINE DE BRUIN, W., FUNG, F., TAYLOR, A. & LOWE, J. 2020. Visualizations of projected rainfall change in the United Kingdom: An interview study about user perceptions. *Sustainability,* 12**,** 2955.
KENNEY, W. L., CRAIGHEAD, D. H. & ALEXANDER, L. M. 2014. Heat waves, aging, and human cardiovascular health. *Medicine and science in sports and exercise,* 46**,** 1891.
KIM, K.-H., KABIR, E. & KABIR, S. 2015. A review on the human health impact of airborne particulate matter. *Environment International,* 74**,** 136-143.
KINAY, P., MORSE, A. P., VILLANUEVA, E. V., MORRISSEY, K. & STADDON, P. L. 2019. Direct and indirect health impacts of climate change on the vulnerable elderly population in East China. *Environmental Reviews,* 27**,** 295-303.
KING, D. A. 2004. Climate change science: adapt, mitigate, or ignore? : American Association for the Advancement of Science.

KINNEY, P. L. 2008. Climate change, air quality, and human health. *American Journal of Preventive Medicine,* 35**,** 459-467.
KIRTON, J. J. & LARIONOVA, M. V. 2018. *Accountability for effectiveness in global governance,* London New York, Routledge/Taylor & Francis Group.
KNUTTI, R. 2019. Closing the knowledge-action gap in climate change. *One Earth,* 1**,** 21-23.
KOK, M. & JÄGER, J. 2009. *Vulnerability of people and the environment: challenges and opportunities: background report on Chapter 7 of the Fourth Global Environment Outlook (GEO-4)*, Netherlands Environment Assessment Agency.
KOKOYE, S. E. H., YEGBEMEY, R. N. R. & AWOYE, O. M. H. R. 2019. *Advancing climate change research in West Africa : trends, impacts, vulnerability, resilience, adaptation and sustainability issues,* New York, Nova Science Publishers.
KOTEYKO, N., NERLICH, B. & HELLSTEN, I. 2015. Climate change communication and the internet: Challenges and opportunities for research. Taylor & Francis.
KUMAR, R. 2019. Applied agricultural practices for mitigating climate change. *Handbook of conservation agriculture volume 2.* Boca Raton, FL: CRC Press,.
LACKNER, B., LEAL FILHO, W. & MCGHIE, H. 2019. Addressing the Challenges in Communicating Climate Change Across Various Audiences. *Climate Change Management,.* 1st ed. Cham: Springer International Publishing : Imprint: Springer,.
LEICHENKO, R. M. & O'BRIEN, K. L. 2002. The dynamics of rural vulnerability to global change: the case of southern Africa. *Mitig. adapt. strategies glob. chang.,* 7**,** 1-18.
LEISEROWITZ, A., SMITH, N. & MARLON, J. R. 2011. American teens' knowledge of climate change. *Yale University. New Haven, CT: Yale Project on Climate Change Communication,* 5.
LEVINE, A. S. & KLINE, R. 2017. A new approach for evaluating climate change communication. *Climatic Change,* 142**,** 301-309.
LI, C., SUN, Y., ZWIERS, F., WANG, D., ZHANG, X., CHEN, G. & WU, H. 2020. Rapid warming in summer wet bulb globe temperature in China with human-induced climate change. *Journal of Climate,* 33**,** 5697-5711.
LI, T., HORTON, R., BADER, D., ZHOU, M., LIANG, X., BAN, J., SUN, Q. & KINNEY, P. 2016. Aging will amplify the heat-related mortality risk under a changing climate: projection for the elderly in Beijing, China. *Scientific Reports,* 6**,** 28161.
LI, Y. 2015. Communicating climate change: Channels, sources, contents and outreach strategies based on China survey. *International Journal of Environmental Science and Development,* 6**,** 732.
LI, Y., LI, C., LUO, S., HE, J., CHENG, Y. & JIN, Y. 2017. Impacts of extremely high temperature and heatwave on heatstroke in Chongqing, China. *Environ. Sci. Pollut. Res.,* 24**,** 8534-8540.
LIANG, L. & GONG, P. 2017. Climate change and human infectious diseases: a synthesis of research findings from global and spatio-temporal perspectives. *Environment International,* 103**,** 99-108.
LIANG, P., XU, W., MA, Y., ZHAO, X. & QIN, L. 2017. Increase of elderly population in the rainstorm hazard areas of China. *International journal of environmental research and public health,* 14**,** 963.
LICKISS, M. D. & CUMISKEY, L. 2019. Design skills for environmental risk communication. Design in and design of an interdisciplinary workshop. *The Design Journal,* 22**,** 1373-1385.
LILAI, X., YUANRONG, H. & WEI, H. 2016. A multi-dimensional integrated approach to assess flood risks on a coastal city, induced by sea-level rise and storm tides. *Environ. Res. Lett.,* 11**,** 014001.
LIN, T., CAO, X., HUANG, N., XU, L., LI, X., ZHAO, Y. & LIN, J. 2018. Social cognition of climate change in coastal community: A case study in Xiamen City, China. *Ocean & Coastal Management*.
LIU, J. C.-E. & ZHAO, B. 2017. Who speaks for climate change in China? Evidence from Weibo. *Climatic Change,* 140**,** 413-422.
LIU, T. 2018. Super-aging and social security for the most elderly in China. *Zeitschrift für Gerontologie und Geriatrie,* 51**,** 105-112.
LU, X. & ZHAO, B. 2013. Analysis of the climatic characteristics of landing tropical cyclones in East China. *J Trop Meteorol,* 19.

LUBER, G. & MCGEEHIN, M. 2008. Climate change and extreme heat events. *American Journal of Preventive Medicine,* 35**,** 429-435.

LUO, M. & LAU, N.-C. 2017. Heat waves in southern China: synoptic behavior, long-term change, and urbanization effects. *J. Clim.,* 30**,** 703-720.

MA, W., YANG, C., CHU, C., LI, T., TAN, J. & KAN, H. 2013. The impact of the 2008 cold spell on mortality in Shanghai, China. *International Journal of Biometeorology,* 57**,** 179-184.

MA, W., ZENG, W., ZHOU, M., WANG, L., RUTHERFORD, S., LIN, H., LIU, T., ZHANG, Y., XIAO, J. & ZHANG, Y. 2015. The short-term effect of heat waves on mortality and its modifiers in China: an analysis from 66 communities. *Environment International,* 75**,** 103-109.

MARKUS, M., ANGEL, J., BYARD, G., MCCONKEY, S., ZHANG, C., CAI, X., NOTARO, M. & ASHFAQ, M. 2018. Communicating the impacts of projected climate change on heavy rainfall using a weighted ensemble approach. *Journal of Hydrologic Engineering,* 23**,** 04018004.

MARTENS, W. J. 1998. Climate change, thermal stress and mortality changes. *Social science & medicine,* 46**,** 331-344.

MASSAD, E., COUTINHO, F. A. B., LOPEZ, L. F. & DA SILVA, D. R. 2011. Modeling the impact of global warming on vector-borne infections. *Phys. Life Rev,* 8**,** 169-199.

MCCARTHY, M. P., BEST, M. J. & BETTS, R. A. 2010. Climate change in cities due to global warming and urban effects. *Geophysical research letters,* 37.

MCCRIGHT, A. M. 2010. The effects of gender on climate change knowledge and concern in the American public. *Population and Environment,* 32**,** 66-87.

MCMICHAEL, A. J. 2003. Global climate change and health: an old story writ large. *Climate change and human health: Risks and responses. Geneva, Switzerland: World Health Organization*.

MCMICHAEL, A. J., WOODRUFF, R. E. & HALES, S. 2006. Climate change and human health: present and future risks. *Lancet,* 367**,** 859-869.

MI, Z., GUAN, D., LIU, Z., LIU, J., VIGUIÉ, V., FROMER, N. & WANG, Y. 2019. Cities: The core of climate change mitigation. *Journal of Cleaner Production,* 207**,** 582-589.

MIN, T. & ZHANG, T. 2016. Study on the Climate Adaptability of Architectural Interface Opening in Suzhou's Regional Residences. *Procedia Engineering,* 169**,** 108-116.

MISHRA, S. R., BHANDARI, P. M., ISSA, R., NEUPANE, D., GURUNG, S. & KHANAL, V. 2015. Climate change and adverse health events: community perceptions from the Tanahu district of Nepal. *Environmental Research Letters,* 10**,** 034007.

MOREFIELD, P. E., FANN, N., GRAMBSCH, A., RAICH, W. & WEAVER, C. P. 2018. Heat-related health impacts under scenarios of climate and population change. *International journal of environmental research and public health,* 15**,** 2438.

MORGAN, M. G., FISCHHOFF, B., BOSTROM, A. & ATMAN, C. J. 2002. *Risk communication: A mental models approach*, Cambridge University Press.

MU, J. & KHAN, S. 2009. The effect of climate change on the water and food nexus in China. *Food Secur,* 1**,** 413-430.

MURSHED, M. & SAADAT, S. Y. 2018. Effects of Urbanization on Climate Change: Evidence from Bangladesh. *Journal of Natural Sciences Research,* 8**,** 1-8.

MYERS, S. S., SMITH, M. R., GUTH, S., GOLDEN, C. D., VAITLA, B., MUELLER, N. D., DANGOUR, A. D. & HUYBERS, P. 2017. Climate change and global food systems: Potential impacts on food security and undernutrition. *Annual review of public health,* 38**,** 259-277.

NEIRA, M. & PRÜSS-USTÜN, A. 2016. Preventing disease through healthy environments: A global assessment of the environmental burden of disease. *Toxicology Letters***,** S1.

NELSON, V. 2011. Gender, generations, social protection & climate change. *JOUR. http://www. nri. org/images/documents/news2011/gender-generations-social-protection-climatechange. pdf*.

NERLICH, B., KOTEYKO, N. & BROWN, B. 2010. Theory and language of climate change communication. *Wiley Interdisciplinary Reviews: Climate Change,* 1**,** 97-110.

NILSSON, M. & KJELLSTROM, T. 2010. Climate change impacts on working people: how to develop prevention policies. *Global Health Action,* 3**,** 5774.
NISBET, M. C. 2009. Communicating Climate Change: Why Frames Matter for Public Engagement. *Environment: Science and Policy for Sustainable Development,* 51**,** 12-23.
NITSCHKE, M., HANSEN, A., BI, P., PISANIELLO, D., NEWBURY, J., KITSON, A., TUCKER, G., AVERY, J. & DAL GRANDE, E. 2013. Risk factors, health effects and behaviour in older people during extreme heat: a survey in South Australia. *International Journal of Environmental Research and Public Health,* 10**,** 6721-6733.
O'BRIEN, K. L. & WOLF, J. 2010. A values-based approach to vulnerability and adaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change,* 1**,** 232-242.
O'CONNOR, J. E. & COSTA, J. E. 2004. The world's largest floods, past and present: their causes and magnitudes. *US Geological Survey Circular***,** 1-13.
O’BRIEN, K. 2010. Responding to climate change. *Integral Theory in Action: Applied, Theoretical, and Constructive Perspectives on the AQAL Model***,** 65.
OCKWELL, D., WHITMARSH, L. & O'NEILL, S. 2009. Reorienting Climate Change Communication for Effective Mitigation Forcing People to be Green or Fostering Grass-Roots Engagement? *Science Communication,* 30**,** 305-327.
OJOMO, E., ELLIOTT, M., AMJAD, U. & BARTRAM, J. 2015. Climate change preparedness: A knowledge and attitudes study in southern Nigeria. *Environments,* 2**,** 435-448.
ONTA, N. & RESURRECCION, B. P. 2011. The role of gender and caste in climate adaptation strategies in Nepal. *Mountain Research and Development,* 31**,** 351-357.
OTSUKA, K. & FAN, S. 2021. Agricultural development : new perspectives in a changing world. Washington, DC: International Food Policy Research Institute,.
OTTO, I. M., RECKIEN, D., REYER, C. P., MARCUS, R., LE MASSON, V., JONES, L., NORTON, A. & SERDECZNY, O. 2017. Social vulnerability to climate change: a review of concepts and evidence. *Reg. Environ. Chang.,* 17**,** 1651-1662.
PAHL-WOSTL, C. 2007. Transitions towards adaptive management of water facing climate and global change. *Water Resour Manag,* 21**,** 49-62.
PAN, X.-C. & LIU, J. 2011. Study on health effects of dust storms (Asian dusts) in China. *Epidemiology,* 22**,** S26-S27.
PARK, H. M. 2015. Regression models for binary dependent variables using STATA, SAS, R, LIMDEP, AND SPSS.
PATZ, J. A., CAMPBELL-LENDRUM, D., HOLLOWAY, T. & FOLEY, J. A. 2005. Impact of regional climate change on human health. *Nature,* 438**,** 310-317.
PAUL, G. & STEGBAUER, C. 2005. Is the digital divide between young and elderly people increasing? *First Monday,* 10.
PEARCE, W., BROWN, B., NERLICH, B. & KOTEYKO, N. 2015. Communicating climate change: conduits, content, and consensus. *Wiley interdisciplinary reviews: Climate change,* 6**,** 613-626.
PEEL, J. L., HAEUBER, R., GARCIA, V., RUSSELL, A. G. & NEAS, L. 2013. Impact of nitrogen and climate change interactions on ambient air pollution and human health. *Biogeochemistry,* 114**,** 121-134.
PETTENGELL, C. 2010. Climate Change Adaptation: Enabling people living in poverty to adapt. *Oxfam Policy and Practice: Climate Change and Resilience,* 6**,** 1-48.
PIAO, S., CIAIS, P., HUANG, Y., SHEN, Z., PENG, S., LI, J., ZHOU, L., LIU, H., MA, Y., DING, Y., FRIEDLINGSTEIN, P., LIU, C., TAN, K., YU, Y., ZHANG, T. & FANG, J. 2010. The impacts of climate change on water resources and agriculture in China. *Nature,* 467**,** 43-51.
PIDGEON, N. 2012. Public understanding of, and attitudes to, climate change: UK and international perspectives and policy. *Climate Policy,* 12**,** S85-S106.
PILLAY, M. 2005. *Knowledge, Attitude and Practices (KAP) survey.* Stellenbosch: Stellenbosch University.

PLOTNIKOFF, R. C., WRIGHT, M.-F. & KARUNAMUNI, N. 2004. Knowledge, attitudes and behaviours related to climate change in Alberta, Canada: implications for public health policy and practice. *International Journal of Environmental Health Research,* 14**,** 223-229.

POORTINGA, W., WHITMARSH, L., STEG, L., BÖHM, G. & FISHER, S. 2019. Climate change perceptions and their individual-level determinants: A cross-European analysis. *Global Environmental Change,* 55**,** 25-35.

PORTIER, C. J., TART, K. T., CARTER, S. R., DILWORTH, C. H., GRAMBSCH, A. E., GOHLKE, J., HESS, J., HOWARD, S., LUBER, G. & LUTZ, J. 2013. A human health perspective on climate change: a report outlining the research needs on the human health effects of climate change. *Journal of Current Issues in Globalization,* 6**,** 621.

POUMADERE, M., MAYS, C., LE MER, S. & BLONG, R. 2005. The 2003 heat wave in France: dangerous climate change here and now. *Risk Analysis: an International Journal,* 25**,** 1483-1494.

PUGATCH, T. 2019. Tropical storms and mortality under climate change. *World Development,* 117**,** 172-182.

QIN, D., DING, Y. & MU, M. 2015. *Climate and environmental change in China: 1951–2012*, Springer.

QU, S., WANG, L., LIN, A., YU, D. & YUAN, M. 2020. Distinguishing the impacts of climate change and anthropogenic factors on vegetation dynamics in the Yangtze River Basin, China. *Ecological Indicators,* 108**,** 105724.

RAHMAN, M. S., KARAMEHIC-MURATOVIC, A., BAGHBANZADEH, M., AMRIN, M., ZAFAR, S., RAHMAN, N. N., SHIRINA, S. U. & HAQUE, U. 2021. Climate change and dengue fever knowledge, attitudes and practices in Bangladesh: A social media–based cross-sectional survey. *Transactions of The Royal Society of Tropical Medicine and Hygiene,* 115**,** 85-93.

RATCLIFFE, J. W. 1976. Analyst biases in KAP surveys: A cross-cultural comparison. *Studies in family planning,* 7**,** 322-330.

RAWLINS, S., CHEN, A., RAWLINS, J., CHADEE, D. & LEGALL, G. 2007. A knowledge, attitude and practices study of the issues of climate change/variability impacts and public health in Trinidad and Tobago, and St Kitts and Nevis. *West Indian Medical Journal,* 56**,** 115-121.

RHOADES, J. L., GRUBER, J. S. & HORTON, B. 2017. Developing an In-depth Understanding of Elderly Adult's Vulnerability to Climate Change. *The Gerontologist***,** gnw167.

ROBBINS, D. 2020. Climate change frame production: Perspectives from government ministers and senior media strategists in Ireland. *Environmental Communication,* 14**,** 509-521.

ROBINSON, P. J. 2001. On the definition of a heat wave. *J. Appl. Meteorol.,* 40**,** 762-775.

ROBINSON, S.-A. 2017. Climate change adaptation in small island developing states.

ROEHR, U. 2007. Gender, climate change and adaptation. Introduction to the gender dimensions. *Background Paper prepared for the Both Ends Briefing Paper Adapting to climate change: How local experiences can shape the debate*.

RYTI, N. R., GUO, Y. & JAAKKOLA, J. J. 2016. Global association of cold spells and adverse health effects: a systematic review and meta-analysis. *Environmental Health Perspectives,* 124**,** 12.

SAXENA, A., QUI, K. & ROBINSON, S.-A. 2018. Knowledge, attitudes and practices of climate adaptation actors towards resilience and transformation in a 1.5° C world. *Environmental Science & Policy,* 80**,** 152-159.

SCHÄFER, M. S. & PAINTER, J. 2021. Climate journalism in a changing media ecosystem: Assessing the production of climate change-related news around the world. *Wiley Interdisciplinary Reviews: Climate Change,* 12**,** e675.

SCHNEIDER, A., RÜCKERL, R., BREITNER, S., WOLF, K. & PETERS, A. 2017. Thermal control, weather, and aging. *Current Environmental Health Reports,* 4**,** 21-29.

SCHOPPER, D., DOUSSANTOUSSE, S. & ORAV, J. 1993. Sexual behaviors relevant to HIV transmission in a rural African population: How much can a KAP survey tell us? *Social science & medicine,* 37**,** 401-412.

SCHWARTZ, J. 2000. Harvesting and long term exposure effects in the relation between air pollution and mortality. *American journal of epidemiology,* 151**,** 440-448.

SEMENZA, J. C., WILSON, D. J., PARRA, J., BONTEMPO, B. D., HART, M., SAILOR, D. J. & GEORGE, L. A. 2008. Public perception and behavior change in relationship to hot weather and air pollution. *Environmental research,* 107**,** 401-411.

SEROUSSI, D.-E., ROTHSCHILD, N., KURZBAUM, E., YAFFE, Y. & HEMO, T. 2019. Teachers' Knowledge, Beliefs, and Attitudes about Climate Change. *International Education Studies,* 12**,** 33-45.

SHAO-HONG, W., TAO, P. & SHAN-FENG, H. 2012. Climate change risk research: a case study on flood disaster risk in China. *Adv. Clim. Change Res.,* 3**,** 92-98.

SHEFFIELD, J., WOOD, E. F. & RODERICK, M. L. 2012. Little change in global drought over the past 60 years. *Nature,* 491**,** 435-438.

SHENG, W., JUN, L. & BIWEN, W. 2008. Research on the summer precipitation variation in Anhui province and the influence on drought-flood. *Journal of Anhui Agricultural Sciences,* 36**,** 2870.

SHI, Y., SHEN, Y., LI, D., ZHANG, G., DING, Y., HU, R. & KANG, E. 2003. Discussion on the present climate change from warm-dry to warm-wet in northwest China. *J. Quaternary Sci.,* 23**,** 152-164.

SHOVE, E. 2010. Beyond the ABC: climate change policy and theories of social change. *Environment and planning A,* 42**,** 1273-1285.

SKANAVIS, C., KOUNANI, A., KOUKOULIS, A., MARIPAS-POLYMERIS, G., TSAMOPOULOS, K. & VALKANAS, S. 2019. Climate Change Communication: A Friendly for Users App. *Addressing the Challenges in Communicating Climate Change Across Various Audiences.* Springer.

SPENCE, A. & PIDGEON, N. 2010. Framing and communicating climate change: The effects of distance and outcome frame manipulations. *Global Environmental Change,* 20**,** 656-667.

STADDON, P. L., MONTGOMERY, H. E. & DEPLEDGE, M. H. 2014. Climate warming will not decrease winter mortality. *Nature Climate Change,* 4**,** 190-194.

STANKE, C., KERAC, M., PRUDHOMME, C., MEDLOCK, J. & MURRAY, V. 2013. Health effects of drought: a systematic review of the evidence. *PLoS Currents,* 5.

STEDMAN, J. R. 2004. The predicted number of air pollution related deaths in the UK during the August 2003 heatwave. *Atmospheric Environment,* 38**,** 1087-1090.

STONE, B., HESS, J. J. & FRUMKIN, H. 2010. Urban form and extreme heat events: are sprawling cities more vulnerable to climate change than compact cities? *Environmental health perspectives,* 118**,** 1425-1428.

STONE, L. & CAMPBELL, J. 1984. The use and misuse of surveys in international development: an experiment from Nepal. *Human Organization,* 43**,** 27-37.

SUEN, L.-J. W., HUANG, H.-M. & LEE, H.-H. 2014. A comparison of convenience sampling and purposive sampling. *Hu Li Za Zhi,* 61**,** 105.

SUGAR, L. 2010. *Global cities and their response to climate change.*

SUMI, A., FUKUSHI, K. & HIRAMATSU, A. 2010. *Adaptation and mitigation strategies for climate change,* Tokyo ; New York, Springer.

THOMAS, A. & BAPTISTE, A. K. 2018. Knowledge, perceptions, concerns, and behaviors to climate change—the Caribbean context: an introduction. *Journal of Environmental Studies and Sciences,* 8**,** 39-41.

THOMAS, K., HARDY, R. D., LAZRUS, H., MENDEZ, M., ORLOVE, B., RIVERA-COLLAZO, I., ROBERTS, J. T., ROCKMAN, M., WARNER, B. P. & WINTHROP, R. 2019. Explaining differential vulnerability to climate change: A social science review. *Wiley Interdisciplinary Reviews: Climate Change,* 10**,** e565.

THOW, A. & DE BLOIS, M. 2008. Climate change and human vulnerability: Mapping emerging trends and risk hotspots for humanitarian actors. *Report to the UN Office for Coordination of Humanitarian Affairs by Maplecroft, Bath*.

TIAN, H., ZHOU, S., DONG, L., VAN BOECKEL, T. P., CUI, Y., NEWMAN, S. H., TAKEKAWA, J. Y., PROSSER, D. J., XIAO, X. & WU, Y. 2015. Avian influenza H5N1 viral and bird migration networks in Asia. *Proc. Natl. Acad. Sci.,* 112**,** 172-177.

TIAN, Z., LI, S., ZHANG, J., JAAKKOLA, J. J. & GUO, Y. 2012. Ambient temperature and coronary heart disease mortality in Beijing, China: a time series study. *Environ. Health,* 11**,** 56.

TOLAN, S. 2007. Coverage of climate change in Chinese media. *Human Development Report,* 8.

