The health impacts of women's low status and gender discrimination in son preference countries

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy by Andrew James Pennington

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Declaration

This thesis is my own work, except where work that has formed part of jointly authored publications has been included. CRediT (Contributor Roles Taxonomy) author statements for publications relating to this thesis are below. Full copies of the publications can be found in Appendix 12 (except for a paper relating to Study 3 which is currently in the final stages of preparation prior to submission for publication). The material contained in this thesis has not been presented, nor is currently being presented, either wholly or in part for any other degree or qualification.

CRediT (Contributor Roles Taxonomy) author statements for publication relating to this thesis

Study 1 paper: *Pennington A, Orton L, Nayak S, Ring A, Petticrew M, Sowden A, et al. (2018) The health impacts of women's low control in their living environment: a theory-based systematic review of observational studies in societies with profound gender discrimination. Health Place. 51:1–10.*

Andy Pennington: Conceptualisation, Project coordination, Methodology, Searches, Screening, Data extraction, Data analysis, Data synthesis, Original draft preparation, Reviewing and Editing, Dissemination (e.g., conference presentations, social media). **Lois Orton**: Conceptualisation, Methodology, Searches, Screening, Data extraction, Data analysis, Data synthesis, Reviewing and Editing. **Shilpa Nayak**: Screening, Data extraction, Data analysis, Reviewing and Editing. **Adele Ring**: Screening, Data extraction, Data analysis, Reviewing and Editing. **Mark Petticrew**: Conceptualisation, Reviewing and Editing. **Amanda Sowden**: Conceptualisation, Methodology, Searches, **Martin White**: Conceptualisation, Reviewing and Editing. **Margaret Whitehead**: Conceptualisation, Project management lead (University of Liverpool PI), Methodology, Searches, Screening, Data analysis, Data synthesis, Reviewing and Editing.

Study 2 paper: *Pennington A, Maudsley G, Whitehead M (2023) The impacts of profound gender discrimination on the survival of girls and women in son-preference countries - A systematic review. Health Place. 79:102942.*

Andy Pennington: Conceptualisation, Project coordination, Methodology, Searches, Screening, Data extraction, Data analysis, Data synthesis, Original draft preparation, Reviewing and Editing, Dissemination (e.g., conference presentations, social media). **Gillian Maudsley:** Searches, Screening, Data analysis, Data synthesis, Reviewing and Editing. **Margaret Whitehead**: Conceptualisation, Project management lead (University of Liverpool PI), Methodology, Searches, Screening, Data analysis, Data synthesis, Reviewing and Editing.

Study 3 paper: *Pennington A, Maudsley G, Whitehead M (In preparation) Migration of gender discrimination? A systematic review of evidence on sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia.*

Andy Pennington: Conceptualisation, Project coordination, Methodology, Searches, Screening, Data extraction, Data analysis, Data synthesis, Original draft preparation, Reviewing and Editing, Forthcoming dissemination. **Gillian Maudsley:** Searches, Screening, Data analysis, Data synthesis, Reviewing and Editing. **Margaret Whitehead**: Conceptualisation, Project management lead (University of Liverpool PI), Methodology, Searches, Screening, Data analysis, Data synthesis, Reviewing and Editing.

Study 4 paper: *Orton L, Pennington A, Nayak S, Sowden A, White M, Whitehead M (2016) Group-based microfinance for collective empowerment: a systematic review of health impacts. Bull World Health Organ. 94:694-704A.*

Lois Orton: Conceptualisation, Project coordination, Methodology, Searches, Screening, Data extraction, Data analysis, Data synthesis, Original draft preparation, Reviewing and Editing, Dissemination (conference presentation, social media). **Andy Pennington**: Conceptualisation, Project coordination, Methodology, Searches, Screening, Data extraction, Data analysis, Data synthesis, Original draft preparation, Reviewing and Editing, Dissemination (interest groups/networks, social media). **Shilpa Nayak**: Screening, Data extraction, Data analysis, Reviewing and Editing. **Martin White**: Conceptualisation, Reviewing and Editing. **Margaret Whitehead**: Conceptualisation, Project management lead (University of Liverpool PI), Methodology, Screening, Data analysis, Data synthesis, Reviewing and Editing.