TONG, S., BERRY, H. L., EBI, K., BAMBRICK, H., HU, W., GREEN, D., HANNA, E., WANG, Z. & BUTLER, C. D. 2016. Climate change, food, water and population health in China. *Bulletin of the World Health Organization,* 94**,** 759.

TURNER, B. L., KASPERSON, R. E., MATSON, P. A., MCCARTHY, J. J., CORELL, R. W., CHRISTENSEN, L., ECKLEY, N., KASPERSON, J. X., LUERS, A. & MARTELLO, M. L. 2003. A framework for vulnerability analysis in sustainability science. *Proc. Natl. Acad. Sci.,* 100**,** 8074-8079.

UPRETI, B. N., DHAKAL, S., BHATTARAI, T. N., ADHIKARI, B. R., BAJRACHARYA, S. R. & YOSHIDA, M. 2017. Climate change impact on glacier retreat and local community in the Langtang Valley, Central Nepal. *Journal of Development Innovations,* 1**,** 45-59.

VALSAMIS, E. M., HUSBAND, H. & CHAN, G. K.-W. 2019. Segmented Linear Regression Modelling of Time-Series of Binary Variables in Healthcare. *Computational and Mathematical Methods in Medicine,* 2019.

VAN LOENHOUT, J., LE GRAND, A., DUIJM, F., GREVEN, F., VINK, N., HOEK, G. & ZUURBIER, M. 2016. The effect of high indoor temperatures on self-perceived health of elderly persons. *Environmental Research,* 146**,** 27-34.

VINCENT, K., WANJIRU, L., AUBRY, A., MERSHON, A., NYANGDIGA, C., TRACY, C. & BANDA, K. 2010. Gender, Climate Change and Community Based Adaptation. *United Nations Development Programme, New York*.

WANG, J., GAO, W., XU, S. & YU, L. 2012. Evaluation of the combined risk of sea level rise, land subsidence, and storm surges on the coastal areas of Shanghai, China. *Climatic change,* 115**,** 537-558.

WANG, J., YE, M., LIU, Y. & XU, S. Design of integrated toolkit for coastal natural disaster risk assessment based on GIS technology. Geoinformatics, 2011 19th International Conference on, 2011. IEEE, 1-6.

WANG, K., ZHONG, S., WANG, X., WANG, Z., YANG, L., WANG, Q., WANG, S., SHENG, R., MA, R. & LIN, S. 2017. Assessment of the public health risks and impact of a tornado in Funing, China, 23 june 2016: a retrospective analysis. *International journal of environmental research and public health,* 14**,** 1201.

WANG, R., YANG, Y., CHEN, R., KAN, H., WU, J., WANG, K., MADDOCK, J. E. & LU, Y. 2015. Knowledge, attitudes, and practices (KAP) of the relationship between air pollution and children's respiratory health in Shanghai, China. *International journal of environmental research and public health,* 12**,** 1834-1848.

WANG, X., DONG, Z., ZHANG, J. & LIU, L. 2004. Modern dust storms in China: an overview. *Journal of Arid Environments,* 58**,** 559-574.

WANG, Y., SONG, Q., DU, Y., WANG, J., ZHOU, J., DU, Z. & LI, T. 2019. A random forest model to predict heatstroke occurrence for heatwave in China. *Science of the Total Environment,* 650**,** 3048-3053.

WATTS, N., ADGER, W. N., AGNOLUCCI, P., BLACKSTOCK, J., BYASS, P., CAI, W., CHAYTOR, S., COLBOURN, T., COLLINS, M. & COOPER, A. 2015. Health and climate change: policy responses to protect public health. *Lancet,* 386**,** 1861-1914.

WELLNER, R. W. & BARTEK, L. R. 2003. The effect of sea level, climate, and shelf physiography on the development of incised-valley complexes: a modern example from the East China Sea. *J. Sediment. Res.,* 73**,** 926-940.

WHITMARSH, L. 2008. Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of risk research,* 11**,** 351-374.

WHITMARSH, L. E. 2005. *A study of public understanding of and response to climate change in the South of England.* University of Bath Bath.

WHO 2008. Advocacy, communication and social mobilization for TB control: a guide to developing knowledge, attitude and practice surveys. WHO.

WHO 2014. *Gender, climate change and health*, World Health Organization.

WILSON, K. M. 2000. Communicating climate change through the media. *Environmental risks and the media***,** 201-217.

WOLF, J., ADGER, W. N., LORENZONI, I., ABRAHAMSON, V. & RAINE, R. 2010. Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. *Global Environmental Change,* 20**,** 44-52.

WRIGHT, D. L., AQUILINO, W. S. & SUPPLE, A. J. 1998. A comparison of computer-assisted and paper-and-pencil self-administered questionnaires in a survey on smoking, alcohol, and drug use. *Public opinion quarterly***,** 331-353.

WU, J. S. & LEE, J. J. 2015. Climate change games as tools for education and engagement. *Nature Climate Change,* 5**,** 413-418.

WU, X., LU, Y., ZHOU, S., CHEN, L. & XU, B. 2016. Impact of climate change on human infectious diseases: empirical evidence and human adaptation. *Environment International,* 86**,** 14-23.

XIAO, J., FAN, W., DENG, Y., LI, S. & YAN, P. 2016. Nurses' knowledge and attitudes regarding potential impacts of climate change on public health in central of China. *International Journal of Nursing Sciences,* 3**,** 158-161.

XING, Y.-F., XU, Y.-H., SHI, M.-H. & LIAN, Y.-X. 2016. The impact of PM2. 5 on the human respiratory system. *Journal of Thoracic Disease,* 8**,** E69-E74.

YANG, J., LIU, H.-Z., OU, C.-Q., LIN, G.-Z., ZHOU, Q., SHEN, G.-C., CHEN, P.-Y. & GUO, Y. 2013. Global climate change: Impact of diurnal temperature range on mortality in Guangzhou, China. *Environmental Pollution,* 175**,** 131-136.

YANG, J., YIN, P., SUN, J., WANG, B., ZHOU, M., LI, M., TONG, S., MENG, B., GUO, Y. & LIU, Q. 2019. Heatwave and mortality in 31 major Chinese cities: Definition, vulnerability and implications. *Science of The Total Environment,* 649**,** 695-702.

YAO-DONG, D., XIAN-WEI, W., XIAO-FENG, Y., WEN-JUN, M., HUI, A. & XIAO-XUAN, W. 2013. Impacts of climate change on human health and adaptation strategies in South China. *Adv. Clim. Change Res.,* 4**,** 208-214.

YE, Q. & GLANTZ, M. 2005. The 1998 Yangtze floods: The use of short-term forecasts in the context of seasonal to interannual water resource management. *Mitig. adapt. strategies glob. chang.,* 10**,** 159-182.

YIN, H., XU, L. & CAI, Y. 2015. Monetary Valuation of PM10-Related Health Risks in Beijing China: The Necessity for PM10 Pollution Indemnity. *International journal of environmental research and public health,* 12**,** 9967-9987.

YIN, Q. & WANG, J. 2017. The association between consecutive days' heat wave and cardiovascular disease mortality in Beijing, China. *BMC Public Health,* 17**,** 223.

YONG-JIAN, R., JIANG-XUE, C., SU-QIN, W., MIN, L., ZHENG-HONG, C., YU-FANG, L. & JI-JUN, W. 2013. Climate change impacts on central China and adaptation measures. *Adv. Clim. Change Res.,* 4**,** 215-222.

YU, M., LI, Q., HAYES, M. J., SVOBODA, M. D. & HEIM, R. R. 2014. Are droughts becoming more frequent or severe in China based on the standardized precipitation evapotranspiration index: 1951–2010? *Int. J. Climatol.,* 34**,** 545-558.

YU, P., TIAN, H., MA, C., MA, C., WEI, J., LU, X., WANG, Z., ZHOU, S., LI, S. & DONG, J. 2015. Hantavirus infection in rodents and haemorrhagic fever with renal syndrome in Shaanxi province, China, 1984–2012. *Epidemiology & Infection,* 143**,** 405-411.

YUAN, X.-C., TANG, B.-J., WEI, Y.-M., LIANG, X.-J., YU, H. & JIN, J.-L. 2015. China's regional drought risk under climate change: a two-stage process assessment approach. *Natural Hazards,* 76**,** 667-684.

ZAHRAN, S., BRODY, S. D., VEDLITZ, A., GROVER, H. & MILLER, C. 2008. Vulnerability and capacity: explaining local commitment to climate-change policy. *Environment and Planning C: Government and policy,* 26**,** 544-562.

ZENG, W., LAO, X., RUTHERFORD, S., XU, Y., XU, X., LIN, H., LIU, T., LUO, Y., XIAO, J. & HU, M. 2014. The effect of heat waves on mortality and effect modifiers in four communities of Guangdong Province, China. *Science of the Total Environment,* 482**,** 214-221.

ZENG, Y., GU, D., PURSER, J., HOENIG, H. & CHRISTAKIS, N. 2010. Associations of environmental factors with elderly health and mortality in China. *American Journal of Public Health,* 100**,** 298-305.

ZHAI, P., ZHANG, X., WAN, H. & PAN, X. 2005. Trends in total precipitation and frequency of daily precipitation extremes over China. *Journal of climate,* 18**,** 1096-1108.

ZHANG, D.-E. 2012. A study of the large scale flooding over eastern China in 1755. *Adv. Clim. Change Res.,* 3**,** 128-137.

ZHANG, J. & LIU, Z. 2006. Hydrological monitoring and flood management in China. *IAHS Publications-Series of Proceedings and Reports,* 305**,** 93-102.

ZHANG, J., ZHOU, C., XU, K. & WATANABE, M. 2002. Flood disaster monitoring and evaluation in China. *Global Environmental Change Part B: Environmental Hazards,* 4**,** 33-43.

ZHANG, M., SONG, Y., CAI, X. & ZHOU, J. 2008a. Economic assessment of the health effects related to particulate matter pollution in 111 Chinese cities by using economic burden of disease analysis. *Journal of Environmental Management,* 88**,** 947-954.

ZHANG, Q., GEMMER, M. & CHEN, J. 2008b. Climate changes and flood/drought risk in the Yangtze Delta, China, during the past millennium. *Quaternary International,* 176**,** 62-69.

ZHANG, Y., FENG, R., WU, R., ZHONG, P., TAN, X., WU, K. & MA, L. 2017. Global climate change: impact of heat waves under different definitions on daily mortality in Wuhan, China. *Global Health Research and Policy,* 2**,** 10.

ZHANG, Y., WANG, J. N., MA, W., NITSCHKE, M., HANSEN, A., BI, P. & JIANG, B. F. 2016. Case study: Improving population health in a rapidly urbanizing world: Are older chinese people ready to adapt to climate change? *Urbanization and in Public Health China.* World Scientific.

ZHAO, Y., CHENG, Z., LU, Y., CHANG, X., CHAN, C., BAI, Y., ZHANG, Y. & CHENG, N. 2017. PM10 and PM2. 5 particles as main air pollutants contributing to rising risks of coronary heart disease: a systematic review. *Environmental Technology Reviews,* 6**,** 174-185.

ZHENG, J.-Y., WANG, W.-C., GE, Q.-S., MAN, Z.-M. & ZHANG, P.-Y. 2006. Precipitation variability and extreme events in eastern China during the past 1500 years. *Terr Atmos Ocean Sci,* 17**,** 579-592.

ZHENG, J., HAN, W., JIANG, B., MA, W. & ZHANG, Y. 2017. Infectious Diseases and Tropical Cyclones in Southeast China. *International journal of environmental research and public health,* 14**,** 494.

ZHOU, L., CHEN, K., CHEN, X., JING, Y., MA, Z., BI, J. & KINNEY, P. L. 2017. Heat and mortality for ischemic and hemorrhagic stroke in 12 cities of Jiangsu Province, China. *Science of The Total Environment,* 601**,** 271-277.

ZHOU, M., WANG, H., ZHU, J., CHEN, W., WANG, L., LIU, S., LI, Y., WANG, L., LIU, Y. & YIN, P. 2016. Cause-specific mortality for 240 causes in China during 1990–2013: a systematic subnational analysis for the Global Burden of Disease Study 2013. *Lancet,* 387**,** 251-272.

ZHOU, M. G., WANG, L. J., LIU, T., ZHANG, Y. H., LIN, H. L., LUO, Y., XIAO, J. P., ZENG, W. L., ZHANG, Y. W. & WANG, X. F. 2014. Health impact of the 2008 cold spell on mortality in subtropical China: the climate and health impact national assessment study (CHINAs). *Environ. Health,* 13**,** 60.

ZHOU, W., ZHU, J. & LI, J. 2009. Characteristics of climate change for heat resources in east China. *Resources Science,* 31**,** 472-478.

ZHU, Z., PENG, D. & WANG, H. 2019. Seawater desalination in China: an overview. *Journal of Water Reuse and Desalination,* 9**,** 115-132.

ZONG, Y. & CHEN, X. 2000. The 1998 flood on the Yangtze, China. *Nat. Hazards,* 22**,** 165-184.

ZOU, Y. & ZHAO, P. 2010. Comparison of some tropical cyclone datasets and correction of yearbook data. *熱帶氣象學報(英文版),* 16**,** 109-114.

APPENDICES

APPENDIX A. PUBLISHED VERSION OF 'PAPER 1' CHAPTER 2.
APPENDIX B. REGRESSION TABLES FOR CHAPTER 6
APPENDIX C. PRESENTATION OF SURVEYS FOR CHAPTER 4-5-6.
APPENDIX D. CONSENT FORM
APPENDIX E. COMMUNICATION TOOLS

NRC Research Press

Direct and indirect health impacts of climate change on the vulnerable elderly population in East China

Pelin Kınay, Andrew P. Morse, Elmer V. Villanueva, Karyn Morrissey, and Philip L. Staddon

Abstract: The latest scientific advances on the impacts of climate change on the health of the elderly in East China were reviewed consulting peer-reviewed publications from 2000 to 2017. The direct impacts of climate change result from rising temperatures, heat waves, and increases in the frequency of complex extreme weather events such as windstorms, floods, and droughts. The health and social consequences of these events are far reaching, ranging from reduced labor productivity and heat-related deaths through to direct physical injury during extreme weather events, the spread of infectious diseases, and mental health effects following widespread flooding or prolonged drought. Research has indicated that climate change will have the greatest impact on vulnerable groups of people, including the elderly population. However, there is a dearth of empirical evidence, a lack of focus on vulnerable segments of the population (especially elderly), limited understanding of how health status will change in the future, and lack of acknowledgement of how different regions in China vary in terms of the consequences of climate change. The main risk in East China that climate change may exacerbate is flooding (sea level rise, coastal and riverine, flood risk). However, in some regions of East China such as in the provinces of Anhui, Jiangsu, Hebei, and Shandong the biggest climate change risk is considered to be drought. Main health risks linked to climate change are evident as cardiovascular and respiratory diseases (heat stroke, exhaustion, and asthma), often caused by interactions between heat wave episodes and concurrent poor air quality.

Key words: climate change, East China, elderly, health impacts, flooding, heat waves.

Résumé : Les derniers progrès scientifiques concernant les impacts du changement climatique sur la santé des personnes âgées en Chine orientale ont été examinés en consultant les publications évaluées par des pairs de 2000 à 2017. Les répercussions directes du changement climatique découlent de la hausse des températures, des vagues de chaleur et de l'augmentation de la fréquence des phénomènes météorologiques extrêmes complexes comme les tempêtes de vent, les inondations et les sécher- esses. Les conséquences de ces événements sur la santé et la société sont considérables, allant de la réduction de la productivité du travail et des décès liés à la chaleur, jusqu'à des blessures physiques directes lors d'événements météorologiques extrêmes, à la propagation de maladies infectieuses et aux effets sur la santé mentale à la suite d'inondations généralisées ou de sécheresses prolongées. Les recherches ont montré que le changement climatique aura le plus grand impact sur les groupes vulnérables, y compris la population âgée. Cependant, il y a un manque de données empiriques, une absence d'orientation pour les segments vulnérables de la population (en particulier les personnes âgées), une compréhension limitée de la façon dont l'état de santé changera dans l'avenir, et un manque de reconnaissance des variations entre les différentes régions de la Chine au niveau des conséquences du changement climatique. Le principal risque d'aggravation du changement climatique en Chine orientale est l'inondation (élévation du niveau de la mer, risque d'inondation riveraine et côtière). Cependant, dans certaines régions de la Chine orientale comme dans les provinces d'Anhui, de Jiangsu, de Hebei et de Shandong, la sécheresse est considérée comme le plus grand risque du changement climatique. Les principaux risques pour la santé liés aux changements climatiques sont évidents tels que les maladies cardiovasculaires et respiratoires (coup de chaleur, épuisement et asthme), souvent causées par les interactions entre les épisodes de vague de chaleur et la mauvaise qualité de l'air concomitante. [Traduit par la Rédaction]

Mots-clés : changement climatique, Chine orientale, personnes âgées, impacts sur la santé, inondations, vagues de chaleur.

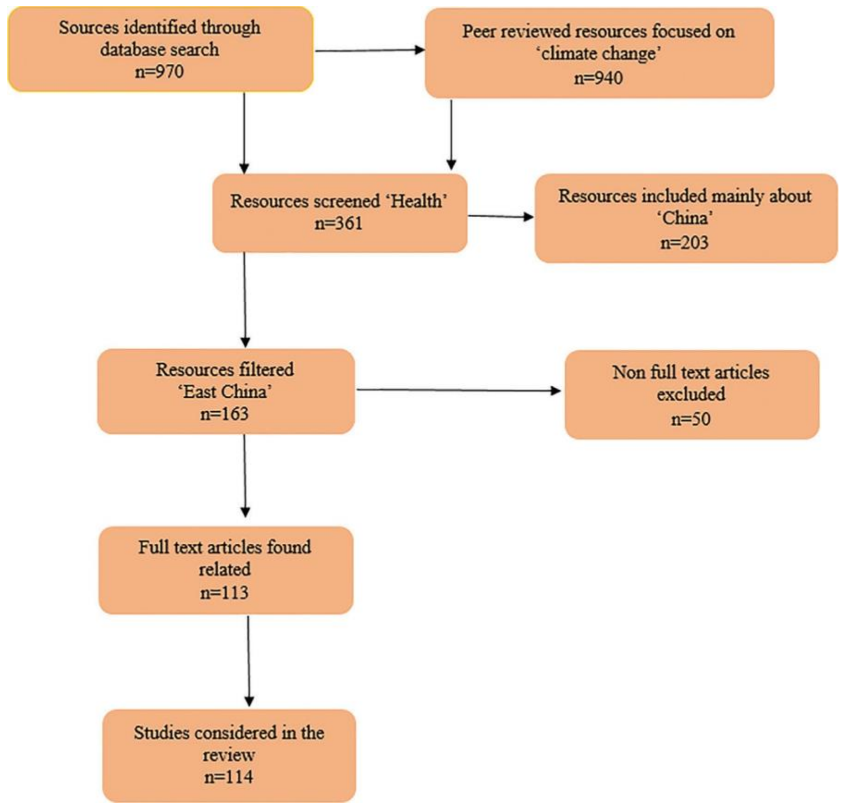
Introduction

Many prevalent human diseases respond to climatic conditions (Liang and Gong 2017). Links between weather and climate exist for cardiovascular diseases (Kim et al. 2015), respiratory illnesses (Hopkinson et al. 2017), and infectious diseases, including water-, food-, and vector-borne, are well established (Patz et al. 2005).

Climate change is one of the greatest challenges currently facing humanity and it is considered to be the biggest global threat to public health this century (Costello et al. 2009). *The Lancet* Com- mission on Climate Change and Human Health noted that the impacts of climate change, through rising temperatures, heat waves, and increases in the frequency of complex extreme weather events such as windstorms, floods, and droughts, are already being felt and

Environ. Rev. **27**: 295–303 (2019) dx.doi.org/10.1139/er-2017-0095 Published at www.nrcresearchpress.com/er on 5 November 2018.

Fig. 1. Prisma flow chart for literature review.



these climate change impacts will have substantial costs to human health (Costello et al. 2009; Portier et al. 2013). Climate change will affect human health via multiple pathways of direct and in- direct impacts (Frumkin et al. 2008; Massad et al. 2011). The effects of climate change on human health will include health prob- lems linked to heat stress, flooding, and increased frequency and intensity of storms (Easterling et al. 2000). For example, cardiovascular and respiratory diseases, may be induced by heat waves and air quality interactions (Kan et al. 2012). Climate change also indirectly threatens human health through adverse changes in temperature (Peel et al. 2013), vector-borne infectious diseases (Epstein 2001), and via food and water quality and security (Myers et al. 2017). Forced migration and shortage of resources can also be predicted as indirect impacts of climate change on human health (Watts et al. 2015).

The climate in China and East China has already experienced significant changes in recent years (Qin et al. 2015). This review focuses on the impacts of climate change on health in the elderly in East China, which is home to 408 million people, and is one of the key economic areas in China. Demographically, population projections predict that by 2050 one-third of the Chinese popula- tion will be elderly (aged older than 65 years) (Yao-Dong et al. 2013). The elderly are a population group that has been identified as being particularly vulnerable and susceptible to the wide range of environmental and societal impacts of climate (Zeng et al. 2010). Thus, the future health profile and needs of this population needs to be a key consideration for Chinese policy-makers. Several studies have been carried out in China related to the health con- cerns of climate change and some have quantified the direct im- pacts of climate change in the health of the elderly population (McMichael et al. 2006; Wu et al. 2016; Zhou et al. 2017). Most studies focus on health impacts of extreme heat and highlights the health risks to the elderly population (cardiovascular, respira- tory, stroke, ischemic heart disease) (Chen et al. 2017; Zhang et al. 2017). Given the large size of the affected population, the climate and environmental diversity across regions and the diverse socio-economic status across East China, it is considered timely to review and summarize the latest scientific advances in under- standing the likely future health impacts of climate change. Here, a broad range of studies on the potential risks of climate change impacts in China are reviewed, the current state of knowledge on the health impacts of climate change in the elderly Chinese pop- ulation is presented, and methods and limitations of previous research are examined.

Approach

Peer-reviewed publications that reported the impact of future climate scenarios on risks to health are reviewed. Web of Science, Environment Complete (EBSCO), Google Scholar, and Science Direct databases were used for the research. The review is based on a structured literature search, but did not include a formal meta-analysis, as too few studies reported suitable effect size for meaningful comparison. The search terms were used in combina- tion and included "climate change", "health", "China", and "elderly"; "East China" was used to filter the resources. This search returned many off-topic articles, as evidenced by their titles and abstracts. Owing to the large number of publications we cannot give an exhaustive overview of all studies. Instead, the most important, relevant, and novel publications were considered to form the main body of review. Since 2000, 970 full articles were identi- fied including 940 confirmed as peer reviewed. Within these results a further search was performed with the term "health impacts" and this filter resulted in 361 articles. The final search identified 163 studies and 114 studies were chosen for this review as they were highly relevant (Fig. 1).

Recent and future climate change in China

Future predictions indicate that climate change may exacerbate a wide range of extreme weather events in China, including ty-

Table 1. Various concepts of vulnerability (based on Füssel 2007).

System (the system or region and/or population group and/or sector of concern)
Human environment
Geographical region
Economic sector Natural system
Attribute of concerns (the valued attribute (or variables of concern) of the vulnerable system that are threatened by its exposure to the hazard)
Human health and life Existence and natural identity
Biodiversity and ecosystem services Income and livelihood
Hazards (the external stressor (or set of stressors) of concern) External – floods
Internal – unsustainable farming practices **Temporal reference** (the time period of interest) Current
Future

phoons, floods, and droughts (Kan 2011). For China different emis- sion scenarios estimate that, by the year 2020 averaged annual mean temperature will increase by 1.5–2.1 °C, by the year 2050 by 2.3–3.3 °C, and by the year 2100 by 3.9–6 °C (Ding et al. 2007). Across most of China future temperatures are expected to rise another 1.3–5 °C by the end of the century, in comparison with the global average predicted rise of 1–3.7 °C (Ding et al. 2007; Guoju et al. 2005).