Dedication

I would like to dedicate this thesis to my parents, David Pennington and Linda Pennington, who taught me, among many things, the value of integrity, and that "education is the great leveller". This thesis was submitted on their 53rd happy wedding anniversary.

Acknowledgements

Abstract

Background

Half the women on the planet live in countries that exhibit a strong preference for sons. In these societies, profound, pervasive gender discrimination adversely affects the health and survival chances of large numbers of girls and women. Discrimination in treatment and allocation of key resources for life, before, during, and after birth, together with sex-selection practices are estimated to be responsible for a population shortfall of over 100 million 'missing women' in the world today. The problem appears to be manifest through two main interconnected pathways: a low control for women pathway, and a 'son preference' pathway. First, girls and women have poorer control over and access to key determinants of health than boys and men through systematic, unfair, and unjust inequalities in the distribution of opportunities and resources for living. Second, since the mid-1980s, sex identification and sex selection technologies (e.g. ultrasound followed by abortion) have become available in son preference countries, and the practice of sex-selective abortion has become widespread. There is also concern that the practice of sex-selective abortion might 'migrate' with some diasporas from son preference countries, making this a global public health and policy issue that transcends borders and regions. This thesis research aimed to systematically review and synthesise the empirical evidence from son preference countries on the two main pathways to poorer survival chances for women; in relation to diasporas from son preference countries; and on the effectiveness of interventions to tackle the problem.

Methods

Based on a theory-based logic model of the pathways and mechanisms between profound gender discrimination and health and survival, four interrelated systematic review studies were conducted. Searches were iteratively developed and painstakingly carried out across multiple databases and supplementary sources to identify evidence from across a vast and disparate interdisciplinary body of knowledge. Evidence on the two pathways, on the role of women's control/empowerment in the pathways, on sex selective abortion of babies of diasporas from son preference countries, and on women's empowerment initiatives was identified, appraised, and narratively synthesised.

Results

The first study found evidence that lower control for women in their living environment was significantly associated with poorer health and survival outcomes for women and for their children. The second study found evidence of a for girls and women in son-preference countries. There was firm evidence for the operation of both a prenatal and postnatal pathway, with girls and women experiencing a survival disadvantage at every stage of life, compared to boys and men. Latest

estimates, based on data for 2010, suggest there were around 126 million girls and women 'missing' from son preference countries and the world's population total, and that the scale of the problem was growing in absolute and relative terms. It also highlighted that the treats to female survival have shifted over time with the advent of new sex selection technologies, and that there are wider impacts on society from millions of 'missing women' and 'excess males'. The third study found evidence from a small number of studies that the practice of sex-selective abortion appears to persist among certain immigrant population groups, particularly from India and China, after arrival in destination countries in Europe, North America, and Australasia, although more research is need. The fourth study of evaluations of the impact of collective empowerment-based microfinance interventions, found clear evidence of improvements to maternal and child health outcomes for members of established schemes that serve millions of disadvantaged women in low- and middle-income countries. The study also highlighted the risk that participation may initially lead to increases in violence against women, as gender norms are challenged, but may lead to overall reductions in violence over time as norms change.

Discussion

The phenomenon of 'missing' girls and women in son preference countries is one of the great inequalities of our time. This injustice has led to many millions of girls and women being denied the chance of life or the opportunity to flourish, and the problems of 'missing women' and its wider effects have grown, not diminished, in recent years, despite improvements in some countries. Predictions suggest significant growth in numbers of missing women across countries and regions in coming years. Wider impacts on the demographic, economic and social 'threads' of the fabric of societies, including increasing millions of 'excess' men need to be addressed. We may be at another important tipping point for female survival through a potential oncoming wave of new, affordable, and discreet technologies for home fetal sex identification and abortion. There have been concerted efforts by international organisations to highlight the impacts of profound gender discrimination in son preference countries, but the full scale and ramifications of the problem have been under recognised as a public health disaster in some quarters. Although further research is urgently required, there are already multiple intervention points to prevent or ameliorate this tragic phenomenon. The empowerment of girls and women is an essential part the solution.

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Chapter 1 – Introduction to the thesis

'*We confront here what is clearly one of the more momentous, and neglected, problems facing the world today... A great many more than 100 million women are "missing*".' Amartya Sen, 1990.

1.1 Aims of the research

The aims of this doctoral research were to synthesis the empirical evidence on the adverse health and survival impacts of profound gender discrimination against girls and women in son preference countries and on the effectiveness of interventions to tackle the problem.

1.2 Relevance of the problem

Discrimination against girls and women is commonplace in most parts of the world. In fact, half the women on the planet live in countries that exhibit a strong preference for sons. In these societies, profound overt gender discrimination adversely affects the health and survival chances of large numbers of girls and women. Discrimination in treatment and allocation of key resources for life, before, during, and after birth, together with sex-selection practices are estimated to be responsible for a population shortfall of over 100 million 'missing women' in the world today; an enduring phenomenon that is one of the great inequalities of our time.

The problem appears to be manifest through two main pathways. First, as identified in the late 1980s and early 1990s by Amartya Sen and others, girls and women have poorer control over and access to resources (determinants of health) than boys and men through systematic, unfair, and unjust inequalities in the distribution of opportunities and resources for living (Sen, 1986, 1989; Coale, 1991; Klasen, 1994; Klasen and Wink, 2002, 2003). Second, since the mid-1980s, sex identification/determination and sex selection technologies (including ultrasound followed by abortion) have become increasingly affordable and available in son preference countries, and the practice of sex-selective abortion has become widespread (Banister, 2004).

There is also concern that the gender discrimination practice of sex-selective abortion might 'migrate' with some diasporas from son preference countries to high-income destination countries in Europe, North America, and Australasia; making this a global public health and policy issue that may transcend the geographical boundaries of countries and continents.

Reducing profound gender inequality and improving the health and survival chances of girls and women are therefore longstanding priorities for global health and human rights organisations and form an important plank of the international development strategy of the UK Government. This is illustrated, for example, by the United Nations Sustainable Development Goals, particularly Goal 5 (Achieve gender equality and empower all women and girls) (UN, 2015), to which the UK is signatory; the interagency statement of the World Health Organisation on preventing gender-biased sex selection (WHO, 2011), the United Nations Children's Fund Gender Policy and Action

Plan 2021-2030 (UNICEF, 2021), the Save the Children programme on Leaving No Child Behind (Save the Children, 2016), and the Global Programme to Prevent Son Preference and Gender-biased Sex Selection (UNFPA, 2017).

1.3 What are the causes?

Profound gender discrimination, the lower status of women, and son preference in certain societies are hypothesised to be the result of an interplay of long-established, culturally enshrined, and pervasive attitudes and practices that result in systematic discrimination in the allocation of opportunities and resources between men and women, boys and girls. In countries where there is a strong cultural preference for sons (so-called 'son preference' countries) in parts of Asia and North Africa boys and men have traditionally been seen as having greater net utility in families than girls in key areas that are the rooted in the patriarchal, patrilineal, and patrilocal organisation of society. Boys are seen as providing parents with higher status and resources, whereas girls are seen as a drain on family resources. They are seen as a "poor investment" in comparison to males. Discriminatory practices such as patrilineal inheritance, dowry payments, and sex-selective abortion continue in son preference countries even where they have strong gender-equitable state laws, including, for example, the prohibition of dowry payments and the banning of sex determination and sex-selective abortion for social reasons. In some societies, punitive restrictions have been instigated on women's everyday activities, from what they can wear to mobility, education, and employment outside the home. These restrictions constitute a severe form of control over women which results in their subordination.