Studies have shown recent trends in annual and summer total precipitation and the large regional precipitation variability in China (Shi et al. 2003; Zhai et al. 2005). In the last decade China has suffered a series of extreme droughts, including the spring– summer drought in northern China in 2000 and 2001, the spring drought in Yunnan in 2005, the spring–summer drought in Sich- uan and Chongqing in 2006, the summer drought in southern China in 2007, the summer drought in Chongqing in 2008, and the spring–summer drought in five southwest provinces in 2010 (Barriopedro et al. 2012). Indeed, data on droughts and floods in the Yangtze and Yellow Rivers over the last 2000 years found that although the intensity of flooding in the 20th century was com- parable with historical events, previous drought events were less intense (Zheng et al. 2006). Between 1876 and 1878 a drought occurred in China that was considered as an extreme climate event after the cold climate at the end of the Little Ice Age (this is a period between about 1300 and 1870) (Zhang and Liang 2010).

Sea level rise in East China is another further concern (Wellner and Bartek 2003). China Meteorological Administration states that a sea level rise of 60 cm by 2050 could make economic growth in Shanghai vulnerable and also poses health risks for the vulner- able segments of the population (Hu 2017).

Vulnerability to climate change

The concept of vulnerability is defined as an important exten- sion of traditional risk analysis, which is focused primarily on natural hazards (Kok and Jäger 2009; Leichenko and O'Brien 2002; Otto et al. 2017; Turner et al. 2003). Table 1 presents various con- cepts of vulnerability (Füssel 2007).

Vulnerabilities may vary greatly from those associated with hu- man health to built infrastructure (Heltberg et al. 2009). Human vulnerability factors can be divided into five groups: natural vul- nerability, human vulnerability, social vulnerability, financial vulnerability, and physical vulnerability (Thow and de Blois 2008) (Fig. 2). The vulnerability levels of human populations vary de- pending on conditions (McMichael 2003). For example, some pop- ulation subgroups may have difficulty adapting to climate change because of scarce resources, lack of information, poor public health infrastructure, as well as a lack of effective guidance and help (Corvalan et al. 2005).

Population groups including the elderly, children, and disabled are considered particularly vulnerable to climate change (Watts et al. 2015). Age is a well-known risk factor for heat-related illness and death and the elderly are under the greatest risk (Basu and Samet 2002).

Increased human health vulnerability to climate change is as- sociated with many factors including rapid population growth (as in the case of China), poverty and hunger, poor health, low levels of education, and lack of access to information on climate change (Demirkesen and Evrendilek 2017; Füssel and Klein 2006). It has been shown that the elderly (people who are 65 years or older) are particularly vulnerable to the impacts of heat waves (Li et al. 2017*b*). For example, the 2003 heat wave in Shanghai was reported to have caused a 12% increase in total deaths and a 19% increase in cardiovascular mortality amongst the elderly (Huang et al. 2010). It has also been reported that high-temperature mortality risks were highest for women over 65 years old in Jinan, China (Li et al. 2017*a*). A recent study established a social vulnerability index at the county level with a composite index to climate change focus- ing on urbanized cities on the Chinese east coast (54 cities govern 407 county-level divisions containing counties, county-level cities, and city districts) and found that more work on health and social care should be put toward this sensitive elderly group (Ge et al. 2017).

These findings indicate that human health interventions aimed at mitigating the climate change health impacts require an in- depth understanding of vulnerable populations (Berrang-Ford et al. 2011). Improving understanding of vulnerability to climate change health impacts is a clear research gap in China that requires ur- gent attention from public health researchers.

Uncertainty of climate impacts on human health

Uncertainty defined in the context of risk, restricts our ability to measure the risks associated with different events (Hillen et al. 2017). In China much of the climate change uncertainty has fo- cused on crop yields and scarcity in water resources, which are two of the biggest indirect impacts of climate change on health (Kang et al. 2017). The uncertainty of the direct impacts of climate change on human health has received very little attention in China. However, some research has examined climate change issues that will indirectly impact on human health, including precipitation, temperature, weather variability, and water man- agement. Research has found that the uncertainty in predictions of future precipitation (Piao et al. 2010), future temperature trends (Wang et al. 2012*b*), weather variability (Piao et al. 2010), and water security of the responses of crops to changes in climate, diseases, pests, and atmospheric constituents can have an important im- pact on human health (Pahl-Wostl 2007). Climate change chal- lenges on existing water resources management practices should be considered amongst the factors that have additional uncer- tainty in future (Pahl-Wostl 2007). For adaptation to change, inte- grated water resources management must therefore take climate change impacts under full consideration to enhance the potential of the resources (Guo et al. 2002). On water management uncer- tainty, there are still many gaps in the climate change assessment methodologies and many uncertainties in the climate health pro- jections (Yong-Jian et al. 2013). Some studies have focused on the potential uncertainty of the effect of climate change, and mathe- matical methods have been employed for model constructions (Piao et al. 2010). On temperature extremes, uncertainty ranges were completed as 0.084 °C/decade and 0.037 °C/decade for the minimum and maximum temperature trends, respectively (Wang et al. 2012*b*). Because of the lack of reliable observations, there are uncertain- ties on tropical cyclones in the exploration of results (Zou and Zhao 2010). Li et al. (2016) focused on rich range of uncertainties

Fig. 2. Vulnerability factors (based on Thow and De Blois 2008).

regarding heat-related climate change impacts, population demographics, and adaptation; however, modeling future adapta- tion is still considered as a big challenge.

Impacts of climate change on health

The World Health Organization estimated that, in 2012, 12.6 million deaths (23% of all deaths worldwide) were attributable to modifi- able environmental factors, many of which could be influenced by climate change or are related to the driving forces of climate change (Neira and Prüss-Ustün 2016). Links between weather and climate exist for cardiovascular diseases (Kim et al. 2015), respira- tory illnesses (Hopkinson et al. 2017), and a number of infectious diseases (Patz et al. 2005). As noted above, many prevalent human diseases respond to climatic conditions (Liang and Gong 2017). Human health in China will also be affected by climate change in numerous ways such as mortality from extreme weather events, changes in quality of air and water, and changes in the ecology of infectious disease vectors (Kan et al. 2012). Indeed, some of the most common infectious diseases, including malaria and dengue, are those transmitted by mosquitoes, many of which have exhib- ited changes to their species range in the last decade (Liang and Gong 2017; Tian et al. 2015; Yu et al. 2015). *The Lancet* Commission (Costello 2009) identified six factors that connect climate change to adverse health outcomes: changing patterns of disease and mortality, food, water and sanitation, shelter and human settle- ments, extreme events, and population and migration. The fol- lowing sections will focus on the impact of increased extreme events linked to climate change will have on human health (Table 2 and Fig. 3).

Storms and typhoons

Climate change is expected to lead to an increased number of storms and typhoons and East China is one of the regions seri- ously affected by tropical storms (Lu and Zhao 2013). Previous research in Guangdong, South China, found that the landing of tropical cyclones not only causes substantial direct economic losses but also threatens human health (Kang et al. 2015). Research has found that tropical cyclones increase the risk of transmitted infectious diseases (Zheng et al. 2017). A study in Guangdong city between 2005 and 2011 concluded that there is an increase on the infectious diarrhea incidents after tropical cyclones (Kang et al. 2015). An assessment on the public health risks and impacts of a tornado in Funing, East China, concluded that the elderly (aged 75–84 year) were at the highest risk death (RR (relative risk) = 82.16; 95% CI (confidence interval) = 19.66, 343.33) and injury (RR = 31.80; 95% CI = 17.26, 58.61), and females were at 53% higher risk of death than males (RR = 1.53; 95% CI = 1.02, 2.29) (Wang et al. 2017).

Heat waves and cold spells

Heat waves are increasing in frequency (Luber and McGeehin 2008; Robinson 2001). Population groups with high vulnerability to heat waves and cold spells (Davídkovová et al. 2014) include the elderly, children, and (or) people with chronic diseases who are more susceptible to extreme temperatures, both hot and cold (Tian et al. 2012). Being exposed to extreme heat can cause heat stroke and dehydration as well as cardiovascular, respiratory, and cerebrovascular disease risks that may cause insomnia, fatigue, clinical exacerbation, or death from heatstroke (Yao-Dong et al. 2013; Zeng et al. 2014). It is estimated that the heat waves will cause severe health impacts on the metropolitan areas in the Pearl River Delta as heat waves become more intense and longer in duration (Yao-Dong et al. 2013). Many studies have investigated heat wave related mortality (Li et al. 2017*b*; Luo and Lau 2017; Yin and Wang 2017; Zhou et al. 2017), but less attention has been given to the health effects of cold spells (Staddon et al. 2014) in the context of global climate change (Zhou et al. 2014). It is important to note that climate change may lead to warmer winters but with greater weather variability leading to the counter-intuitive effect of more cold spells occurring. A recent study showed that a total of 5% excess deaths were associated with heat waves in 66 Chinese communities, with the highest excess deaths in North China, fol- lowed by East China and South China (Ma et al. 2015). In Beijing research on the elderly found that ignoring adaptation and demo- graphic changes among the elderly who are most susceptible to heat leads to differences in estimations on future heat-related mortality (Li et al. 2016).

Increased mortality rates are associated also with cold waves in populations around the world (Ryti et al. 2016). Both extremely cold and hot temperatures increase heart disease mortality in China (Guo et al. 2012). The elderly are more vulnerable to low temperatures than young people, which can trigger some chronic diseases (De'Donato et al. 2013). Also, cold spells lead to increases in patients with fractures from the possible injuries from icy ground (Yao-Dong et al. 2013). In Shanghai a study done on the elderly showed that cold spells had a significant impact in elderly people with increasing mortality rates (age >65 years) (Ma et al. 2013).

Flooding

River flooding

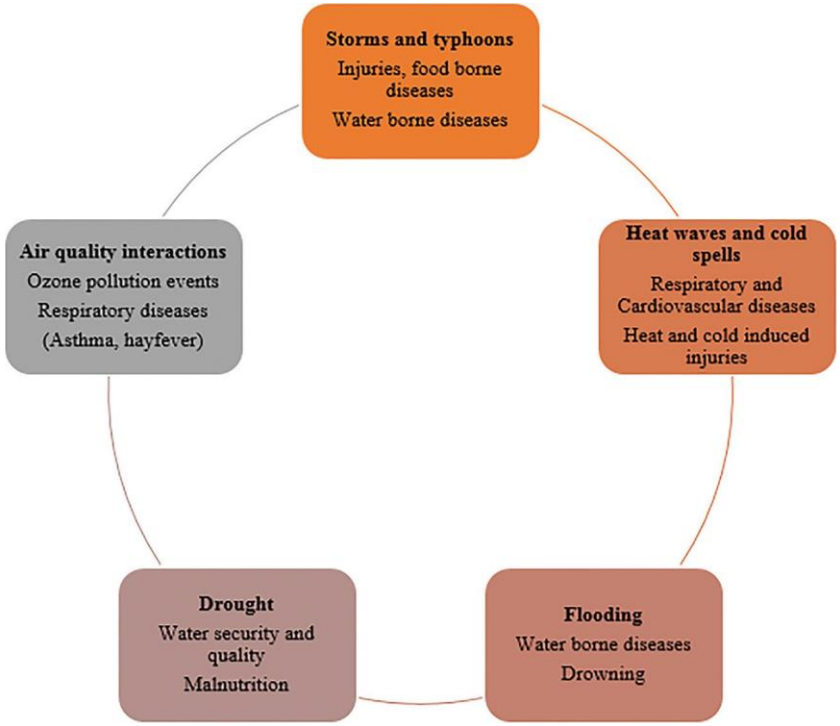
Flooding events are generally considered among the deadliest natural disasters and have led to the highest number of mortali- ties in the 20th century (O'Connor and Costa 2004). Flood disasters have been recognized as the most severe natural hazard in China

Table 2. Climate change impacts on health.

Storms and typhoons	Heat waves and cold spells	Flooding	Drought	Air-quality interactions
Increased number of storms and typhoons, East China is strictly affected (Lu and Zhao 2013)	Increase in frequency (Luber and McGeehin 2008; Robinson 2001), less attention given to cold spells (Staddon et al. 2014)	Has led to the highest number of mortalities in the 20th century (O'Connor and Costa 2004)	From 1900 to 2012, people in China severely affected by drought (Stanke et al. 2013)	Respiratory infections, cardiovascular diseases, and lung cancer (Arceo et al. 2016; Currie and Neidell 2005; Currie et al. 2009)
In Guangdong, potential loss in economy and health (Kang et al. 2015)	Vulnerable population groups susceptible to extreme temperatures, both hot and cold (Davídkovová et al. 2014; Tian et al. 2012; Li et al. 2016; De'Donato et al. 2013; Ma et al. 2013)	Flooding is of great concern to the different levels of Chinese government (Zhang and Liu 2006)	Malnutrition and mortality, water-related diseases, airborne and dust-related diseases, vector borne diseases, and mental health effects (Stanke et al. 2013)	Air pollutants increase the risk of coronary heart disease mortality and respiratory problems (PM_{10}, $PM_{2.5}$) (Zhao et al. 2017; D'Amato et al. 2013)
Increased risk of transmitted infectious diseases (Zheng et al. 2017; Kang et al. 2015)	Extreme heat can cause heat stroke and dehydration, as well as cardiovascular, respiratory, and cerebrovascular disease risks (Yao-Dong et al. 2013; Zeng et al. 2014).	East China is severely affected by floods throughout history (Zhang 2012)	Northwest, north, and northeast of China, an increase in frequency of droughts (Yu et al. 2014)	PM_{10}-induced health losses are evident in China (Zhang et al. 2008)
Public health risks and impacts of a tornado in Funing, East China, the elderly (group aged 75–84 years) had highest risk of death (Wang et al. 2017)	Metropolitan areas in the Pearl River Delta are at risk of extreme heat (Yao-Dong et al. 2013)	An ares of East China measuring 130,000 km^2 was flooded resulting in health impacts including injuries (Gautam and Van Der Hoek 2003; Ye and Glantz 2005; Jonkman 2005; Shao-Hong et al. 2012)		$PM_{2.5}$ is positively related to daily mortality of people especially of older adults (Schwartz 2000)
	5% excess deaths were linked with heat waves in 66 Chinese communities, with the highest excess deaths in North East and South China (Ma et al. 2015)	Drowning, injuries, and hypothermia are direct impacts of flood (Du et al. 2010)		In Beijing some severe haze events were studied (Gao et al. 2015; Yin et al. 2015).
	Increased heart disease mortality in China is linked with extreme temperatures (Guo et al. 2012)	People with limited physical capacity or limited mobility are at particularly high risk (Galea et al. 2005; Jonkman and Kelman 2005)		Respiratory and cardiovascular hospitalization are associated with dust events after adjusting 319 the effect of sulphur dioxide and (or) nitrogen dioxide (Pan and Liu 2011; Wang et al. 2004)
	Cold spells lead to increases in patients with fractures due to the icy ground(Yao-Dong et al. 2013)	China's coastal region (East China) is physically vulnerable to coastal flooding (Wang et al. 2011; Ahern et al. 2005; Fang et al. 2017; Zhang et al. 2002; Lilai et al. 2016; Wang et al. 2012*a*)		

Published by NRC Research Press

Fig. 3. Health impacts of climate change.



since the country frequently experiences natural disasters, of which flooding is of great concern to the different levels of Chinese government (Zhang and Liu 2006). Disastrous flooding occurred in several river valleys across East China in 1755. Serious flooding occurred in the middle and lower reaches of the Yellow River in 1756 and 1757, it was a rarely seen precipitation pattern of north-flood and south-drought in China for two successive years (Zhang 2012). In 1931 in Central China there was a series of floods that occurred and these floods took the lives of nearly 4 million people (Zong and Chen 2000). In the summer of 1991, an area in the East of China measuring 130,000 km^2 was flooded and 3 million houses were damaged or destroyed resulting in health impacts including injuries (for those who sustained open wounds etc.) (Gautam and Van Der Hoek 2003). In the summer of 1998, China suffered extensive flooding in three areas along the Yangtze River in South Central China (Ye and Glantz 2005). East China also ex- perienced a series of severe floods during the summer of 1998 and these floods adversely affected the human population, directly and indirectly (Jonkman 2005). Regions most at risk are: central North China, the Huaihe River (provinces: Henan, Anhui, Jiangsu), the middle and lower reaches of the Yangtze River, and the Pearl River Basin (cities around Shanghai, Nantong, Zhenjiang, Nanjing, Tongling, Wuhu, and Jingzhou) (Shao-Hong et al. 2012). Drowning, injuries, and hypothermia are amongst the immediate direct health impacts of floods (Du et al. 2010). All populations affected by a flood are at direct or indirect risk of health impacts during and after the event, but the literature also mentions the certain groups are at higher risk than others. People with limited physical capacity or limited mobility, who require home care or regular visits to health care facilities, and who have weak social networks, poor flood awareness, few resources, and little access to flood warnings are at particularly high risk (Galea et al. 2005). Informa- tion on risk factors for flood-related death remains limited, and those drowning in their own homes are largely the elderly as they are less mobile (Jonkman and Kelman 2005).

Coastal flooding

Under future climate change, altered patterns of precipitation and sea-level rise are expected to increase in frequency and in the intensity of floods in many coastal regions (Ahern et al. 2005). China's coastal region is physically vulnerable to sea-level rise and associated coastal flooding because of its low topography (Wang et al. 2011). The East Sea, South Sea, and East China regions with high population density have the greatest exposure to coastal flooding risk from sea-level rise (Fang et al. 2017; Zhang et al. 2002). Xiamen is proposing an integrated assessment approach to sea-level rise and storm tide-induced flood risks on a coastal urban system (Lilai et al. 2016). Half of Shanghai is projected to be at risk of flooding by the year 2100, and 46% of the seawalls and levees would be breached; sea-level rise projections show 86.6 mm,
185.6 mm, and 433.1 mm rise by 2030, 2050, and 2100, respectively (Wang et al. 2012*a*).

Drought

Drought is a major natural hazard determined by water avail- ability being significantly below normal conditions for a region (Sheffield et al. 2012). From 1900 to 2012, China was amongst the countries with the greatest number of people affected by drought (Stanke et al. 2013). During the three most recent decades North- west, North, and Northeast China have seen an increase in drought frequency (Yu et al. 2014). Drought impacts on health are generally indirect and include: malnutrition and mortality due to decreased crop yields, water-related diseases due to increasing concentra- tions of pollutants and algae, airborne and dust-related diseases, vector-borne diseases, and mental health effects (Stanke et al. 2013). Although information on health impacts of drought is avail- able globally, in East China, specific literature related to the el- derly population is very limited.

Air quality interactions

There is considerable literature on the relationship between air quality and numerous health problems, including respiratory in- fections, cardiovascular diseases, and lung cancer (Arceo et al.

2016; Currie and Neidell 2005; Currie et al. 2009). Air quality is strongly dependent on weather and is therefore sensitive to cli- mate (Jacob and Winner 2009). Changes in the climate will impact air quality, for example by increasing formation of ozone during heat waves (Stedman 2004). Most air pollutants significantly in- crease the risk of coronary heart disease mortality especially particulate matter (PM_{10}, $PM_{2.5}$) (Zhao et al. 2017). Due to climate change, patterns of air pollution are changing in urban areas, and this brings a huge threat to respiratory health (D'Amato et al. 2013). Other air contaminants of relevance to human health, including smoke from wildfires and airborne pollens and molds, may be influ- enced by climate change (Kinney 2008).

Studies related PM_{10}-induced health losses are evident, covering most of the large and medium-sized cities in China (Zhang et al. 2008). $PM_{2.5}$ is known for its harm to the human respiratory sys- tem, and it is positively related to daily mortality of people, espe- cially older adults (RR = 1.5%, 95% CI: 1.1%–1.9%) (Schwartz 2000). According to the Chinese disease surveillance report, mortality due to respiratory diseases, cardiovascular diseases, and neoplasm is higher in the over 60 age group (Zhou et al. 2016). In Beijing some severe haze events were studied, and such studies about the quan- tification of PM_{10} health effects can help in policy-making (Gao et al. 2015; Yin et al. 2015). Dust storms have also been positively associated with excess mortality in China (Wang et al. 2004). Re- spiratory and cardiovascular hospitalization are associated with the dust events after adjusting the effect of sulphur dioxide and (or) nitrogen dioxide (Pan and Liu 2011). Although the literature provides information on the interaction between air quality and climate change impacts, more research is needed in this area. Research should focus on air quality interactions with climate change and what the consequences will be for population health.

Conclusions

The impact of climate change on human health is beginning to receive more attention; however, except for heat wave impacts, specific information on how climate change will impact the health of the ageing Chinese population is sparse. This review highlights the broad range of health risks linked to climate change and identi- fies where more research effort is needed. In particular, more quantitative and epidemiological studies are required to better understand the likely impact of climate change on the health of the growing elderly populations affected. This research gap re- quires further investment if we are to have an evidence-based adaptation strategy to climate change. Furthermore, research is urgently required on the indirect pathways by which climate change will impact the health of elderly Chinese and other seg- ments of the population. China, with its ageing population, rapid development, and likely climate change impacts, has a great chal- lenge in safeguarding the health of its population in the face of demographic and environmental changes of a magnitude rarely seen. Hence, this research gap on quantitative and epidemiologi- cal studies must be addressed if we are to have an evidence-based adaptation strategy to climate change.

References

Ahern, M., Kovats, R.S., Wilkinson, P., Few, R., and Matthies, F. 2005. Global health impacts of floods: epidemiologic evidence. Epidemiol. Rev. **27**(1): 36– 46. doi:10.1093/epirev/mxi004. PMID:15958425.

Arceo, E., Hanna, R., and Oliva, P. 2016. Does the effect of pollution on infant mortality differ between developing and developed countries? Evidence from Mexico City. Econ. J. **126**(591): 257–280. doi:10.1111/ecoj.12273.

Barriopedro, D., Gouveia, C.M., Trigo, R.M., and Wang, L. 2012. The 2009/10 drought in China: possible causes and impacts on vegetation. J. Hydrometeor. **13**(4): 1251–1267. doi:10.1175/JHM-D-11-074.1.

Basu, R., and Samet, J.M. 2002. Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. Epidemiol. Rev. **24**(2): 190–202. doi:10.1093/epirev/mxf007. PMID:12762092.

Berrang-Ford, L., Ford, J.D., and Paterson, J. 2011. Are we adapting to climate change? Glob. Environ. Chang. **21**(1): 25–33. doi:10.1016/j.gloenvcha.2010.09. 012.

Chen, K., Horton, R.M., Bader, D.A., Lesk, C., Jiang, L., Jones, B., Zhou, L., et al. 2017. Impact of climate change on heat-related mortality in Jiangsu Province, China. Environ. Pollut. **224**: 317–325. doi:10.1016/j.envpol.2017.02.011. PMID: 28237309.

Corvalan, C., Hales, S., and McMichael, A.J. 2005. Ecosystems and human well-being: health synthesis. World Health Organization.

Costello, A., Abbas, M., Allen, A., Ball, S., Bell, S., Bellamy, R., Friel, S., et al. 2009. Managing the health effects of climate change. Lancet, **373**(9676): 1693–1733. doi:10.1016/S0140-6736(09)60935-1. PMID:19447250.

Currie, J., and Neidell, M. 2005. Air pollution and infant health: what can we learn from California's recent experience? Q. J. Econ. **120**(3): 1003–1030. doi: 10.1093/qje/120.3.1003.

Currie, J., Neidell, M., and Schmieder, J.F. 2009. Air pollution and infant health: lessons from New Jersey. J. Health Econ. **28**(3): 688–703. doi:10.1016/j.jhealeco. 2009.02.001. PMID:19328569.

D'Amato, G., Baena-Cagnani, C.E., Cecchi, L., Annesi-Maesano, I., Nunes, C., Ansotegui, I., D'Amato, M., et al. 2013. Climate change, air pollution and extreme events leading to increasing prevalence of allergic respiratory dis- eases. Multidiscip. Respir. Med. **8**(1): 12. doi:10.1186/2049-6958-8-12. PMID: 23398734.

Davídkovová, H., Plavcová, E., Kynčl, J., and Kyselý, J. 2014. Impacts of hot and cold spells differ for acute and chronic ischaemic heart diseases. BMC Publ. Health, **14**(1): 480. doi:10.1186/1471-2458-14-480.

De'Donato, F.K., Leone, M., Noce, D., Davoli, M., and Michelozzi, P. 2013. The impact of the February 2012 cold spell on health in Italy using surveillance data. PLoS One, **8**(4). doi:10.1371/journal.pone.0061720.

Demirkesen, A.C., and Evrendilek, F. 2017. Compositing climate change vulner- ability of a Mediterranean region using spatiotemporally dynamic proxies for ecological and socioeconomic impacts and stabilities. Environ. Monit. Assess. **189**(1): 29. doi:10.1007/s10661-016-5750-0. PMID:28004348.

Ding, Y., Ren, G., Zhao, Z., Xu, Y., Luo, Y., Li, Q., and Zhang, J. 2007. Detection, causes and projection of climate change over China: an overview of recent progress. Adv. Atmos. Sci. **24**(6): 954–971. doi:10.1007/s00376-007-0954-4.

Du, W., FitzGerald, G.J., Clark, M., and Hou, X.Y. 2010. Health impacts of floods. Prehosp. Disaster Med. **25**(3): 265–272. doi:10.1017/S1049023X00008141. PMID:20586021.

Easterling, D.R., Evans, J., Groisman, P.Y., Karl, T.R., Kunkel, K.E., and Ambenje, P. 2000. Observed variability and trends in extreme climate events: a brief review. Bull. Amer. Meteor. Soc. **81**(3): 417–425. doi:10.1175/1520-0477(2000)081<0417:OVATIE>2.3.CO;2.

Epstein, P.R. 2001. Climate change and emerging infectious diseases. Microbes Infect. **3**(9): 747–754. doi:10.1016/S1286-4579(01)01429-0.

Fang, J., Liu, W., Yang, S., Brown, S., Nicholls, R.J., Hinkel, J., Shi, X., et al. 2017. Spatial-temporal changes of coastal and marine disasters risks and im- pacts in Mainland China. Ocean Coast Manag. **139**: 125–140. doi:10.1016/j. ocecoaman.2017.02.003.

Frumkin, H., Hess, J., Luber, G., Malilay, J., and McGeehin, M. 2008. Climate change: the public health response. Am. J. Public Health, **98**(3): 435–445. doi:10.2105/AJPH.2007.119362. PMID:18235058.

Füssel, H.-M. 2007. Vulnerability: a generally applicable conceptual framework for climate change research. Global Environmental Change, **17**(2): 155–167. doi:10.1016/j.gloenvcha.2006.05.002.

Füssel, H.-M., and Klein, R.J.T. 2006. Climate change vulnerability assessments: an evolution of conceptual thinking. Clim. Change, **75**(3): 301–329. doi:10. 1007/s10584-006-0329-3.

Galea, S., Nandi, A., and Vlahov, D. 2005. The epidemiology of post-traumatic stress disorder after disasters. Epidemiol. Rev. **27**(1): 78–91. doi:10.1093/epirev/ mxi003. PMID:15958429.

Gao, M., Guttikunda, S.K., Carmichael, G.R., Wang, Y., Liu, Z., Stanier, C.O., Saide, P.E., et al. 2015. Health impacts and economic losses assessment of the 2013 severe haze event in Beijing area. Sci. Total Environ. **511**: 553–561. doi: 10.1016/j.scitotenv.2015.01.005. PMID:25585158.

Gautam, K., and Van Der Hoek, E. 2003. Literature study on environmental impact of floods. Delft Cluster-publication, DC1-233-13.

Ge, Y., Dou, W., and Liu, N. 2017. Planning resilient and sustainable cities: identifying and targeting social vulnerability to climate change. Sustain- ability, **9**(8): 1394. doi:10.3390/su9081394.

Guo, S., Wang, J., Xiong, L., Ying, A., and Li, D. 2002. A macro-scale and semi-distributed monthly water balance model to predict climate change impacts in China. J. Hydrol. **268**(1–4): 1–15. doi:10.1016/S0022-1694(02)00075-6.

Guo, Y., Jiang, F., Peng, L., Zhang, J., Geng, F., Xu, J., Zhen, C., et al 2012. The association between cold spells and pediatric outpatient visits for asthma in Shanghai, China. PLoS One, **7**(7). doi:10.1371/journal.pone.0042232.

Guoju, X., Weixiang, L., Qiang, X., Zhaojun, S., and Jing, W. 2005. Effects of temperature increase and elevated CO_2 concentration, with supplemental irrigation, on the yield of rain-fed spring wheat in a semiarid region of China. Agricultural Water Management, **74**(3): 243–255. doi:10.1016/j.agwat.2004.11. 006.

Heltberg, R., Siegel, P.B., and Jorgensen, S.L. 2009. Addressing human vulnerabil- ity to climate change: toward a 'no-regrets' approach. Glob. Environ. Chang. **19**(1): 89–99. doi:10.1016/j.gloenvcha.2008.11.003.

Hillen, M.A., Gutheil, C.M., Strout, T.D., Smets, E.M.A., and Han, P.K.J. 2017. Tolerance of uncertainty: conceptual analysis, integrative model, and implications for healthcare. Soc. Sci. Med. 180(C): 62–75. doi:10.1016/j.socscimed.2017.03.024. PMID:28324792.

Hopkinson, N.S., Hart, N., Jenkins, G., Kaminski, N., Rosenfeld, M., Smyth, A., and Wilkinson, A. 2017. Climate change and lung health: the challenge for a new president. Thorax, 72(4): 295–296. doi:10.1136/thoraxjnl-2017-209978. PMID:28104829.

Hu, G. 2017. China's cost of handling climate change. *In* The Cost of Develop- ment in China. Springer. pp. 489–506.

Huang, W., Kan, H., and Kovats, S. 2010. The impact of the 2003 heat wave on mortality in Shanghai, China. Sci. Total Environ. 408(11): 2418–2420. doi:10.1016/j.scitotenv.2010.02.009. PMID:20219235.

Jacob, D.J., and Winner, D.A. 2009. Effect of climate change on air quality. Atmos. Environ. 43(1): 51–63. doi:10.1016/j.atmosenv.2008.09.051.

Jonkman, S.N. 2005. Global perspectives on loss of human life caused by floods. Nat. Hazards, 34(2): 151–175. doi:10.1007/s11069-004-8891-3.

Jonkman, S.N., and Kelman, I. 2005. An analysis of the causes and circumstances of flood disaster deaths. Disasters, 29(1): 75–97. doi:10.1111/j.0361-3666.2005.00275.x. PMID:15720382.

Kan, H. 2011. Climate change and human health in China. Environ. Health Perspect. 119(2): A60–1. doi:10.1289/ehp.1003354. PMID:21288808.

Kan, H., Chen, R., and Tong, S. 2012. Ambient air pollution, climate change, and population health in China. Environ. Int. 42: 10–19. doi:10.1016/j.envint.2011.03.003. PMID:21440303.

Kang, R., Xun, H., Zhang, Y., Wang, W., Wang, X., Jiang, B., Ma, W., et al. 2015. Impacts of different grades of tropical cyclones on infectious diarrhea in Guangdong, 2005–2011. PLoS One, 10(6): e0131423. doi:10.1371/journal.pone. 0131423. PMID:26106882.

Kang, S., Hao, X., Du, T., Tong, L., Su, X., Lu, H., Li, X., et al. 2017. Improving agricultural water productivity to ensure food security in China under chang- ing environment: from research to practice. Agric. Water Manag. 179: 5–17. doi:10.1016/j.agwat.2016.05.007.

Kim, K.H., Kabir, E., and Kabir, S. 2015. A review on the human health impact of airborne particulate matter. Environ. Int. 74: 136–143. doi:10.1016/j.envint.2014.10.005. PMID:25454230.

Kinney, P.L. 2008. Climate change, air quality, and human health. Am. J. Prev. Med. 35(5): 459–467. doi:10.1016/j.amepre.2008.08.025. PMID:18929972.

Kok, M., and Jäger, J. 2009. Vulnerability of people and the environment: chal- lenges and opportunities: background report on Chapter 7 of the Fourth Global Environment Outlook (GEO-4). Netherlands Environment Assessment Agency.

Leichenko, R.M., and O'Brien, K.L. 2002. The dynamics of rural vulnerability to global change: the case of southern Africa. Mitig. Adapt. Strategies Glob. Chang. 7(1): 1–18. doi:10.1023/A:1015860421954.

Li, J., Xu, X., Yang, J., Liu, Z., Xu, L., Gao, J., Liu, X., et al. 2017*a*. Ambient high temperature and mortality in Jinan, China: a study of heat thresholds and vulnerable populations. Environ. Res. 156: 657–664. doi:10.1016/j.envres.2017.04.020. PMID:28463825.

Li, T., Horton, R.M., Bader, D., Zhou, M., Liang, X., Ban, J., Sun, Q., et al. 2016. Aging will amplify the heat-related mortality risk under a changing climate: projection for the elderly in Beijing, China. Sci. Rep. 6: 28161. doi:10.1038/ srep28161. PMID:27320724.

Li, Y., Li, C., Luo, S., He, J., Cheng, Y., and Jin, Y. 2017*b*. Impacts of extremely high temperature and heatwave on heatstroke in Chongqing, China. Environ. Sci. Pollut. Res. 24(9): 8534–8540. doi:10.1007/s11356-017-8457-z.

Liang, L., and Gong, P. 2017. Climate change and human infectious diseases: a synthesis of research findings from global and spatio-temporal perspectives. Environ. Int. 103: 99–108. doi:10.1016/j.envint.2017.03.011. PMID:28342661.

Lilai, X., Yuanrong, H., Wei, H., and Shenghui, C. 2016. A multi-dimensional integrated approach to assess flood risks on a coastal city, induced by sea- level rise and storm tides. Environ. Res. Lett. 11(1): 014001. doi:10.1088/1748- 9326/11/1/014001.

Lu, X., and Zhao, B. 2013. Analysis of the climatic characteristics of landing tropical cyclones in East China. J. Trop. Meteorol. 19(2).

Luber, G., and McGeehin, M. 2008. Climate change and extreme heat events. Am. J. Prev. Med. 35(5): 429–435. doi:10.1016/j.amepre.2008.08.021. PMID:18929969.

Luo, M., and Lau, N.-C. 2017. Heat waves in southern China: synoptic behavior, long-term change, and urbanization effects. J. Clim. 30(2): 703–720. doi:10. 1175/JCLI-D-16-0269.1.

Ma, W., Yang, C., Chu, C., Li, T., Tan, J., and Kan, H. 2013. The impact of the 2008 cold spell on mortality in Shanghai, China. Int. J. Biometeorol. 57(1): 179–184. doi:10.1007/s00484-012-0545-7. PMID:22527759.

Ma, W., Zeng, W., Zhou, M., Wang, L., Rutherford, S., Lin, H., Liu, T., et al. 2015. The short-term effect of heat waves on mortality and its modifiers in China: an analysis from 66 communities. Environ. Int. 75: 103–109. doi:10.1016/j.envint.2014.11.004. PMID:25461419.

Massad, E., Coutinho, F.A.B., Lopez, L.F., and da Silva, D.R. 2011. Modeling the impact of global warming on vector-borne infections. Phys. Life Rev. 8(2): 169–199. PMID:21257353.

McMichael, A.J. 2003. Global climate change and health: an old story writ large. Climate change and human health: risks and responses. Geneva, Switzerland: World Health Organization.

McMichael, A.J., Woodruff, R.E., and Hales, S. 2006. Climate change and human health: present and future risks. Lancet, 367(9513): 859–869. doi:10.1016/ S0140-6736(06)68079-3. PMID:16530580.

Myers, S.S., Smith, M.R., Guth, S., Golden, C.D., Vaitla, B., Mueller, N.D., Dangour, A.D., et al. 2017. Climate change and global food systems: potential impacts on food security and undernutrition. Annu. Rev. Public Health, 38: 259–277. doi:10.1146/annurev-publhealth-031816-044356. PMID:28125383.

Neira, M., and Prüss-Ustün, A. 2016. Preventing disease through healthy environments: a global assessment of the environmental burden of disease. Toxicol. Lett. (259): S1.

O'Connor, J.E., and Costa, J.E. 2004. The world's largest floods, past and present: their causes and magnitudes. US Geological Survey Circular, (1254): 1–13.

Otto, I.M., Reckien, D., Reyer, C.P., Marcus, R., Le Masson, V., Jones, L., Norton, A., et al. 2017. Social vulnerability to climate change: a review of concepts and evidence. Reg. Environ. Chang. 17(6): 1651–1662. doi:10.1007/s10113-017-1105-9. Pahl-Wostl, C. 2007. Transitions towards adaptive management of water facing climate and global change. Water Resour. Manag. 21(1): 49–62. doi:10.1007/ s11269-006-9040-4.

Pan, X.-C., and Liu, J. 2011. Study on health effects of dust storms (Asian dusts) in China. Epidemiology, 22(1): S26–S27.

Patz, J.A., Campbell-Lendrum, D., Holloway, T., and Foley, J.A. 2005. Impact of regional climate change on human health. Nature, 438(7066): 310–317. doi:10.1038/nature04188. PMID:16292302.

Peel, J.L., Haeuber, R., Garcia, V., Russell, A.G., and Neas, L. 2013. Impact of nitrogen and climate change interactions on ambient air pollution and human health. Biogeochemistry, 114(1–3): 121–134. doi:10.1007/s10533-012-9782-4.

Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., Zhou, L., et al. 2010. The impacts of climate change on water resources and agriculture in China. Nature, 467(7311): 43–51. doi:10.1038/nature09364. PMID:20811450.

Portier, C.J., Thigpen, T.K., Carter, S.R., Dilworth, C.H., Grambsch, A.E., Gohlke, J., Hess, et al. 2013. A human health perspective on climate change: a report outlining the research needs on the human health effects of climate change. J. Current Iss. in Globaliz. 6(4): 621.

Qin, D., Ding, Y., and Mu, M. 2015. Climate and environmental change in China: 1951–2012. Springer.

Robinson, P.J. 2001. On the definition of a heat wave. J. Appl. Meteor. 40(4): 762–775. doi:10.1175/1520-0450(2001)040<0762:OTDOAH>2.0.CO;2.

Ryti, N.R., Guo, Y., and Jaakkola, J.J. 2016. Global association of cold spells and adverse health effects: a systematic review and meta-analysis. Environ. Health Perspect. 124(1): 12–22. doi:10.1289/ehp.1408104. PMID:25978526.

Schwartz, J. 2000. Harvesting and long term exposure effects in the relation between air pollution and mortality. Am. J. Epidemiol. 151(5): 440–448. doi:10.1093/oxfordjournals.aje.a010228. PMID:10707911.

Shao-Hong, W., Tao, P., and Shan-Feng, H. 2012. Climate change risk research: acase study on flood disaster risk in China. Adv. Clim. Change Res. 3(2): 92–98. doi:10.3724/SP.J.1248.2012.00092.

Sheffield, J., Wood, E.F., and Roderick, M.L. 2012. Little change in global drought over the past 60 years. Nature, 491(7424): 435–438. doi:10.1038/nature11575. PMID:23151587.

Shi, Y., Shen, Y., Li, D., Zhang, G., Ding, Y., Hu, R., and Kang, E. 2003. Discussion on the present climate change from warm-dry to warm-wet in northwest China. J. Quaternary Sci. 23(2): 152–164.

Staddon, P.L., Montgomery, H.E., and Depledge, M.H. 2014. Climate warming will not decrease winter mortality. Nat. Clim. Change, 4(3): 190–194. doi:10.1038/nclimate2121.

Stanke, C., Kerac, M., Prudhomme, C., Medlock, J., and Murray, V. 2013. Health effects of drought: a systematic review of the evidence. PLoS Currents 5.

Stedman, J.R. 2004. The predicted number of air pollution related deaths in the UK during the August 2003 heatwave. Atmos. Environ. 38(8): 1087–1090. doi:10.1016/j.atmosenv.2003.11.011.

Thow, A., and de Blois, M. 2008. Climate change and human vulnerability: Mapping emerging trends and risk hotspots for humanitarian actors. Report to the UN Office for Coordination of Humanitarian Affairs by Maplecroft, Bath.

Tian, H., Zhou, S., Dong, L., Van Boeckel, T.P., Cui, Y., Newman, S.H., Takekawa, J.Y., et al. 2015. Avian influenza H5N1 viral and bird migration networks in Asia. Proc. Natl. Acad. Sci. 112(1): 172–177. doi:10.1073/pnas. 1405216112. PMID:25535385.

Tian, Z., Li, S., Zhang, J., Jaakkola, J.J., and Guo, Y. 2012. Ambient temperature and coronary heart disease mortality in Beijing, China: a time series study. Environ. Health, 11(1): 56. doi:10.1186/1476-069X-11-56. PMID:22909034.

Turner, B.L., Kasperson, R.E., Matson, P.A., McCarthy, J.J., Corell, R.W., Christensen, L., Eckley, N., et al. 2003. A framework for vulnerability analysis in sustainability science. Proc. Natl. Acad. Sci. 100(14): 8074–8079. doi:10.1073/ pnas.1231335100. PMID:12792023.

Wang, J., Ye, M., Liu, Y., and Xu, S. 2011. Design of integrated toolkit for coastal natural disaster risk assessment based on GIS technology. *In* Geoinformatics, 2011 19th International Conference on. IEEE. pp. 1–6.

Wang, J., Gao, W., Xu, S., and Yu, L. 2012*a*. Evaluation of the combined risk of sea level rise, land subsidence, and storm surges on the coastal areas of Shanghai, China. Climatic Change, 115(3–4): 537–558., 10.1007/s10584-012-0468-7.

Wang, J., Gao, W., Xu, S., and Yu, L. 2012*b*. Evaluation of the combined risk of sea level rise, land subsidence, and storm surges on the coastal areas of Shang- hai, China. Clim. Change, **115**(3–4): 537–558. doi:10.1007/s10584-012-0468-7.

Wang, K., Zhong, S., Wang, X., Wang, Z., Yang, L., Wang, Q., Wang, S., et al. 2017. Assessment of the public health risks and impact of a tornado in Funing, China, 23 June 2016: a retrospective analysis. Int. J. Environ. Res. Public Health, **14**(10): 1201. doi:10.3390/ijerph14101201.

Wang, X., Dong, Z., Zhang, J., and Liu, L. 2004. Modern dust storms in China: an overview. J. Arid Environ. **58**(4): 559–574. doi:10.1016/j.jaridenv.2003.11.009.

Watts, N., Adger, W.N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., Chaytor, S., et al. 2015. Health and climate change: policy responses to protect public health. Lancet, **386**(10006): 1861–1914. doi:10.1016/S0140-6736(15)60854-6. PMID:26111439.

Wellner, R.W., and Bartek, L.R. 2003. The effect of sea level, climate, and shelf physiography on the development of incised-valley complexes: a modern example from the East China Sea. J. Sediment. Res. **73**(6): 926–940. doi:10. 1306/041603730926.

Wu, X., Lu, Y., Zhou, S., Chen, L., and Xu, B. 2016. Impact of climate change on human infectious diseases: empirical evidence and human adaptation. Environ. Int. **86**: 14–23. doi:10.1016/j.envint.2015.09.007. PMID:26479830.

Yao-Dong, D., Xian-Wei, W., Xiao-Feng, Y., Wen-Jun, M., Hui, A., and Xiao-Xuan, W. 2013. Impacts of climate change on human health and adaptation strategies in South China. Adv. Clim. Change Res. **4**(4): 208–214. doi: 10.3724/SP.J.1248.2013.208.

Ye, Q., and Glantz, M. 2005. The 1998 Yangtze floods: The use of short-term forecasts in the context of seasonal to interannual water resource management. Mitig. Adapt. Strategies Glob. Chang. **10**(1): 159–182. doi:10.1007/s11027- 005-7838-7.

Yin, H., Xu, L., and Cai, Y. 2015. Monetary valuation of PM10-related health risks in Beijing China: the necessity for PM10 pollution indemnity. Int. J. Environ. Res. Public Health, **12**(8): 9967–9987. doi:10.3390/ijerph120809967. PMID: 26308020.

Yin, Q., and Wang, J. 2017. The association between consecutive days' heat wave and cardiovascular disease mortality in Beijing, China. BMC Publ. Health, **17**(1): 223. doi:10.1186/s12889-017-4129-7.

Yong-Jian, R., Jiang-Xue, C., Su-Qin, W., Min, L., Zheng-Hong, C., Yu-Fang, L., and Ji-Jun, W. 2013. Climate change impacts on central China and adaptation measures. Adv. Clim. Change Res. **4**(4): 215–222. doi:10.3724/SP.J.1248.2013. 215.

Yu, M., Li, Q., Hayes, M.J., Svoboda, M.D., and Heim, R.R. 2014. Are droughts becoming more frequent or severe in China based on the standardized precipitation evapotranspiration index: 1951–2010? Int. J. Climatol. **34**(3): 545–558. doi:10.1002/joc.3701.

Yu, P.B., Tian, H.Y., Ma, C.F., Ma, C.A., Wei, J., Lu, X.L., Wang, Z., et al. 2015. Hantavirus infection in rodents and haemorrhagic fever with renal syn- drome in Shaanxi province, China, 1984–2012. Epidemiol. Infect. **143**(2): 405– 411. doi:10.1017/S0950268814001009. PMID:24787374.

Zeng, W., Lao, X., Rutherford, S., Xu, Y., Xu, X., Lin, H., Liu, T., et al. 2014. The effect of heat waves on mortality and effect modifiers in four communities of Guangdong Province, China. Sci. Total Environ. **482**: 214–221. PMID: 24651057.

Zeng, Y., Gu, D., Purser, J., Hoenig, H., and Christakis, N. 2010. Associations of environmental factors with elderly health and mortality in China. Am. J. Public Health, **100**(2): 298–305. doi:10.2105/AJPH.2008.154971. PMID:20019314.

Zhai, P., Zhang, X., Wan, H., and Pan, X. 2005. Trends in total precipitation and frequency of daily precipitation extremes over China. Journal of climate, **18**(7): 1096–1108. doi:10.1175/JCLI-3318.1.

Zhang, D.-E. 2012. A study of the large scale flooding over eastern China in 1755. Adv. Clim. Change Res. **3**(3): 128–137. doi:10.3724/SP.J.1248.2012.00128.

Zhang, D., and Liang, Y. 2010. A long lasting and extensive drought event over China during 1876–1878. Adv. Clim. Change Res. **2**: 009. doi:10.3724/SP.J.1248. 2010.00091.

Zhang, J., and Liu, Z. 2006. Hydrological monitoring and flood management in China. IAHS Publications-Series of Proceedings and Reports, **305**: 93–102.

Zhang, J., Zhou, C., Xu, K., and Watanabe, M. 2002. Flood disaster monitoring and evaluation in China. Global Environmental Change Part B: Environmental Hazards, **4**(2): 33–43.

Zhang, M., Song, Y., Cai, X., and Zhou, J. 2008. Economic assessment of the health effects related to particulate matter pollution in 111 Chinese cities by using economic burden of disease analysis. J. Environ. Manage. **88**(4): 947– 954. doi:10.1016/j.jenvman.2007.04.019. PMID:17573182.

Zhang, Y., Feng, R., Wu, R., Zhong, P., Tan, X., Wu, K., and Ma, L. 2017. Global climate change: impact of heat waves under different definitions on daily mortality in Wuhan, China. Global Health Research and Policy, **2**(1): 10. doi: 10.1186/s41256-017-0030-2. PMID:29202078.

Zhao, Y., Cheng, Z., Lu, Y., Chang, X., Chan, C., Bai, Y., Zhang, Y., et al. 2017. PM10 and PM2. 5 particles as main air pollutants contributing to rising risks of coronary heart disease: a systematic review. Environ. Technol. Rev. **6**(1): 174– 185. doi:10.1080/21622515.2017.1334711.

Zheng, J., Wang, W., Ge, Q., Man, Z., and Zhang, P. 2006. Precipitation variability and extreme events in eastern China during the past 1500 years. Terr. Atmos. Ocean. Sci. **17**(3): 579–592. doi:10.3319/TAO.2006.17.3.579(A).

Zheng, J., Han, W., Jiang, B., Ma, W., and Zhang, Y. 2017. Infectious diseases and tropical cyclones in southeast China. Int. J. Environ. Res. Public Health, **14**(5): 494. doi:10.3390/ijerph14050494.

Zhou, L., Chen, K., Chen, X., Jing, Y., Ma, Z., Bi, J., and Kinney, P.L. 2017. Heat and mortality for ischemic and hemorrhagic stroke in 12 cities of Jiangsu Province, China. Sci. Total Environ. **601**: 271–277. PMID:28558275.

Zhou, M.G., Wang, L.J., Liu, T., Zhang, Y.H., Lin, H.L., Luo, Y., Xiao, J.P., et al. 2014. Health impact of the 2008 cold spell on mortality in subtropical China: the climate and health impact national assessment study (CHINAs). Environ. Health, **13**(1): 60. doi:10.1186/1476-069X-13-60. PMID:25060645.

Zhou, M., Wang, H., Zhu, J., Chen, W., Wang, L., Liu, S., Li, Y., et al. 2016. Cause-specific mortality for 240 causes in China during 1990–2013: a system- atic subnational analysis for the Global Burden of Disease Study 2013. Lancet, **387**(10015): 251–272. doi:10.1016/S0140-6736(15)00551-6. PMID:26510778.

Zong, Y., and Chen, X. 2000. The 1998 flood on the Yangtze, China. Nat. Hazards, **22**(2): 165–184. doi:10.1023/A:1008119805106.

Zou, Y., and Zhao, P. 2010. Comparison of some tropical cyclone datasets and correction of yearbook data. J. Trop. Meteorol. **16**(2): 109–114.

APPENDIX B. CHAPTER 6 REGRESSION ANALYSIS FOR SUZHOU, HEFEI AND XIAMEN

Summary of Binary Regression Models for Three Cities

Binary logistic regression models were used to analyze the associations between baseline variables such as age, gender, education and occupation and knowledge, attitude and practices for all sites respectively. For the purpose of analysis, the variables were grouped in 4 sets, each containing age, gender, education and occupation independent predictors in addition to the identification and specific variables of the set. Again, the magnitude of this association was expressed through the odds ratio. The statistical significance of the results obtained was tested using a 95% confidence interval and where a value of $p<0.05$ being considered significant and $p<0.01$, $p<0.001$ is statistically significant. All statistical analysis were carried out in IBM SPSS Statistics 25. Independent variables for regression model include age, gender, education, and occupation. The dependent variables are defined as the survey questions on knowledge, attitudes and practices of the participants. Binary regressions were conducted to examine whether age, gender, education and occupation variables have an impact over knowledge level on climate change.

Awareness of Climate Change

For the Suzhou model overall age and knowledge level were associated ($p=0.036$). A test of the overall contribution of multi-category variables, as well as a test of the contribution of some of the individual parameters revealed a significant association (age group 70-74 and 75+). Examining the individual level predictors revealed that older participants are associated with lower level of knowledge on climate change among elderly. Between gender and knowledge level no significant relationship was found (p=0.053). Between overall education and knowledge level the relationship found as highly significant (p=0.000). In terms of education, participants with post graduate degree were 13.89 times more likely to know about climate change than people with less than high school education level (OR 13.89; 95% CI 0.39-24.65). Between overall occupation and knowledge level there was no significant relationship found (p=0.641) (Appendix B Table 6.17).

For the Hefei model overall age was associated with knowledge level (p=0.002). The model found that higher levels of age are associated with lower level of knowledge on climate change among elderly. Between gender and knowledge of the participants on climate change, there is a relationship found (p=0.015). While education of the participants has contributed to the model (p=0.000), for example individual predictor education category ‘no education’ had a statistically significant impact on the model (p<0.001). Occupation of the participants had no effect on the model (p=0.467) (Appendix B Table 6.18).

For Xiamen, overall age, gender and occupation categorical variables were not associated with knowledge level (p=0.218, p=0.325, p=0.472, respectively). While education of the participants has contributed to the model (p=0.000), for example individual predictor education category ‘no education’ had statistically significant impact on the model (p<0.001). Like Hefei model occupation of the participants had no association (p=0.467) (Appendix B Table 6.19).

Change in Climate Patterns

For Suzhou, overall age was not significantly associated with the belief that climate patterns have changed in the last 20 years (p=0.056). Examining the individual predictors revealed that participants aged '70-74' were significant predictors of the model. There was no significant relationship between gender and the belief that climate patterns changed in the last 20 years (p=0.148). Overall, education and occupation were not significantly associated with the belief that climate patterns changed in the last 20 years (p=0.187, p=0.333, respectively) (Appendix B Table 6.20).

For both Hefei (Appendix B Table 6.21) and Xiamen (Appendix B Table 6.22) none of the independent variables revealed statistically insignificant relationship with the dependent variable.

Attitudes of the Participants and Binary Regression Models

In this section respondents from all three cities were asked questions on their attitudes to climate change. First, they were asked whether or not they think climate change threatens their health. Second, they were asked if government provided any help in extreme weather or not.

Climate Change Related Health Threats

Age was highly associated with participants' thought on whether climate change threatens their health (p=0.000). Gender had no significant association with whether the participant believed that climate change threatens their health (p=0.202). Overall education and occupation had a significant association with whether the participants believed that climate change threatens their health (p=0.000, and p=0.001, respectively). Participants with no education were more likely to think that climate change will harm their health than people with less than high school degree education. Participants who worked in healthcare sector were 2.32 times more likely to think that climate change will affect their health than the participants who worked in business sector (Appendix B Table 6.23).

Government Assistance

When asked the question 'Do you think your government is doing enough to protect or warn you about the health impacts of climate change?' age, education and occupation variables were significantly associated (p=0.046, p=0.001, p=0.008, respectively). The gender of the participants had no impact on the model (p=0.606). Participants aged 65-69 were more likely to think that government is doing enough to protect or warn them from the impacts of climate change (OR 1.04; 95% CI 0.65-1.66) (Appendix B Table 6.26). Participants of postgraduate degree (OR 3.34, 95% CI0.70-15.89) and law sector (OR 1.44, 95% CI 0.16-12.96) were more likely to think that government is doing enough to protect or warn them.

For both the Hefei (Appendix B Table 6.27) and Xiamen (Appendix B Table 6.28) model when asked the question 'Do you think your government is doing enough to protect or warn you from the health impacts of climate change?' none of the independent variables were associated with the dependent variable (p>0.05).

Practices of the Participants and Binary Regression Models

Participants were asked what practices they would engage in to avoid heat stroke or exhaustion, respiratory and infectious diseases and injuries. For each climate change health impact, multiple options were given for elderly to choose for their practices. For practices to prevent heat stroke or exhaustion, participants were given the options of 'drinking more water', 'staying in the shade', 'staying indoors' and 'using air conditioners'. For practices in order to prevent respiratory discomfort, participants were given the options of 'using masks', 'using air purifiers' and 'avoiding exposure to pollutants'. In order to prevent infectious disease participants were offered to choose the options of 'getting vaccinated', 'staying at home if they have signs of infection', 'disinfecting the hot zones in their residence' and 'washing hands often'. Whereas for injuries, participants were given the options 'avoiding going out in stormy weather', 'avoiding staying under the sun', 'readying a first aid kit' and 'using sun protection if working outside'.

Heat Stroke or Exhaustion

Age, education and occupation variables were associated with the practice 'drinking more water' in order to prevent heat stroke or exhaustion (p=0.000, p=0.001, p=0.009, respectively). People aged between 60-64 years old were 0.54 times less likely to drink more water than people with the age 59 years or below. People holding some university degree were 2.63 times more likely to choose drinking more water. When people were given the option' staying under shadow' none of the independent variables were associated with this practice (age p=0.520, gender p=0.301, and education p=0.172) but occupation (p=0.001) (Appendix B Table 6.29). When given the option 'staying indoors' age of the participants was not associated with this practice (p=0.059). However, gender, education and occupation of the participants were associated with this practice (p=0.020, p=0.004, p=0.001, respectively). Female participants were 1.34 times more likely to stay indoors in order to prevent heat stroke or exhaustion than male participants. Participants with university education were more likely to stay indoors (OR 1.69, 95% CI 1.08-2.64) (Appendix B Table 6.29).

When given the option of ‘using air conditioner’, age, education and occupation of the participants were associated with this practice (p=0.011, p=0.000, p=0.015, respectively). People with university degree were more likely to use air conditioners than people with less than high school education (OR 2.07; 95% CI 1.32-3.23). Gender was not associated with the practices ‘drinking more water’, ‘staying in the shade’, ‘using air conditioner’ (p>0.01) (Appendix B Table 6.29-30).

For Hefei, the age, gender and occupation variables were not associated with the practice ‘drinking more water’ in order to prevent heat stroke or exhaustion (p=0.153, p=0.162, p=0.684, respectively). The education of the participants was related to the dependent variable (p=0.022). People with some university level were 1.21 times more likely to choose drinking more water. When people were given the option ‘staying in shade’, education and gender variables were associated with this practice (p=0.019 and p=0.004, respectively). When given the option of ‘staying indoors’ only the age and education of the participants was associated with this practice (p=0.012 and p=0.000 respectively). When given the option of ‘using air conditioner’, only the education of the participants was associated with this practice (p=0.001) (Appendix B Table 6.31-32).

For Xiamen none of the independent indicators were associated with the model when participants were given the option ‘drink more water’ and ‘stay in the shade’ (age p=0.346, 0.075; gender p=0.851, 0.992; education p=0.204, 0.327 and occupation p=0.237, 0.667) (Appendix B Table 6.33). When given the option ‘stay indoors’, participants with some university level were more likely to stay indoors than participants with less than high school degree (OR 2.10; 95% CI 1.10-3.39). When participants given the option of ‘using air conditioner' to prevent heat stroke or exhaustion, again none of the independent variables had any association with dependent variable (age p=0.104, gender p=0.964, education p=0.101 and occupation p=0.444) (Appendix B Table 6.34).

Respiratory Problems

The age, education and occupation profile of the participants were significantly associated with the option 'use masks' in order to prevent any respiratory problems (p=0.027, p=0.000, p=0.000, respectively). People aged between 60-64 years old were more likely to use masks to prevent respiratory problems that may be exacerbated by climate change (OR 1.42; 95% CI 0.92-2.21). Participants with postgraduate degree and people from law sector were more likely to use masks (OR 2.11; 95% CI 0.69-6.44, OR 3.81; 95% CI 0.44-33.25, respectively). When given the option 'using air purifiers' age, education and occupation independent variables were again associated with this kind of practice (p=0.000, p=0.008, p=0.000, respectively). When given the option 'avoiding exposure with pollutants, only age and occupation of the participants were associated with this practice (p=0.003, p=0.013, respectively) (Appendix B Table 6.35).

For Hefei participants, when given the option ‘use mask’ only the education level of participants was significantly associated (p=0.017) with this practice. When given the option ‘use air purifiers’ only education of the participants was significantly associated with this practice. (p=0.000). Participants education was the only variable that had an effect on their practice ‘avoiding exposure with pollutants’ for Hefei model (p=0.000). Participants with some university education were more likely to perform this practice (OR. 1.90; 95% CI 1.08-3.35) (Appendix B Table 6.36).

For Xiamen, when given the option ‘use masks’, while age and education of the participants were associated with this model (p=0.000, p=0.000, respectively), gender and occupation of the participants had no impact on the model (p=0.355, p=0.105, respectively). Participants aged between 70-74 years old were 7.32 times more likely to use masks than participants aged between 59 years old or younger. (95% CI 2.86-18.77). Participants with some university education were 5.82 times more likely to use masks than participants with less than high school education (95% CI 3.01-11.25). When given the option ‘use air purifiers’ participants’ age and education were again associated with the model (p=0.003, p=0.000, respectively). However, gender and occupation of the participants had no impact on the model (p=0.861, p=0.258, respectively). When given the option ‘avoid exposure with pollutants’ only the education independent variable was associated with Xiamen model (p=0.013) (Appendix B Table 6.37).

Infectious Diseases

The age, education and occupation profile of the participants were highly associated when given the option 'get vaccinated' in order to prevent any infectious problems (p=0.000, p=0.000, p=0.000, respectively). People aged between 60-64 years old were less likely to get vaccinated and participants with no education were more likely to get vaccinated (OR 0.59; 95% CI 0.30-0.91, OR 1.45; 95% CI 0.97-2.16, respectively). When given the option 'stay at home if you have signs of infection' age, education and occupation independent variables were again associated with this kind of practice (p=0.002, p=0.003, p=0.000, respectively) (Appendix B Table 6.38). When given the option 'disinfect the hot zones in your residence' age education and occupation of the participants were associated with this practice (p=0.000, p=0.005, p=0.000, respectively). Interestingly people with no education were 1.44 times more likely to disinfect the hot zones in their residence (95% CI 0.97-2.14). The 'washing hands often' option was only associated with age and occupation variables (p=0.000, p=0.007, respectively) (Appendix B Table 6.39).

For Hefei participants, while age and education factors were significantly associated with the 'get vaccinated' in order to prevent any infectious problems option (p=0.031, p=0.001, respectively), other variables such as gender and occupation of the participants did not contribute to the model (p=0.398, p=0.249, respectively). When given the option 'stay at home if you have signs of infection' only the education independent variable was associated with this kind of practice (p=0.000). When given the option 'disinfect the hot zones in your residence' and 'wash your hands often', again only the education of the participants was associated with these practices (p=0.005, p=0.003, respectively) (Appendix B Table 6.40-41).

For participants in Xiamen, when given the option 'get vaccinated', age and education variables were associated with the model (p=0.000, p=0.000, respectively). However, gender and occupation of the participants did not have an impact on the model (p=0.455, p=0.318, respectively). Related infectious diseases when participants were given the option 'stay home if you have signs of infection' again age and education variables were associated with Xiamen model (p=0.000, p=0.000, respectively). Gender and occupation variables had no impact on the model (p=0.869, p=0.429, respectively) (Appendix B Table 6.42).

When participants were given the option 'disinfect the hot zones in their residence,' age and education variables were associated with Xiamen model (p=0.022, p=0.000, respectively). Gender and occupation variables had no impact on the model (p=0.443, p=0.632, respectively). Lastly, when participants were given the option 'wash your hands often' none of the variables were associated with model (age p=0.650, gender p=0.261, education p=0.403 and occupation p=0.640) (Appendix B Table 6.43).

Physical Injuries

For participants in Suzhou, the age and occupation of participants were associated with avoiding going out in stormy weather, (p=0.000, p=0.000, respectively). When given the option 'avoid staying in the sun' all independent variables were associated with this practice (p=0.000, p=0.007, p=0.023, p=0.001, respectively) (Appendix B Table 6.44). Interestingly, people with no education were 1.44 times more likely to 'disinfect the hot zones in their residence' (95% CI 0.97-2.14). When participants were given the option of 'readying a first aid kit for injuries', age, education and occupation of the participants were associated with the model (p=0.000, p=0.000, p=0.000, respectively). Given the option of using sun protection while working outside only age and occupation of the participants were associated (p=0.000, p=0.000, respectively). Participants of law sector were 1.85 times more likely to perform this practice (Appendix B Table 6.45).

For participants in Hefei, when given the option of 'avoiding going out in stormy weather', age and education independent variables were associated (p=0.032, p=0.028, respectively). When given the option 'avoid staying in the sun' only gender was associated with this practice (p=0.012), with female participants 0.56 times more likely to perform this practice than the male participants. When participants were given the option of 'readying a first aid kit for injuries' only the occupation of the participants was significantly associated (p=0.037). Only the education of the participants was associated with the option of 'using sun protection while working outside' (p=0.030). Participants with postgraduate level were 2.77 times more likely to 'use sun protection' while working outside than the participants with less than high school education (95% CI 0.44-17.27) (Appendix B Table 6.46-47). Lastly for Xiamen, when the participants were given the option 'avoid going out in stormy weather' (age p=0.002, education p=0.000), 'avoid staying under the sun' (age p=0.012, education p=0.000) and 'ready a first aid kit for injuries' (age p=0.003, education p=0.000) age and education dependent variable were associated with the model. For the option 'use sun protection while working outside' none of the independent indicators had any association with the model (age p=0.515, gender p=0.486, education p=0.420, and occupation p=0.988) (Appendix B Table 6.48-49).

Summary of Sociodemographic Factors for Three Sites

Age

Overall age and knowledge level were associated (p=0.036). An inspection of individual predictors revealed that higher levels of age are associated with lower level of knowledge on climate change among elderly for Suzhou model assumptions. Active individual predictors of the model were participants of age group 60-64 and 65-69.

For Hefei city, when participants were asked on their knowledge level regarding climate change age was associated with the model (p=0.002) (Appendix B Table 6.18). Defining climate change with drought, storms, wildfires and heatwaves age was not associated with Hefei model (p>0.05). When participants asked about their thoughts on whether climate patterns changed in last 20 years or not, age was again not associated with Hefei model (p=0.429) (Appendix B Table 6.21). Different than Suzhou model and all sites model, age was rarely associated with dependent variables for MODEL 2. For Xiamen site age was not a significant contributor to the model (p>0.05).

Gender

Gender independent categorical variable was not associated with most of the models for Suzhou Model (p>0.05). However, when participants were asked on their practices to prevent injuries 'avoid staying under the sun' to prevent physical injuries, female participants were 1.41 times more likely to perform this action than male participants and this considered as significant (95% CI 1.10-1.82).

It was only when participants were asked about whether or not they had heard about climate change, that gender categorical variable was associated with Hefei model (p=0.015)

(Appendix B Table 6.18). Other dependent variables showed no relationship with gender. Gender was not found to be a significant variable in the Xiamen model (p>0.05).

Education

Education overall being associated with most of the models for Suzhou model, when participants were asked *'Do you think climate change patterns changed in last 20 years?'* education of the participants was not associated (p=0.187) (Appendix B Table 6.20). Regarding participant practices using sun protection while working outside and avoiding going out in stormy weather to prevent any injuries, education of the participants had no impact on the model (p=0.113, p=0.455) (Appendix B Table 6.45-46). In order to prevent any respiratory problems when participants were given the option to avoid exposure with pollutants, again education variable was not associated (p=0.145) (Appendix B Table 6.35). In order to prevent heat stroke or exhaustion when participants were given the option of staying under shadow, education was not significant (p=0.172) (Appendix B Table 6.39). When participants were asked about their thoughts on change in climate patterns in last 20 years education of the participants was not associated with Hefei model (p=0.672) (Appendix B Table 6.21). Education also was not associated with the dependent variable 'Do you think climate change threatens your health?' for Hefei model (p=0.336) (Appendix B Table 6.24). Most of the regressions revealed that participants with high school education and participants with some university education were important predictors of the model. People with some university education was significant predictors of the model however education was not always associated with all of the models for Xiamen model.

Occupation

Overall occupation of the participants being highly associated with the model, individual predictors ‘health care sector’, ‘design’ and ‘law’ sector were the important predictors of the model for Suzhou model. For Hefei model, occupation of the participants was not associated with the model ($p>0.05$). This is a different result than all models, and Model 1 regressions. For the Xiamen model occupation was not associated for most of the dependent variables. However, when participants were asked to define climate change, occupation was associated with ‘flooding’ and ‘heatwaves’ factor ($p=0.005$, $p=0.000$, respectively). Participants who worked in healthcare sector were 2.71 times more likely to define climate change with flooding factor (95% CI 1.11-6.59).

Appendix B Table 6.17: Regressions analysis and knowledge on climate change (MODEL 1).

Have you heard about climate change?					
MODEL 1		**OR.*	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p<0.05 (p=0.036)	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**
	60-64	0.82	0.49	1.38	0.451
	65-69	0.62	0.39	1.00	0.051
	70-74	0.60	0.37	0.96	0.033
	75+	0.47	0.27	0.79	0.005
Gender Overall p>0.05 (p=0.053)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.75	0.56	1.00	0.053
Education Overall p<0.001 (p=0.000)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	1.10	0.70	1.50	0.909
	Some university	1.57	0.91	2.42	0.115
	Graduate	2.10	1.84	8.41	0.000
	Post graduate	13.89	0.39	24.65	0.281
	No education	1.05	0.25	0.54	0.000
Occupation Overall p>0.05 (p=0.641)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	0.91	0.60	2.73	0.526
	Design	0.63	0.53	37.22	0.169
	Engineering	0.28	0.60	2.11	0.718
	Healthcare	0.62	0.48	4.90	0.478
	Law	2.32	0.00	NA*****	0.999
	Sales	0.31	0.29	1.69	0.423
	Others	0.39	0.57	1.42	0.646

**C.I.= confidence interval; *OR. = odds ratio; ***Ref.= reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.18: Regressions analysis and knowledge on climate change (MODEL 2).

Have you heard about climate change?					
MODEL 2		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p<0.05 (p=0.002)	***≤ 59 (Ref.) ****	***1.00***	-	-	-
	60-64	0.54	0.20	1.49	0.238
	65-69	0.28	0.11	0.75	0.011
	70-74	0.36	0.13	0.98	0.046
	75+	0.18	0.07	0.50	0.001
Gender Overall p<0.05 (p=0.015)	***Male (Ref.)***	***1.00***	-	-	-
	Female	0.57	0.36	0.89	0.015
Education Overall p<0.001 (p=0.000)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	2.35	0.73	7.52	0.151
	Some university	1.39	0.62	3.11	0.423
	Graduate	1.08	0.31	3.74	0.905
	Post graduate	0.40	0.06	2.58	0.337
	No education	0.25	0.15	0.43	0.000
Occupation Overall p>0.05 (p=0.467)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	0.24	0.05	1.09	0.064
	Design	0.40	0.06	2.85	0.364
	Engineering	2.84	0.29	27.76	0.370
	Healthcare	0.64	0.10	4.27	0.645
	Law	NA*****	0.00	NA	0.999
	Sales	2.02	0.16	25.02	0.583
	Others	0.77	0.29	2.07	0.604

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.19: Regressions analysis and knowledge on climate change (MODEL 3).

Have you heard about climate change?					
MODEL 3		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.218)	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**
	60-64	0.77	0.40	1.50	0.447
	65-69	0.72	0.37	1.40	0.335
	70-74	0.78	0.40	1.53	0.477
	75+	0.44	0.21	0.89	0.023
Gender Overall p>0.05 (p=0.325)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.81	0.54	1.23	0.325
Education Overall p<0.001 (p=0.000)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	1.98	1.06	3.73	0.033
	Some university	1.92	0.97	3.78	0.059
	Graduate	1.78	0.89	3.59	0.105
	Post graduate	NA*****	0.00	NA	0.999
	No education	0.39	0.22	0.67	0.001
Occupation Overall p>0.05 (p=0.472)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	1.83	0.55	6.06	0.322
	Design	1.84	0.50	6.78	0.358
	Engineering	1.21	0.54	2.69	0.646
	Healthcare	1.31	0.43	4.02	0.632
	Law	1.72	0.16	18.16	0.653
	Sales	1.63	0.61	4.40	0.331
	Others	2.23	1.01	4.94	0.048

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.20: Regressions on 'Do you think climate patterns changed in last 20 years?'.

Do you think climate patterns changed in last 20 years?					
MODEL 1		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.056)	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**
	60-64	0.73	0.36	1.49	0.387
	65-69	0.76	0.39	1.48	0.420
	70-74	0.44	0.23	0.83	0.011
	75+	0.49	0.24	1.00	0.051
Gender Overall p>0.05 (p=0.148)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.75	0.50	1.11	0.148
Education Overall p>0.05 (p=0.187)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	0.67	0.41	1.09	0.104
	Some university	1.58	0.74	3.37	0.239
	Graduate	0.96	0.49	1.87	0.909
	Post graduate	1.35	0.17	10.96	0.779
	No education	1.53	0.73	3.18	0.258
Occupation Overall p>0.05 (p=0.333)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	0.68	0.22	2.13	0.507
	Design	NA*****	0.00	NA	0.999
	Engineering	0.53	0.20	1.38	0.195
	Healthcare	1.58	0.18	14.07	0.681
	Law	NA	0.00	NA	0.999
	Sales	0.34	0.10	1.15	0.083
	Others	0.40	0.18	0.91	0.029

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.21: Regressions on 'Do you think climate patterns changed in last 20 years?' (MODEL 2).

Do you think climate patterns changed in last 20 years?					
MODEL 2		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.429)	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**
	60-64	1.95	0.58	6.54	0.278
	65-69	1.87	0.54	6.48	0.322
	70-74	4.82	0.90	25.78	0.066
	75+	1.30	0.34	4.90	0.702
Gender Overall p>0.05 (p=0.847)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.92	0.38	2.19	0.847
Education Overall p>0.05 (p=0.672)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	1.38	0.25	7.47	0.712
	Some university	0.64	0.19	2.15	0.472
	Graduate	0.70	0.11	4.38	0.701
	Post graduate	0.22	0.02	2.84	0.244
	No education	0.51	0.17	1.51	0.224
Occupation Overall p>0.05 (p=0.990)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	NA*****	0.00	NA	0.999
	Design	NA	0.00	NA	0.999
	Engineering	0.76	0.11	5.40	0.786
	Healthcare	0.97	0.07	12.47	0.979
	Law	NA	0.00	NA	0.999
	Sales	0.60	0.04	8.27	0.701
	Others	1.45	0.36	5.77	0.599

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.22: Regressions on 'Do you think climate patterns changed in last 20 years? (MODEL 3).

Do you think climate patterns changed in last 20 years?					
MODEL 3		**OR.*	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.767)	***≤ 59 (Ref.) ******	***1.00***	-	-	-
	60-64	0.99	0.46	2.14	0.989
	65-69	1.21	0.54	2.72	0.645
	70-74	1.44	0.63	3.28	0.385
	75+	0.84	0.35	2.01	0.692
Gender p>0.05 (p=0.489)	***Male (Ref.)***	***1.00***	-	-	-
	Female	1.21	0.70	2.09	0.489
Education p>0.05 (p=0.066)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	2.10	1.03	4.29	0.041
	Some university	3.30	1.28	8.49	0.013
	Graduate	2.27	0.89	5.75	0.084
	Post graduate	0.37	0.02	9.09	0.542
	No education	1.24	0.58	2.65	0.574
Occupation p>0.05 (p=0.945)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	0.60	0.12	3.02	0.531
	Design	0.43	0.07	2.46	0.342
	Engineering	0.66	0.18	2.43	0.529
	Healthcare	2.07	0.20	21.76	0.546
	Law	0.88	0.03	22.86	0.938
	Sales	0.63	0.15	2.62	0.522
	Others	0.67	0.19	2.38	0.531

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.23: Regression model on ‘Do you think climate change threatens your health?’ (MODEL 1).

Do you think climate change threatens your health?					
MODEL 1		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p<0.001 (p=0.000)	***≤ 59 (Ref.) *****	***1.00***	-	-	-
	60-64	0.28	0.15	0.51	0.000
	65-69	0.35	0.20	0.64	0.001
	70-74	0.26	0.15	0.47	0.000
	75+	0.33	0.17	0.62	0.001
Gender Overall p>0.05 (p=0.202)	***Male (Ref.)***	***1.00***	-	-	-
	Female	0.81	0.58	1.12	0.202
Education Overall p<0.001 (p=0.000)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	0.67	0.45	1.01	0.053
	Some university	1.71	0.93	3.15	0.086
	Graduate	0.33	0.20	0.54	0.000
	Post graduate	1.33	0.27	6.56	0.723
	No education	2.87	1.41	5.84	0.004
Occupation Overall p<0.01 (p=0.001)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	0.66	0.27	1.61	0.362
	Design	NA*****	0.00	NA	0.998
	Engineering	0.23	0.11	0.47	0.000
	Healthcare	2.32	0.28	19.41	0.438
	Law	NA	0.00	NA	0.999
	Sales	0.54	0.17	1.74	0.301
	Others	0.33	0.17	0.62	0.001

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.24: Regression model on 'Do you think climate change impacts health?' (MODEL 2).

Do you think climate change threatens your health?					
MODEL 2		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.661)	***≤ 59 (Ref.) ******	***1.00***	-	-	-
	60-64	0.52	0.20	1.35	0.179
	65-69	0.51	0.19	1.35	0.177
	70-74	0.55	0.20	1.52	0.250
	75+	0.73	0.24	2.21	0.572
Gender Overall p>0.05 (p=0.742)	***Male (Ref.)***	***1.00***	-	-	-
	Female	1.09	0.64	1.87	0.742
Education Overall p>0.05 (p=0.336)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	1.86	0.65	5.35	0.250
	Some university	1.20	0.54	2.65	0.660
	Graduate	0.41	0.13	1.28	0.125
	Post graduate	0.58	0.05	6.35	0.652
	No education	0.80	0.43	1.51	0.496
Occupation Overall p>0.05 (p=0.967)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	NA*****	0.00	NA	0.999
	Design	NA	0.00	NA	0.999
	Engineering	0.76	0.15	3.74	0.734
	Healthcare	0.99	0.09	10.43	0.992
	Law	0.38	0.05	2.61	0.323
	Sales	0.64	0.06	7.13	0.713
	Others	0.55	0.19	1.59	0.272

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.25: Regression model on 'Do you think climate change impacts your health' (MODEL 3).

Do you think climate change threatens your health?					
MODEL 3		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p>0.05 (p=0.350)	***≤ 59 (Ref.) *****	***1.00***	**-**	**-**	**-**
	60-64	1.42	0.78	2.59	0.246
	65-69	1.90	1.02	3.54	0.044
	70-74	1.41	0.78	2.57	0.253
	75+	1.19	0.60	2.35	0.627
Gender Overall p>0.05 (p=0.203)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	1.31	0.86	1.99	0.203
Education Overall p>0.05 (p=0.132)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	1.06	0.62	1.82	0.825
	Some university	2.03	1.03	3.98	0.040
	Graduate	1.10	0.57	2.10	0.784
	Post graduate	0.44	0.04	5.51	0.526
	No education	0.67	0.37	1.20	0.175
Occupation Overall p>0.05 (p=0.271)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	2.81	0.66	11.92	0.161
	Design	0.53	0.16	1.80	0.309
	Engineering	0.89	0.37	2.17	0.800
	Healthcare	2.76	0.64	11.80	0.172
	Law	0.64	0.08	5.03	0.675
	Sales	1.41	0.50	4.02	0.519
	Others	0.95	0.40	2.23	0.898

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.26: Regressions on government assistance (MODEL 1).

Do you think your government is doing enough to protect-warn you from the health impacts of climate change?					
MODEL 1		*OR. **	*95% C.I.***		*p value*****
			lower	*upper*	
Age Overall p<0.05 (p=0.046)	***≤ 59 (Ref.) ******	***1.00***	-	-	-
	60-64	0.89	0.54	1.45	0.632
	65-69	1.04	0.65	1.66	0.865
	70-74	0.82	0.51	1.29	0.386
	75+	0.52	0.31	0.88	0.014
Gender Overall p>0.05 (p=0.606)	***Male (Ref.)***	***1.00***	-	-	-
	Female	1.08	0.80	1.46	0.606
Education Overall p<0.01 (p=0.001)	***Less than high school (Ref.)***	***1.00***	-	-	-
	High school	0.98	0.67	1.44	0.937
	Some university	1.78	1.09	2.90	0.020
	Graduate	0.66	0.42	1.05	0.083
	Post graduate	3.34	0.70	15.89	0.129
	No education	2.28	1.27	4.09	0.006
Occupation Overall p<0.01 (p=0.008)	***Business (Ref.)***	***1.00***	-	-	-
	Finance	1.24	0.60	2.56	0.562
	Design	1.40	0.36	5.37	0.628
	Engineering	0.40	0.23	0.72	0.002
	Healthcare	1.28	0.39	4.21	0.687
	Law	1.44	0.16	12.96	0.743
	Sales	1.28	0.49	3.37	0.611
	Others	0.67	0.42	1.08	0.103

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.27: Regressions on government assistance (MODEL 2).

Do you think your government is doing enough to protect or warn you from the health impacts of climate change?					
MODEL 2		*OR. **	*95% C.I.***		*p value****
			lower	*upper*	
Age Overall p>0.05 (p=0.600)	***≤ 59 (Ref.) *****	***1.00***	**-**	**-**	**-**
	60-64	0.81	0.40	1.64	0.550
	65-69	1.20	0.58	2.50	0.617
	70-74	0.81	0.38	1.72	0.590
	75+	0.72	0.31	1.67	0.441
Gender Overall p>0.05 (p=0.663)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.90	0.57	1.42	0.663
Education Overall p>0.05 (p=0.840)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	1.15	0.55	2.39	0.717
	Some university	1.10	0.58	2.08	0.772
	Graduate	1.21	0.43	3.39	0.712
	Post graduate	1.37	0.08	24.13	0.830
	No education	1.49	0.85	2.61	0.162
Occupation Overall p>0.05 (p=0.226)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	2.72	0.47	15.92	0.266
	Design	0.00	0.00	NA*****	0.999
	Engineering	0.29	0.08	1.05	0.059
	Healthcare	0.55	0.10	2.96	0.488
	Law	0.15	0.01	1.45	0.101
	Sales	1.10	0.19	6.24	0.913
	Others	0.59	0.27	1.29	0.184

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.28: Regressions on government assistance (MODEL 3).

Do you think your government is doing enough to protect or warn you from the health impacts of climate change?					
MODEL 3		*OR. **	*95% C.I.***		*p value****
			lower	*upper*	
Age Overall p>0.05 (p=0.108)	***≤ 59 (Ref.) *****	***1.00***	**-**	**-**	**-**
	60-64	0.94	0.57	1.56	0.8242
	65-69	0.53	0.31	0.89	0.0166
	70-74	0.89	0.53	1.48	0.6533
	75+	0.76	0.42	1.40	0.3845
Gender Overall p>0.05 (p=0.058)	***Male (Ref.)***	***1.00***	**-**	**-**	**-**
	Female	0.71	0.50	1.01	0.0578
Education Overall p>0.05 (p=0.666)	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**
	High school	0.99	0.63	1.55	0.9640
	Some university	0.76	0.45	1.28	0.3034
	Graduate	1.34	0.77	2.32	0.3051
	Post graduate	0.46	0.03	8.43	0.6004
	No education	1.01	0.59	1.74	0.9647
Occupation Overall p>0.05 (p=0.155)	***Business (Ref.)***	***1.00***	**-**	**-**	**-**
	Finance	2.15	0.80	5.72	0.1270
	Design	1.15	0.36	3.64	0.8134
	Engineering	2.56	1.16	5.65	0.0204
	Healthcare	1.84	0.66	5.12	0.2428
	Law	3.54	0.46	26.94	0.2226
	Sales	1.26	0.52	3.09	0.6075
	Others	2.11	0.98	4.54	0.0557

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.29: Regressions on practices of elderly (Heat stroke-exhaustion)

(MODEL 1).

		PRACTICES OF ELDERLY							
		HEAT STROKE OR EXHAUSTION							
MODEL 1		**DRINK MORE WATER** *Overall p-values for Age p=0.000, Gender p=0.435, Education p=0.001, Occupation p=0.009*				**STAY IN SHADE** *Overall p-values for Age p=0.520, Gender p=0.301, Education p=0.172, Occupation p=0.001*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.54	0.35	0.86	0.008	0.87	0.58	1.31	0.516
	65-69	0.48	0.31	0.73	0.001	0.86	0.59	1.26	0.438
	70-74	0.39	0.25	0.59	0.000	0.91	0.62	1.34	0.645
	75+	0.29	0.18	0.47	0.000	0.68	0.43	1.06	0.086
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.11	0.86	1.44	0.435	1.14	0.89	1.46	0.301
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.91	0.64	1.28	0.572	0.63	0.45	0.89	0.008
	Some university	0.79	0.53	1.18	0.243	0.83	0.57	1.22	0.343
	Graduate	2.63	1.53	4.51	0.000	0.93	0.60	1.45	0.755
	Post graduate	1.11	0.32	3.80	0.869	1.22	0.40	3.68	0.724
	No education	0.68	0.47	1.00	0.051	0.89	0.61	1.30	0.543
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	1.60	0.81	3.17	0.173	0.72	0.41	1.26	0.243
	Design	1.27	0.40	4.08	0.683	0.97	0.34	2.80	0.953
	Engineering	0.85	0.50	1.44	0.550	0.61	0.37	1.00	0.051
	Healthcare	1.91	0.66	5.51	0.234	0.96	0.41	2.28	0.930
	Law	NA*****	0.00	NA	0.999	NA	0.00	NA	0.999
	Sales	0.63	0.28	1.41	0.264	0.53	0.25	1.13	0.101
	Others	0.61	0.41	0.92	0.017	0.42	0.29	0.62	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.30: Regressions on practices of elderly (Heat stroke-exhaustion) (MODEL 1) (Cont'd).

PRACTICES OF ELDERLY									
HEAT STROKE OR EXHAUSTION									
MODEL 1		**STAY INDOORS** *Overall p-values for Age p=0.059, Gender p=0.020, Education p=0.004, Occupation p=0.001*				**USE AIR CONDITIONER** *Overall p-values for Age p=0.011, Gender p=0.250, Education p=0.000, Occupation p=0.015*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*Upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	60-64	0.62	0.41	0.93	0.022	0.62	0.40	0.95	0.029
	65-69	0.62	0.42	0.91	0.015	0.53	0.35	0.79	0.002
	70-74	0.59	0.40	0.87	0.007	0.53	0.35	0.80	0.003
	75+	0.58	0.37	0.91	0.018	0.78	0.49	1.24	0.287
Gender	***Male (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Female	1.35	1.05	1.73	0.020	1.17	0.89	1.54	0.250
Education	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	High school	0.65	0.46	0.91	0.012	0.55	0.38	0.81	0.002
	Some university	0.98	0.66	1.43	0.899	0.82	0.54	1.24	0.338
	Graduate	1.69	1.08	2.64	0.022	2.07	1.32	3.23	0.001
	Post graduate	0.70	0.23	2.13	0.525	0.40	0.11	1.53	0.182
	No education	0.79	0.54	1.16	0.230	0.54	0.35	0.84	0.006
Occupation	***Business (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Finance	0.75	0.42	1.34	0.340	2.02	1.09	3.73	0.025
	Design	0.72	0.25	2.12	0.556	0.21	0.03	1.74	0.149
	Engineering	0.52	0.32	0.87	0.013	2.21	1.28	3.85	0.005
	Healthcare	0.62	0.26	1.46	0.275	1.41	0.55	3.66	0.474
	Law	0.96	0.20	4.65	0.964	6.13	1.25	30.17	0.026
	Sales	0.32	0.14	0.71	0.005	1.00	0.41	2.44	0.999
	Others	0.43	0.30	0.64	0.000	1.48	0.95	2.29	0.081

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.31: Regressions on practices of elderly (Heat stroke-exhaustion) (MODEL 2).

PRACTICES OF ELDERLY									
HEAT STROKE OR EXHAUSTION									
MODEL 2		**DRINK MORE WATER** *Overall p-values for Age p=0.153, Gender p=0.162, Education p=0.022, Occupation p=0.684*				**STAY UNDER SHAODOW** *Overall p-values for Age p=0.209, Gender p=0.004, Education p=0.019, Occupation p=0.894*			
		*OR. **	*95% C.I.***		*p value***	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	60-64	0.77	0.41	1.47	0.434	0.93	0.49	1.78	0.834
	65-69	0.65	0.34	1.23	0.185	0.70	0.37	1.34	0.283
	70-74	0.94	0.48	1.85	0.855	1.13	0.58	2.21	0.725
	75+	0.48	0.24	0.97	0.041	0.60	0.29	1.21	0.151
Gender	***Male (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Female	0.76	0.52	1.11	0.162	0.57	0.39	0.84	0.004
Education	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	High school	0.72	0.37	1.38	0.318	0.64	0.33	1.24	0.187
	Some university	1.21	0.69	2.12	0.513	0.90	0.51	1.57	0.707
	Graduate	1.05	0.41	2.67	0.925	0.81	0.32	2.06	0.665
	Post graduate	0.85	0.15	4.68	0.851	0.45	0.08	2.68	0.381
	No education	0.51	0.32	0.80	0.003	0.45	0.29	0.71	0.001
Occupation	***Business (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Finance	0.53	0.15	1.91	0.330	0.77	0.22	2.73	0.684
	Design	1.14	0.22	5.85	0.879	0.98	0.20	4.84	0.978
	Engineering	0.41	0.13	1.25	0.117	0.52	0.17	1.58	0.251
	Healthcare	1.46	0.31	6.79	0.629	0.62	0.15	2.66	0.521
	Law	1.17	0.20	6.97	0.864	1.81	0.30	10.72	0.515
	Sales	0.84	0.17	4.20	0.837	1.35	0.27	6.63	0.715
	Others	0.66	0.32	1.38	0.268	0.80	0.39	1.66	0.557

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.32: Regressions on practices of elderly (Heat stroke-exhaustion) (MODEL 2) (Cont'd).

MODEL 2		STAY INDOORS *Overall p-values for Age p=0.012, Gender p=0.427, Education p=0.000, Occupation p=0.349*				USE AIR CONDITIONER *Overall p-values for Age p=0.213, Gender p=0.158, Education p=0.001, Occupation p=0.878*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.73	0.38	1.41	0.349	1.20	0.58	2.49	0.626
	65-69	0.57	0.30	1.09	0.091	0.65	0.31	1.39	0.270
	70-74	1.01	0.51	2.00	0.973	0.83	0.38	1.81	0.634
	75+	0.36	0.18	0.76	0.007	0.57	0.24	1.32	0.187
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	0.85	0.58	1.26	0.427	0.72	0.45	1.14	0.158
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.37	0.18	0.74	0.005	0.35	0.15	0.83	0.018
	Some university	1.09	0.62	1.91	0.769	0.82	0.44	1.52	0.522
	Graduate	0.74	0.29	1.91	0.537	1.43	0.54	3.82	0.470
	Post graduate	0.52	0.09	3.20	0.481	1.27	0.21	7.66	0.796
	No education	0.41	0.26	0.66	0.000	0.33	0.18	0.58	0.000
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.73	0.20	2.70	0.639	1.97	0.50	7.85	0.336
	Design	0.79	0.15	4.05	0.779	1.99	0.31	12.76	0.469
	Engineering	0.44	0.14	1.37	0.157	0.70	0.18	2.74	0.607
	Healthcare	0.47	0.11	2.07	0.321	1.58	0.32	7.90	0.578
	Law	1.09	0.18	6.49	0.929	2.31	0.42	12.82	0.338
	Sales	1.63	0.31	8.74	0.566	0.86	0.09	8.68	0.900
	Others	0.47	0.22	0.98	0.045	1.30	0.56	3.05	0.542

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.33: Regressions on practices of elderly (Heat stroke-exhaustion) (MODEL 3).

PRACTICES OF ELDERLY									
HEAT STROKE OR EXHAUSTION									
MODEL 3		**DRINK MORE WATER** *Overall p-values for Age p=0.346, Gender p=0.851, Education p=0.204, Occupation p=0.237*				**STAY IN SHADE** *Overall p-values for Age p=0.075, Gender p=0.992, Education p=0.327, Occupation p=0.667*			
		*OR. **	*95% C.I.***		*P**** value*	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	60-64	1.23	0.76	1.97	0.398	1.73	1.03	2.91	0.038
	65-69	1.12	0.70	1.80	0.637	1.90	1.13	3.19	0.015
	70-74	1.60	0.99	2.60	0.056	1.98	1.18	3.33	0.010
	75+	1.10	0.63	1.91	0.743	1.38	0.75	2.53	0.295
Gender	***Male (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Female	0.97	0.71	1.33	0.851	1.00	0.72	1.39	0.992
Education	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	High school	1.06	0.69	1.63	0.781	0.93	0.59	1.47	0.750
	Some university	1.29	0.80	2.09	0.295	1.56	0.96	2.53	0.071
	Graduate	0.76	0.46	1.26	0.287	1.20	0.71	2.03	0.494
	Post graduate	0.94	0.09	9.41	0.960	3.65	0.32	41.81	0.298
	No education	0.67	0.42	1.06	0.088	1.29	0.80	2.07	0.302
Occupation	***Business (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Finance	3.10	1.25	7.69	0.015	1.14	0.46	2.84	0.774
	Design	2.00	0.77	5.20	0.157	1.22	0.47	3.16	0.676
	Engineering	1.80	0.94	3.45	0.079	1.00	0.51	1.97	0.998
	Healthcare	3.13	1.28	7.70	0.013	1.08	0.44	2.67	0.862
	Law	1.68	0.32	8.70	0.537	0.52	0.09	3.07	0.470
	Sales	1.63	0.77	3.48	0.204	0.63	0.28	1.44	0.275
	Others	1.67	0.89	3.13	0.111	1.19	0.62	2.27	0.606

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.34: Regressions on practices of elderly (Heat stroke-exhaustion) (MODEL 3) (Cont'd).

MODEL 3		STAY INDOORS *Overall p-values for Age p=0.852, Gender p=0.149, Education p=0.028, Occupation p=0.695*				USE AIR CONDITIONER *Overall p-values for Age p=0.104, Gender p=0.964, Education p=0.101, Occupation p=0.444*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	1.03	0.63	1.68	0.916	0.77	0.45	1.33	0.349
	65-69	1.05	0.64	1.72	0.862	0.75	0.43	1.30	0.300
	70-74	1.22	0.74	2.01	0.437	0.52	0.29	0.94	0.031
	75+	0.90	0.50	1.62	0.714	0.42	0.20	0.88	0.022
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.27	0.92	1.76	0.149	1.01	0.69	1.48	0.964
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	1.26	0.81	1.97	0.303	1.18	0.71	1.95	0.517
	Some university	2.10	1.30	3.39	0.003	1.36	0.78	2.36	0.281
	Graduate	0.91	0.53	1.56	0.722	1.01	0.54	1.89	0.963
	Post graduate	0.88	0.07	11.32	0.919	2.68	0.14	49.79	0.508
	No education	0.94	0.58	1.54	0.809	0.46	0.24	0.90	0.024
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	2.24	0.91	5.52	0.079	0.02	3.52	1.22	10.191
	Design	1.35	0.51	3.54	0.547	0.26	1.99	0.60	6.581
	Engineering	1.17	0.58	2.34	0.659	0.25	1.69	0.69	4.139
	Healthcare	1.68	0.68	4.13	0.262	0.42	1.61	0.51	5.062
	Law	1.04	0.19	5.72	0.960	0.69	0.57	0.04	8.846
	Sales	1.10	0.49	2.46	0.813	0.15	2.06	0.76	5.533
	Others	1.27	0.65	2.47	0.488	0.15	1.89	0.79	4.527

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.35: Regressions on practices of elderly (Respiratory problems) (MODEL 1).

PRACTICES OF ELDERLY													
RESPIRATORY PROBLEMS													
MODEL 1		**USE MASKS** *Overall p-values for Age p=0.027, Gender p=0.652, Education p=0.000, Occupation p=0.000*				**USE AIR PURIFIERS** *Overall p-values for Age p=0.000, Gender p=0.650, Education p=0.008, Occupation p=0.000*				**AVOID EXPOSURE WITH POLLUTANTS** *Overall p-values for Age p=0.003, Gender p=0.622, Education p=0.145, Occupation p=0.013*			
		*OR. **	*95% C.I.***		*P**** value*	*OR.*	*95% C.I.*		*p value*	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	1.42	0.92	2.21	0.114	0.64	0.42	0.97	0.038	0.47	0.31	0.72	0.000
	65-69	1.24	0.81	1.88	0.318	0.58	0.39	0.86	0.007	0.59	0.40	0.86	0.006
	70-74	1.29	0.85	1.96	0.229	0.54	0.36	0.81	0.003	0.50	0.34	0.74	0.001
	75+	0.69	0.41	1.14	0.147	0.32	0.19	0.52	0.000	0.55	0.35	0.86	0.009
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.06	0.81	1.39	0.652	1.06	0.82	1.39	0.650	1.07	0.83	1.37	0.622
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.60	0.41	0.88	0.009	0.57	0.39	0.83	0.003	0.69	0.49	0.98	0.037
	Some university	1.17	0.78	1.75	0.438	0.88	0.59	1.33	0.553	0.88	0.60	1.29	0.510
	Graduate	0.41	0.24	0.71	0.002	0.62	0.38	1.02	0.058	0.74	0.47	1.16	0.184
	Post graduate	2.11	0.69	6.44	0.188	0.69	0.21	2.27	0.539	0.42	0.13	1.43	0.168
	No education	1.61	1.09	2.38	0.017	1.33	0.90	1.98	0.153	0.68	0.46	1.00	0.053
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.33	0.18	0.60	0.000	0.88	0.50	1.56	0.659	1.04	0.59	1.83	0.884
	Design	0.80	0.27	2.33	0.684	0.70	0.24	2.04	0.509	1.24	0.43	3.57	0.693
	Engineering	0.21	0.12	0.37	0.000	0.24	0.14	0.42	0.000	0.56	0.33	0.94	0.027
	Healthcare	0.55	0.23	1.30	0.173	0.59	0.25	1.40	0.232	1.41	0.59	3.34	0.441
	Law	3.81	0.44	33.25	0.226	4.27	0.48	37.62	0.191	2.92	0.53	16.05	0.218
	Sales	0.47	0.21	1.03	0.060	0.41	0.19	0.90	0.026	0.56	0.26	1.22	0.147
	Others	0.25	0.17	0.37	0.000	0.27	0.18	0.40	0.000	0.62	0.42	0.90	0.013

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.36: Regressions on practices of elderly (Respiratory problems) (MODEL 2).

PRACTICES OF ELDERLY														
RESPIRATORY PROBLEMS														
MODEL 2		**USE MASKS** *Overall p-values for Age p=0.331, Gender p=0.936, Education p=0.017, Occupation p=0.744*				**USE AIR PURIFIERS** *Overall p-values for Age p=0.085, Gender p=0.388, Education p=0.000, Occupation p=0.430*				**AVOID EXPOSURE WITH POLLUTANTS** *Overall p-values for Age p=0.063, Gender p=0.949, Education p=0.000, Occupation p=0.851*				
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*	*OR.*	*95% C.I.*		*p value*	
			lower	*upper*			*lower*	*upper*			*lower*	*upper*		
Age	***≤ 59 (Ref.)******	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-	
	60-64	1.05	0.54	2.01	0.894	0.82	0.42	1.60	0.570	0.62	0.32	1.20	0.157	
	65-69	1.07	0.56	2.04	0.844	0.85	0.44	1.64	0.619	0.43	0.22	0.83	0.012	
	70-74	1.58	0.80	3.10	0.189	1.36	0.69	2.70	0.378	0.66	0.33	1.32	0.240	
	75+	0.84	0.41	1.72	0.633	0.56	0.27	1.17	0.124	0.40	0.19	0.84	0.015	
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-	
	Female	0.98	0.67	1.44	0.936	0.84	0.57	1.24	0.388	0.99	0.66	1.47	0.949	
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-	
	High school	0.75	0.39	1.47	0.407	0.34	0.16	0.74	0.006	0.85	0.43	1.67	0.636	
	Some university	1.28	0.74	2.24	0.380	1.77	1.01	3.11	0.048	1.90	1.08	3.35	0.026	
	Graduate	0.64	0.25	1.64	0.351	0.75	0.29	1.96	0.555	1.39	0.55	3.53	0.489	
	Post graduate	0.57	0.10	3.39	0.539	1.69	0.30	9.55	0.553	0.87	0.15	5.18	0.879	
	No education	0.51	0.33	0.81	0.004	0.61	0.39	0.97	0.038	0.48	0.30	0.78	0.003	
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-	
	Finance	0.43	0.12	1.57	0.200	0.75	0.21	2.73	0.661	0.41	0.11	1.57	0.196	
	Design	0.46	0.09	2.36	0.354	1.27	0.24	6.72	0.777	1.18	0.24	5.86	0.837	
	Engineering	0.53	0.17	1.60	0.258	0.27	0.08	0.93	0.038	0.62	0.20	1.94	0.415	
	Healthcare	0.89	0.21	3.75	0.879	0.61	0.14	2.69	0.515	0.67	0.16	2.92	0.596	
	Law	1.67	0.28	10.00	0.575	1.47	0.24	8.85	0.673	1.82	0.30	11.02	0.515	
	Sales	0.94	0.19	4.62	0.937	1.51	0.29	7.90	0.624	0.76	0.15	3.95	0.742	
	Others	0.62	0.30	1.28	0.200	0.65	0.31	1.36	0.253	0.75	0.36	1.55	0.433	

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.37: Regressions on practices of elderly (Respiratory problems) (MODEL 3).

PRACTICES OF ELDERLY													
RESPIRATORY PROBLEMS													
MODEL 3		**USE MASKS** *Overall p-values for Age p=0.000, Gender p=0.355, Education p=0.000, Occupation p=0.105*				**USE AIR PURIFIERS** *Overall p-values for Age p=0.003, Gender p=0.861, Education p=0.000, Occupation p=0.258*				**AVOID EXPOSURE WITH POLLUTANTS** *Overall p-values for Age p=0.113, Gender p=0.416, Education p=0.013, Occupation p=0.883*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	3.49	1.31	9.28	0.012	1.88	0.81	4.33	0.140	0.80	0.40	1.58	0.519
	65-69	6.02	2.33	15.51	0.000	3.03	1.36	6.76	0.007	1.10	0.57	2.11	0.778
	70-74	7.33	2.86	18.77	0.000	4.28	1.95	9.37	0.000	1.71	0.91	3.20	0.096
	75+	3.66	1.28	10.47	0.015	2.15	0.87	5.32	0.097	0.91	0.41	1.99	0.806
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.23	0.79	1.91	0.355	0.96	0.62	1.49	0.861	1.19	0.78	1.80	0.416
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.55	0.21	1.44	0.221	0.55	0.21	1.46	0.232	0.85	0.44	1.64	0.624
	Some university	5.82	3.01	11.25	0.000	4.47	2.29	8.72	0.000	2.51	1.40	4.51	0.002
	Graduate	3.64	1.78	7.44	0.000	5.61	2.80	11.23	0.000	1.12	0.56	2.26	0.743
	Post graduate	0.00	0.00	NA*****	0.999	0.00	0.00	NA	0.999	0.00	0.00	NA	0.999
	No education	4.70	2.39	9.23	0.000	5.19	2.64	10.18	0.000	1.64	0.89	3.02	0.114
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.37	0.10	1.35	0.132	0.78	0.24	2.47	0.668	1.12	0.37	3.40	0.843
	Design	0.36	0.12	1.10	0.073	0.95	0.33	2.77	0.931	0.73	0.23	2.32	0.598
	Engineering	0.48	0.21	1.07	0.071	0.44	0.20	1.01	0.053	0.96	0.42	2.21	0.931
	Healthcare	0.22	0.06	0.79	0.021	0.52	0.17	1.60	0.254	0.49	0.14	1.79	0.283
	Law	0.13	0.01	1.31	0.084	0.51	0.08	3.34	0.480	1.17	0.18	7.66	0.867
	Sales	0.17	0.04	0.66	0.011	0.21	0.05	0.81	0.024	0.59	0.20	1.75	0.344
	Others	0.37	0.17	0.81	0.013	0.50	0.23	1.09	0.080	0.92	0.41	2.06	0.844

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant. *****NA= Not applicable.

Appendix B Table 6.38: Regressions on practices of elderly (Infectious diseases) (MODEL 1).

PRACTICES OF ELDERLY INFECTIOUS DISEASES									
MODEL 1		**GET VACCINATED** *Overall p-values for Age p=0.000, Gender p=0.720, Education p=0.000, Occupation p=0.000*				**STAY HOME IF YOU HAVE SIGNS OF INFECTION** *Overall p-values for Age p=0.021, Gender p=0.202, Education p=0.003, Occupation p=0.000*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.59	0.39	0.91	0.016	1.20	0.78	1.83	0.412
	65-69	0.53	0.36	0.80	0.002	1.10	0.74	1.65	0.636
	70-74	0.53	0.35	0.79	0.002	0.92	0.61	1.38	0.671
	75+	0.29	0.17	0.47	0.000	0.56	0.34	0.91	0.021
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	0.95	0.73	1.25	0.720	1.19	0.91	1.55	0.202
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.52	0.36	0.76	0.001	0.51	0.35	0.74	0.000
	Some university	1.10	0.74	1.65	0.626	0.88	0.59	1.31	0.516
	Graduate	0.45	0.27	0.76	0.003	1.24	0.79	1.95	0.354
	Post graduate	0.51	0.14	1.77	0.286	1.34	0.44	4.07	0.610
	No education	1.45	0.97	2.16	0.067	1.16	0.78	1.72	0.465
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.95	0.53	1.68	0.848	0.32	0.18	0.58	0.000
	Design	0.85	0.29	2.52	0.772	1.02	0.35	2.97	0.975
	Engineering	0.27	0.15	0.48	0.000	0.37	0.22	0.62	0.000
	Healthcare	0.83	0.35	1.99	0.682	0.68	0.29	1.62	0.387
	Law	NA*****	0.00	NA	0.999	2.28	0.42	12.55	0.342
	Sales	0.40	0.18	0.90	0.026	0.40	0.18	0.92	0.030
	Others	0.31	0.21	0.46	0.000	0.31	0.21	0.46	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.39: Regressions on practices of elderly (Infectious diseases) (MODEL 1) (Cont'd).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
MODEL 1		**DISINFECT THE HOT ZONES IN YOUR RESIDENCE** *Overall p-values for Age p=0.000, Gender p=0.942, Education p=0.005, Occupation p=0.000*				**WASH YOUR HANDS OFTEN** *Overall p-values for Age p=0.000, Gender p=0.388, Education p=0.161, Occupation p=0.007*			
		*OR. **	*95% C.I.***		*p value*** **	*OR.*	*95% C.I.*		*p value*
			lower	*Upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	60-64	0.52	0.34	0.80	0.003	0.30	0.19	0.46	0.000
	65-69	0.56	0.38	0.84	0.004	0.31	0.21	0.47	0.000
	70-74	0.51	0.34	0.76	0.001	0.24	0.16	0.36	0.000
	75+	0.32	0.20	0.53	0.000	0.23	0.14	0.38	0.000
Gender	***Male (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Female	1.01	0.78	1.32	0.942	0.89	0.68	1.16	0.388
Education	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	High school	0.57	0.39	0.82	0.003	0.68	0.47	0.98	0.037
	Some university	0.85	0.57	1.27	0.420	0.79	0.52	1.18	0.247
	Graduate	0.69	0.43	1.11	0.126	0.60	0.37	0.99	0.046
	Post graduate	0.94	0.30	2.91	0.913	0.41	0.12	1.45	0.168
	No education	1.44	0.97	2.14	0.068	0.76	0.50	1.17	0.211
Occupation	***Business (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Finance	0.74	0.42	1.31	0.302	1.00	0.56	1.79	0.988
	Design	2.06	0.69	6.17	0.195	0.71	0.22	2.28	0.571
	Engineering	0.45	0.27	0.77	0.003	0.66	0.39	1.12	0.123
	Healthcare	1.61	0.66	3.88	0.293	2.00	0.81	4.93	0.132
	Law	6.13	0.69	54.24	0.103	1.81	0.36	9.05	0.468
	Sales	0.55	0.25	1.21	0.140	0.82	0.38	1.82	0.633
	Others	0.37	0.25	0.55	0.000	0.56	0.38	0.83	0.004

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.40: Regressions on practices of elderly (Infectious diseases) (MODEL 2).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
MODEL 2		**GET VACCINATED** *Overall p-values for Age p=0.031, Gender p=0.398, Education p=0.001, Occupation p=0.249*				**STAY AT HOME IF YOU HAVE SIGNS OF INFECTION** *Overall p-values for Age p=0.088, Gender p=0.632, Education p=0.000, Occupation p=0.330*			
		*OR.**	*95% C.I. ***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.)******	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	60-64	0.71	0.35	1.44	0.336	0.89	0.44	1.80	0.748
	65-69	0.71	0.35	1.44	0.343	0.81	0.40	1.64	0.554
	70-74	1.49	0.73	3.05	0.275	1.57	0.76	3.22	0.220
	75+	0.57	0.26	1.26	0.166	0.64	0.29	1.42	0.273
Gender	***Male (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Female	0.83	0.55	1.27	0.398	0.90	0.59	1.38	0.632
Education	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	High school	0.46	0.20	1.03	0.060	0.45	0.20	1.01	0.053
	Some university	1.61	0.90	2.87	0.107	1.73	0.98	3.08	0.060
	Graduate	1.55	0.60	4.03	0.370	1.13	0.43	2.97	0.811
	Post graduate	1.01	0.17	6.18	0.991	0.44	0.05	4.10	0.472
	No education	0.49	0.29	0.82	0.007	0.45	0.27	0.76	0.003
Occupation	***Business(Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Finance	0.69	0.19	2.55	0.583	0.60	0.16	2.26	0.447
	Design	0.66	0.12	3.52	0.627	1.76	0.34	9.15	0.502
	Engineering	0.34	0.10	1.11	0.073	0.43	0.12	1.49	0.182
	Healthcare	0.59	0.13	2.60	0.486	0.62	0.13	2.96	0.554
	Law	1.51	0.25	9.10	0.651	2.28	0.38	13.66	0.367
	Sales	0.47	0.08	2.88	0.415	2.18	0.42	11.30	0.355
	Others	0.39	0.19	0.83	0.014	0.64	0.30	1.35	0.238

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.41: Regressions on practices of elderly (Infectious diseases) (MODEL 2) (Cont'd).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
MODEL 2		**DISINFECT HOT ZONES IN YOUR RESIDENCE** *Overall p-values for Age p=0.464, Gender p=0.383, Education p=0.005, Occupation p=0.074*				**WASH YOUR HANDS OFTEN** *Overall p-values for Age p=0.129, Gender p=0.487, Education p=0.003, Occupation p=0.367*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	60-64	0.82	0.40	1.67	0.577	0.81	0.40	1.64	0.558
	65-69	0.85	0.42	1.73	0.653	0.54	0.26	1.12	0.099
	70-74	1.13	0.54	2.36	0.741	0.59	0.27	1.28	0.180
	75+	0.59	0.26	1.32	0.195	0.35	0.15	0.85	0.019
Gender	***Male (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Female	0.83	0.54	1.27	0.383	0.85	0.53	1.35	0.487
Education	***Less than high school (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	High school	0.66	0.31	1.41	0.282	1.10	0.51	2.39	0.806
	Some university	1.53	0.85	2.75	0.154	1.96	1.04	3.68	0.037
	Graduate	0.78	0.27	2.20	0.634	2.90	1.07	7.84	0.036
	Post graduate	0.49	0.05	4.61	0.530	2.70	0.44	16.59	0.284
	No education	0.47	0.28	0.80	0.005	0.55	0.30	1.02	0.058
Occupation	***Business (Ref.)***	***1.00***	**-**	**-**	**-**	***1.00***	**-**	**-**	**-**
	Finance	0.34	0.09	1.36	0.129	1.15	0.27	4.95	0.846
	Design	1.11	0.22	5.56	0.900	4.78	0.89	25.50	0.067
	Engineering	0.16	0.04	0.67	0.012	1.25	0.35	4.45	0.731
	Healthcare	0.46	0.10	2.13	0.319	0.72	0.12	4.25	0.715
	Law	1.84	0.31	10.96	0.501	6.73	1.06	42.90	0.044
	Sales	0.82	0.16	4.33	0.818	1.65	0.25	10.70	0.599
	Others	0.42	0.20	0.88	0.022	1.32	0.56	3.11	0.526

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.42: Regressions on practices of elderly (Infectious diseases) (MODEL 3).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
MODEL 3		**GET VACCINATED** *Overall p-values for Age p=0.000, Gender p=0.455, Education p=0.000, Occupation p=0.318*				**STAY AT HOME IF YOU HAVE SIGNS OF INFECTION** *Overall p-values for Age p=0.000, Gender p=0.869, Education p=0.000, Occupation p=0.429*			
		*OR. **	*95% C.I.***		*p value***	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	2.77	0.95	8.11	0.063	2.37	0.78	7.16	0.127
	65-69	5.75	2.09	15.85	0.001	4.89	1.73	13.77	0.003
	70-74	8.56	3.14	23.33	0.000	6.72	2.42	18.67	0.000
	75+	5.60	1.88	16.67	0.002	2.17	0.65	7.24	0.207
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.19	0.75	1.88	0.455	0.96	0.58	1.58	0.869
	Less than high school (Ref.)	***1.00***	-	-	-	***1.00***	-	-	-
	High school	1.07	0.44	2.59	0.888	0.13	0.02	0.99	0.049
	Some university	7.30	3.62	14.72	0.000	5.50	2.59	11.66	0.000
	Graduate	3.47	1.62	7.43	0.001	4.09	1.84	9.11	0.001
	Post graduate	8.22	0.55	123.71	0.128	8.99	0.59	136.84	0.114
	No education	3.87	1.82	8.24	0.000	4.85	2.18	10.79	0.000
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.54	0.14	2.02	0.359	0.50	0.12	2.16	0.355
	Design	0.62	0.20	1.89	0.397	0.86	0.28	2.67	0.800
	Engineering	0.77	0.33	1.78	0.538	0.58	0.24	1.39	0.219
	Healthcare	0.75	0.24	2.41	0.634	0.65	0.19	2.20	0.486
	Law	0.32	0.05	2.26	0.253	0.31	0.04	2.21	0.244
	Sales	0.16	0.03	0.82	0.028	0.00	0.00	NA*****	0.997
	Others	0.47	0.20	1.09	0.077	0.36	0.15	0.87	0.023

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant. *****NA= Not applicable.

Appendix B Table 6.43: Regressions on practices of elderly (Infectious diseases) (MODEL 3) (Cont'd).

PRACTICES OF ELDERLY									
INFECTIOUS DISEASES									
MODEL 3		**DISINFECT THE HOT ZONES IN YOUR RESIDENCE** *Overall p-values for Age p=0.022, Gender p=0.443, Education p=0.000, Occupation p=0.632*				**WASH YOUR HANDS OFTEN** *Overall p-values for Age p=0.650, Gender p=0.261, Education p=0.403, Occupation p=0.640*			
		*OR. **	*95% C.I.***		*p value****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	2.21	0.78	6.23	0.135	0.62	0.29	1.33	0.218
	65-69	3.62	1.35	9.71	0.010	0.82	0.40	1.70	0.598
	70-74	4.11	1.55	10.91	0.004	0.60	0.28	1.30	0.197
	75+	1.66	0.51	5.44	0.399	0.65	0.26	1.63	0.362
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.22	0.73	2.05	0.443	1.34	0.80	2.24	0.261
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.60	0.15	2.33	0.461	0.82	0.38	1.81	0.630
	Some university	9.81	4.21	22.85	0.000	1.81	0.87	3.80	0.114
	Graduate	6.39	2.60	15.73	0.000	1.32	0.57	3.05	0.513
	Post graduate	0.00	0.00	NA*****	0.999	0.00	0.00	NA	0.999
	No education	4.32	1.74	10.73	0.002	1.67	0.77	3.63	0.192
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.78	0.20	3.05	0.722	1.73	0.47	6.36	0.410
	Design	0.53	0.16	1.78	0.303	0.88	0.19	4.15	0.875
	Engineering	0.64	0.25	1.60	0.337	1.32	0.46	3.80	0.612
	Healthcare	0.59	0.16	2.13	0.416	0.22	0.02	2.04	0.183
	Law	0.29	0.03	3.03	0.303	0.00	0.00	NA	0.999
	Sales	0.12	0.01	1.02	0.052	1.39	0.41	4.73	0.594
	Others	0.53	0.21	1.31	0.167	0.89	0.31	2.56	0.834

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant. *****NA= Not applicable.

Appendix B Table 6.44: Regressions on practices of elderly (Injuries) (MODEL 1).

PRACTICES OF ELDERLY									
INJURIES									
MODEL1		**AVOID GOING OUT IN STORMY WEATHER** *Overall p-values for Age p=0.000, Gender p=0.683, Education p=0.455, Occupation p=0.000*				**AVOID STAYING UNDER THE SUN** *Overall p-values for Age p=0.000, Gender p=0.007, Education p=0.023, Occupation p=0.001*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.67	0.44	1.01	0.054	0.56	0.37	0.85	0.007
	65-69	0.60	0.41	0.89	0.011	0.59	0.40	0.87	0.007
	70-74	0.49	0.33	0.73	0.000	0.51	0.35	0.76	0.001
	75+	0.34	0.22	0.54	0.000	0.36	0.23	0.57	0.000
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.05	0.82	1.36	0.683	1.41	1.10	1.82	0.007
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.87	0.62	1.21	0.400	0.82	0.58	1.15	0.249
	Some university	0.99	0.67	1.46	0.946	0.98	0.66	1.44	0.911
	Graduate	1.34	0.86	2.10	0.196	1.96	1.24	3.09	0.004
	Post graduate	2.02	0.60	6.82	0.255	1.22	0.40	3.73	0.733
	No education	0.94	0.64	1.37	0.735	0.88	0.60	1.29	0.523
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.79	0.44	1.42	0.436	0.76	0.42	1.36	0.353
	Design	1.03	0.34	3.11	0.952	1.33	0.44	4.03	0.610
	Engineering	0.60	0.36	1.00	0.050	0.67	0.40	1.11	0.120
	Healthcare	1.17	0.47	2.95	0.734	1.99	0.74	5.37	0.176
	Law	NA*****	0.00	NA	0.999	1.75	0.32	9.65	0.518
	Sales	0.46	0.21	0.99	0.047	0.68	0.31	1.47	0.323
	Others	0.41	0.28	0.61	0.000	0.48	0.32	0.70	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant. *****NA= Not applicable.

Appendix B Table 6.45: Regressions on practices of elderly (Injuries) (MODEL 1) (Cont'd).

PRACTICES OF ELDERLY										
INJURIES										
MODEL1		**READY A FIRST AID KIT FOR INJURIES** *Overall p-values for Age p=0.000, Gender p=0.848, Education p=0.000, Occupation p=0.000*				**USE SUN PROTECTION IF WORKING OUTSIDE** *Overall p-values for Age p=0.000, Gender p=0.549, Education p=0.113, Occupation p=0.000*				
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	**1.00**	-	-	-	**1.00**	-	-	-
	60-64	0.59	0.38	0.91	0.017	0.45	0.29	0.70	0.000
	65-69	0.48	0.32	0.73	0.001	0.40	0.27	0.60	0.000
	70-74	0.56	0.37	0.85	0.007	0.46	0.31	0.69	0.000
	75+	0.30	0.18	0.51	0.000	0.27	0.16	0.45	0.000
Gender	***Male (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	Female	1.03	0.78	1.36	0.848	0.92	0.70	1.21	0.549
Education	***Less than high school (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	High school	0.42	0.28	0.63	0.000	0.56	0.38	0.83	0.004
	Some university	0.91	0.60	1.37	0.652	0.75	0.49	1.14	0.174
	Graduate	0.50	0.30	0.85	0.010	0.69	0.42	1.14	0.148
	Post graduate	0.36	0.09	1.40	0.139	0.86	0.27	2.76	0.795
	No education	1.35	0.90	2.02	0.151	0.86	0.56	1.32	0.484
Occupation	***Business (Ref.)***	**1.00**	-	-	-	**1.00**	-	-	-
	Finance	0.70	0.39	1.25	0.230	0.69	0.38	1.23	0.206
	Design	1.29	0.44	3.82	0.641	1.28	0.43	3.76	0.657
	Engineering	0.29	0.16	0.50	0.000	0.42	0.24	0.73	0.002
	Healthcare	0.51	0.21	1.25	0.140	1.58	0.66	3.78	0.302
	Law	6.17	0.69	55.27	0.104	1.85	0.38	8.97	0.444
	Sales	0.40	0.17	0.91	0.029	0.61	0.28	1.37	0.234
	Others	0.28	0.19	0.41	0.000	0.42	0.28	0.63	0.000

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.46: Regressions on practices of elderly (Injuries) (MODEL 2).

PRACTICES OF ELDERLY									
INJURIES									
MODEL 2		**AVOID GOING OUT IN STORMY WEATHER** *Overall p-values for Age p=0.032, Gender p=0.067, Education p=0.028, Occupation p=0.269*				**AVOID STAYING UNDER THE SUN** *Overall p-values for Age p=0.082, Gender p=0.012, Education p=0.050, Occupation p=0.074*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ******	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.46	0.22	0.93	0.031	0.64	0.32	1.31	0.226
	65-69	0.35	0.17	0.72	0.004	0.46	0.22	0.96	0.038
	70-74	0.62	0.30	1.29	0.199	0.84	0.40	1.75	0.633
	75+	0.35	0.16	0.80	0.013	0.39	0.17	0.89	0.026
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	0.65	0.41	1.03	0.067	0.56	0.36	0.88	0.012
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.79	0.36	1.72	0.545	0.82	0.38	1.78	0.623
	Some university	1.27	0.69	2.34	0.451	1.36	0.74	2.51	0.321
	Graduate	1.04	0.37	2.94	0.945	1.31	0.47	3.65	0.603
	Post graduate	0.00	0.00	NA*****	0.999	0.62	0.06	5.91	0.677
	No education	0.42	0.23	0.75	0.004	0.49	0.27	0.86	0.014
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.84	0.22	3.16	0.795	0.68	0.18	2.53	0.567
	Design	1.00	0.19	5.30	0.997	1.40	0.28	7.12	0.682
	Engineering	0.30	0.08	1.13	0.076	0.29	0.08	0.99	0.049
	Healthcare	0.18	0.02	1.65	0.128	0.12	0.01	1.14	0.065
	Law	0.89	0.17	4.77	0.895	0.66	0.13	3.51	0.629
	Sales	1.36	0.25	7.27	0.719	1.18	0.22	6.24	0.842
	Others	0.48	0.22	1.04	0.062	0.39	0.18	0.83	0.014

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.
*****NA= Not applicable.

Appendix B Table 6.47: Regressions on practices of elderly (Injuries) (MODEL 2) (Cont'd).

PRACTICES OF ELDERLY										
INJURIES										
MODEL 2		**READY A FIRST AID KIT FOR INJURIES** *Overall p-values for Age p=0.206, Gender p=0.097, Education p=0.075, Occupation p=0.037*				**USE SUN PROTECTION IF WORKIN OUTSIDE** *Overall p-values for Age p=0.284, Gender p=0.370, Education p=0.030, Occupation p=0.271*				
		*OR. **	*95% C.I.***		*p value*******	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.76	0.35	1.63	0.477	0.80	0.37	1.76	0.582
	65-69	0.63	0.29	1.35	0.233	0.56	0.25	1.26	0.160
	70-74	0.94	0.43	2.04	0.868	0.73	0.32	1.66	0.449
	75+	0.39	0.16	0.96	0.041	0.38	0.14	0.98	0.045
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	0.67	0.42	1.08	0.097	0.79	0.47	1.32	0.370
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.43	0.17	1.07	0.069	0.45	0.17	1.19	0.108
	Some university	1.20	0.63	2.27	0.579	1.23	0.63	2.43	0.545
	Graduate	0.90	0.30	2.74	0.853	1.73	0.59	5.02	0.316
	Post graduate	2.03	0.31	13.06	0.457	2.77	0.44	17.27	0.275
	No education	0.54	0.30	0.98	0.043	0.48	0.25	0.93	0.029
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.58	0.15	2.35	0.450	0.99	0.21	4.70	0.985
	Design	2.44	0.46	12.78	0.292	6.89	1.23	38.65	0.028
	Engineering	0.15	0.03	0.76	0.022	0.59	0.13	2.65	0.493
	Healthcare	0.42	0.07	2.38	0.328	0.95	0.16	5.78	0.959
	Law	0.95	0.18	4.97	0.953	2.42	0.43	13.60	0.316
	Sales	1.80	0.33	9.69	0.495	2.40	0.36	15.93	0.364
	Others	0.43	0.20	0.92	0.030	0.99	0.40	2.42	0.977

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.48: Regressions on practices of elderly (Injuries) (MODEL 3).

MODEL 3		**AVOID GOING OUT IN STORMY WEATHER** *Overall p-values for Age p=0.002, Gender p=0.647, Education p=0.000, Occupation p=0.324*				**AVOID STAYING UNDER THE SUN** *Overall p-values for Age p=0.012, Gender p=0.302, Education p=0.000, Occupation p=0.592*			
		OR. *	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) ****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	0.99	0.50	1.99	0.983	1.08	0.51	2.29	0.835
	65-69	1.73	0.91	3.28	0.094	1.74	0.86	3.49	0.121
	70-74	2.80	1.50	5.23	0.001	2.77	1.41	5.46	0.003
	75+	1.53	0.72	3.25	0.271	1.55	0.68	3.51	0.295
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	1.10	0.74	1.64	0.647	1.25	0.82	1.92	0.302
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	1.45	0.80	2.62	0.223	1.66	0.84	3.29	0.143
	Some university	3.63	2.04	6.44	0.000	3.94	2.06	7.53	0.000
	Graduate	2.26	1.22	4.19	0.009	3.81	1.95	7.45	0.000
	Post graduate	2.32	0.17	31.82	0.529	3.24	0.23	46.08	0.386
	No education	1.24	0.63	2.43	0.539	2.00	0.96	4.16	0.064
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	0.76	0.23	2.55	0.658	1.79	0.57	5.57	0.317
	Design	1.09	0.36	3.24	0.883	1.25	0.39	3.94	0.707
	Engineering	1.79	0.80	4.02	0.159	1.41	0.58	3.40	0.446
	Healthcare	1.49	0.51	4.30	0.465	1.68	0.55	5.07	0.360
	Law	1.29	0.22	7.56	0.780	1.58	0.26	9.68	0.622
	Sales	1.18	0.44	3.16	0.738	1.11	0.38	3.26	0.854
	Others	0.92	0.41	2.08	0.847	0.84	0.35	2.04	0.704

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant.

Appendix B Table 6.49: Regressions on practices of elderly (Injuries) (MODEL 3) (Cont'd).

MODEL 3		READY A FIRST AID KIT FOR INJURIES *Overall p-values for Age p=0.003, Gender p=0.090, Education p=0.000, Occupation p=0.152*				USE SUN PROTECTION IF WORKIN OUTSIDE *Overall p-values for Age p=0.515, Gender p=0.486, Education p=0.420, Occupation p=0.988*			
		*OR. **	*95% C.I.***		*p value*****	*OR.*	*95% C.I.*		*p value*
			lower	*upper*			*lower*	*upper*	
Age	***≤ 59 (Ref.) *****	***1.00***	-	-	-	***1.00***	-	-	-
	60-64	1.38	0.41	4.62	0.606	0.88	0.14	5.49	0.890
	65-69	2.96	0.98	8.96	0.055	1.20	0.21	6.96	0.837
	70-74	4.86	1.66	14.18	0.004	2.20	0.43	11.12	0.342
	75+	1.02	0.25	4.23	0.974	0.48	0.04	5.60	0.562
Gender	***Male (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Female	0.59	0.32	1.09	0.090	1.42	0.53	3.83	0.486
Education	***Less than high school (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	High school	0.45	0.09	2.30	0.337	0.59	0.06	5.83	0.651
	Some university	10.59	4.11	27.30	0.000	3.20	0.68	15.03	0.141
	Graduate	4.12	1.47	11.56	0.007	1.24	0.19	8.18	0.823
	Post graduate	0.00	0.00	NA*****	0.999	0.00	0.00	NA	0.999
	No education	4.61	1.53	13.85	0.006	2.93	0.71	12.16	0.139
Occupation	***Business (Ref.)***	***1.00***	-	-	-	***1.00***	-	-	-
	Finance	2.69	0.63	11.53	0.183	1.39	0.00	NA	1.000
	Design	0.81	0.20	3.19	0.758	NA	0.00	NA	0.998
	Engineering	1.34	0.46	3.93	0.595	NA	0.00	NA	0.997
	Healthcare	2.27	0.56	9.13	0.249	NA	0.00	NA	0.997
	Law	1.66	0.22	12.52	0.621	NA	0.00	NA	0.997
	Sales	0.24	0.03	2.26	0.211	1.54	0.00	NA	1.000
	Others	0.64	0.21	1.96	0.434	NA	0.00	NA	0.997

**C.I. = confidence interval; *OR. = odds ratio; ***Ref. = reference category. ****p<0.05 is considered as significant. *****NA= Not applicable.

APPENDIX C. PRESENTATION OF SURVEYS FOR CHAPTER 4-5-6.

Survey 1: Communicating Climate Change with Elderly Chinese: Tool Visualization

(Chapter 4)

This survey was prepared for communication of climate change with Chinese elderly. The survey reflects on the information the elderly views on the communication tools (Appendix C Table 1).

Appendix C Table 1: Survey questions: Communicating climate change.

Demographic characteristics		
What is your age?	***Are you born in Suzhou?***	***What is your highest level of education?***
59 or younger	Yes	No formal schooling
60-64	No	Primary school
65-69		Middle school
70 or older		High school
		Entered but did not complete University
		Completed University
		Post-graduate degree
Do you and your children live together in the same house or apartment?	***Considering all the members of your household, what would you say is the combined monthly earnings?***	
Yes	Less than 2,500 RMB per month	

No	2,500 to less than 5,000 RMB per month	
I have no children	5,000 to less than 7,500 RMB per month	
	At least 7,500 RMB per month	
	Prefer not to say.	

Visual tools and survey questions		
Infographic	**Video**	**Text-Graph**
What weather impacts of climate change you can list of according to infographic you have just seen? (Given the options of flooding, drought, storms, Heatwaves, and air quality interactions)	***What weather impacts of climate change you can list of according to video you have just seen?*** (Given the options of flooding, drought, storms, Heatwaves, and air quality interactions)	***What weather impacts of climate change you can list of according to text-graph you have just seen?*** (Given the options of flooding, drought, storms, Heatwaves, and air quality interactions)
What weather impacts of climate change you can list of according to infographic you have just seen? (Given the options of heart disease, respiratory diseases, lung disease, malaria, injuries, mental health)	***What weather impacts of climate change you can list of according to video you have just seen?*** (Given the options of heart disease, respiratory diseases, lung disease, malaria, injuries, mental health)	***What weather impacts of climate change you can list of according to text-graph you have just seen?*** (Given the options of heart disease, respiratory diseases, lung disease, malaria, injuries, mental health)
Which of these health impacts do you think will affect people in Suzhou? Please rank them. (Given the options of heart disease, respiratory diseases, lung disease, malaria, injuries, mental health)	***Which of these health impacts do you think will affect people in Suzhou? Please rank them.*** (Given the options of heart disease, respiratory diseases, lung disease, malaria, injuries, mental health)	***Which of these health impacts do you think will affect people in Suzhou? Please rank them.*** (Given the options of heart disease, respiratory diseases, lung disease, malaria, injuries, mental health)

b. Survey 2: Understanding of Climate Change in Chinese Elderly: KAP Study

(Chapter 5)

This survey generally included questions on elderly knowledge, attitude and practices; however, it also included information on knowledge channels, climate change manifestation and elderly concerns, and measures.

Appendix C Table 2: Survey questions: Understanding climate change.

Demographic characteristics			
Age:	***Sex:***	***Education level:***	***Previous occupation:***
-------	Female	No schooling	Agriculture
	Male	Primary School	Mining
		Middle school	Manufacturing
		High School	Energy sector
		College	Traffic officer
		Postgraduate	Medical
			Business, finance
			Construction worker
			Education sector
Have you heard about climate change?	***What are the main ways for you to learn about climate change?***	***How do you think climate change will manifest?***	***Concerned of Climate Change?***
			Yes
No	Newspaper	Extreme heat	No

Yes	Magazine Radio Television Neighbors Family members	Rainfalls Storms Floods Drought Other Don't know	Don’t know
How do you think climate change will affect your health? Heat stroke Water quality related Water borne diseases Infectious diseases Air quality related Respiratory diseases Sunburn Cancer Stress Other	***Climate change affects your lifestyle?*** Yes No Don’t know	***Are you vulnerable to climate change?*** Yes No Don’t know	***Do you have enough information to prepare for the impacts of climate change?*** Yes No Don’t know
In extreme heat what are your practices? Drink more water	***What kind of trouble have you meet when you take measures to resist climate change?*** Lack of knowledge		***Extreme weather assistance From the government?*** Yes

Open the windows	Lack of skills	No
Stay in shade	Lack of motivation	
Stay in home	Lack of time	
Use air conditioner	Lack of resources	
Lower your activity	Lack of assistance	
Wear less clothes	No use of resistance to climate change	
Use sun protector	Climate change is not emerging	
Bath often	Government will solve it	
Use public air conditioner	Others	
Take medicines		

c. Survey 3: Climate Change Adaptation and Elderly Health: Large Scale Analysis in Three Chinese Cities

(Chapter 6)

In this last questionnaire covering three cities, the participants were asked on their knowledge, attitude and practices.

Appendix C Table 3: Survey for large scale analysis.

Demographic characteristics			
Age:	***Gender:***	***Highest degree of education:***	***Occupation:***
59 or below	Male	Under high school	Business, consulting, management
60-64	Female	High school	Accounting, banking, finance
65-69		Some university	Design
70-75		University graduate	Engineering/manufacturing
75+		Postgrad	Healthcare
		No schooling	Law
			Sales/marketing
			Other
Have you heard about climate change?	***How would you define climate change impacts? Choose multiple.***	***Do you think climate patterns changed in the last 20 years?***	***Which one of the below impacts you have noticed changes? (yes, no, I don't know)***
Yes	Flooding	Yes	More storms
No	Drought	No	More floods

	Storms Heatwaves Wildfires	More drought More heat More cold
Do you think climate change threatens your health? Yes No	***Which of the following ways climate change threatens your health? Choose any.*** Heat stroke- exhaustion Respiratory- breathing problems Infectious diseases such as malaria, dengue Injuries due to extreme events, such as floods, storms.	
For each of the below what would you do to manage your health?	Heat stroke- exhaustion (drink more water, stay in shade, stay indoors, use ac) Respiratory- breathing problems (use masks, use air purifiers indoors, avoid closure with pollutants) Infectious diseases such as malaria, dengue (get vaccinated, stay home in signs of infection, disinfect the hot zones in your residence, wash your hands often) Injuries due to extreme events, such as floods, storms (avoid going out in stormy weather, if it is hot avoid staying under the sun to avoid sunburns, ready a first aid kit for physical injuries, use sunscreen when working outside)	

APPENDIX D. CONSENT FORM

MODEL CONSENT FORM

知情同意书模板

Title of Research Project: **项目名称：**	Climate Change Adaptation and Human Health: Reducing Climate Change Health Risks in the Ageing Chinese Population
Researcher(s): **研究人员:**	PELIN KINAY

Please initial box

1. I confirm that I have read and have understood the information sheet dated [ ] for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

   本人确认已于[日期]阅读并了解了该项目相关研究信息，并已从项目负责人处得到考虑、提问的机会，且得到满意答复。

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. ☐

   本人知晓对该项目的参与为自愿，且可以随时退出，无需任何理由，同时权利不会受任何影响。

3. I understand that I can at any time ask for access to the information I provide and I can also request the destruction of that information if I wish. ☐

   本人知晓可随时要求获取或销毁所提供的个人信息。

4. I agree to take part in the above study.

本人同意参加此项研究。 ☐

Participant Name 参与者	Date 日期	Signature 签名
Name of Person taking consent 知情同意书提供者	Date 日期	Signature 签名
Researcher 研究人员	Date 日期	Signature 签名

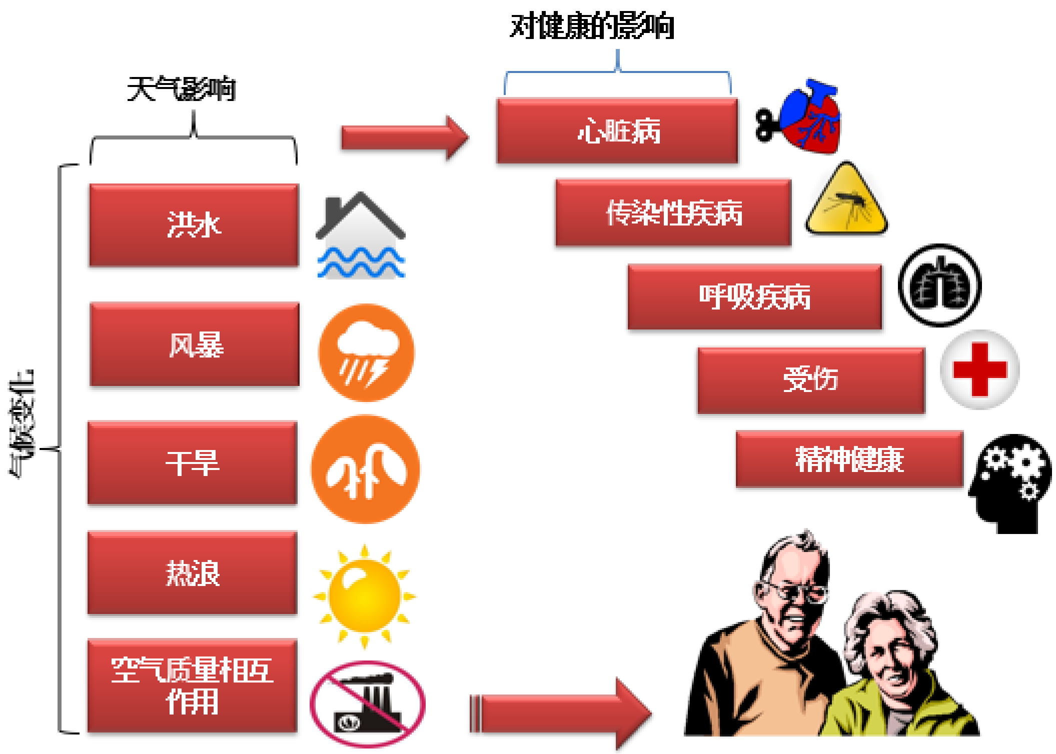
The contact details of lead Researcher (Principal Investigator) are:
项目负责人的联系方式如下：

[Contact Details, including Telephone, Email and Work Address]
[联系方式，请包含电话号码、邮件地址及工作地址]

APPENDIX E. COMMUNICATION TOOLS

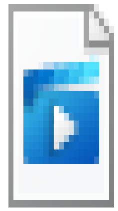
1. INFOGRAPHIC TOOL

Appendix E Figure 1. Infographic tool (Chinese)



2. **VIDEO TOOL**

Appendix E Figure 2. Video tool (Chinese)



Communication Project Video Tool.mp4

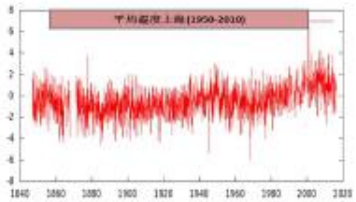
Please click the link to view the video: https://vimeo.com/517522235

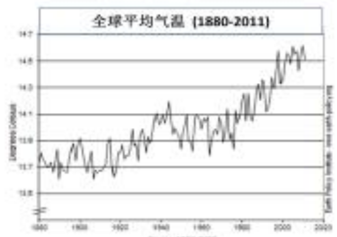
3. TEXT-GRAPH TOOL

Appendix E Figure 3. Text-graph tool (Chinese)

气候变化是什么？

气候变化是指气候在一段时间内的波动变化。一段时间也可能是指几十年或几百万年，波动范围可以是区域性或全球性的，其平均气象指数的变化。目前对气候变迁讨论最多的是关于环境政策对当代气候的影响，也就是说人为因素对气候的影响，尤其是关于全球变暖问题。





气候变化影响健康问题的社会和环境决定因素——清洁的空气、安全的饮用水、充足的食物和有保障的住所。

气候变化预计将在2030年至2050年间，每年多造成约25万人死于营养不良、疟疾、腹泻和气温过高。

据估计，到2030年时对健康带来的直接损失费用。

卫生基础设施薄弱地区（主要在发展中国家）最缺乏能力在无援助的情况下进行应对、做好准备和作出反应。

*********** THE END **********