1.4 Current understanding

In 2016, we conducted the first synthesis of theories on relationships between 'control over destiny' in the living environment and socio-economic inequalities in health (Whitehead, Pennington, et al., 2016). Our analysis drew particular attention to Amartya Sen's work on 'missing women' as an extreme example of macro, societal level discrimination against a particular group - girls and women in son preference countries. We identified a 'central theory' '*that low female status in particular societies may lead to reduced control for women over their access to food and nutrition, health services, education and employment opportunities, as well as reduced access to household resources and fertility and reproductive rights*' (Sen 1999a, 1999b, 2001). We also highlighted hypotheses concerning further mechanisms that may come into play, with son preference leading to sex-selective abortion and infanticide, which, in combination with the impacts of lower control over key resources/determinants for health, lead to lower survival and poorer health outcomes for girls and women, compared to boys and men.

Amartya Sen first used the phrase 'missing women' to describe a survival disadvantage for women exposed to extreme gender prejudice in son preference countries. In 1989 he estimated that, despite considerable evidence of a biological survival advantage for females, there appeared to be 100 million fewer women in Asian and North African populations than expected. He concluded that gender discrimination in the provision of resources for health and survival were to blame - that women were at a social survival disadvantage. His work inspired decades of research into the scale, distribution, causes and wider impacts of the phenomenon of 'missing women'.

1.5 Gaps in evidence

A large and disparate body of evidence on the phenomenon of 'missing women' was inspired by Sen's work. This important body of knowledge has so far not been comprehensively and systematically identified, collated, critically appraised, and coherently synthesised. Synthesis of the evidence is needed to provide a comprehensive, coherent assessment of the empirical support for the proposed pathways and mechanisms between women's low status in society and health and survival outcomes shown in the Logic model (Figure 1). This could help to improve the 'global' understanding of the phenomenon of 'missing women' and in the identification of intervention points for policies to eliminate or ameliorate the impacts of son preference practices on girls and women in their communities and in society at large. It may also help to identify remaining gaps in the knowledge base (including theory and empirical evidence).

There are also gaps in the intervention evidence. A range of past and current legislation, policies and interventions may have intentionally and unintentionally, directly and indirectly influenced the scale, severity and impacts of son preference practices. The range of legislation and policies include, for example, legal prohibitions on pre-natal sex determination and sex-selective abortion for non-medical reasons (for example, India's Pre-Conception and Pre-Natal Diagnostic Techniques Act, 1994), policies designed to control population growth (China's One-child Policy, and the more recent Two-child Policy), and interventions to raise the social standing and empower women in the societies in which they live (Bhaktwani, 2012). The health impacts of these interventions need to be clearly understood. Such interventions may have the potential not only to reduce adverse health and survival outcomes for women and girls, but they may also influence the culture of son preference and the practices of discrimination that underly them.

1.6 What the thesis will cover, and how are the studies linked?

The aims of the research reported in this thesis are to synthesis the empirical evidence on the adverse health and survival impacts of low status and profound gender discrimination on girls and women in son preference countries and on the effectiveness of interventions to tackle the problem.

The objectives are:

1. To conduct a systematic review and synthesis of observational evidence on the health impacts of women's low control/autonomy in societies with profound gender discrimination and gender bias (STUDY 1).
2. To conduct a systematic review and synthesis of the empirical evidence on the impacts of profound gender discrimination on the survival of girls and women in son-preference countries, including estimates of the numbers of 'Missing Women' over time (STUDY 2).
3. To elucidate whether the discriminatory practice of pre-natal sex selection 'migrates' with some diasporas from son preference countries to high-income destination countries without son preference. This will be achieved by conducting a systematic review of evidence on sex ratios at birth for infants of migrants from son-preference countries compared to sex ratios at birth in recipient countries without overt son preference (STUDY 3).
4. To conduct one or more systematic reviews of policies and interventions to tackle discriminatory practices that threaten female health and survival in son-preference countries, starting with schemes based on collective empowerment of girls and women (STUDY 4).
5. To draw together the insights from studies 1-4 and the wider literature for future research and policy implications.

Figure 1 presents the underpinning logic model from our previous review of theories, with the addition of potential policy/intervention entry points and an indication of where each of the four thesis studies fits in.

Figure 1. Overview showing how the studies in this thesis relate to the logic model of pathways and mechanisms between women's low status in society and poorer health outcomes.
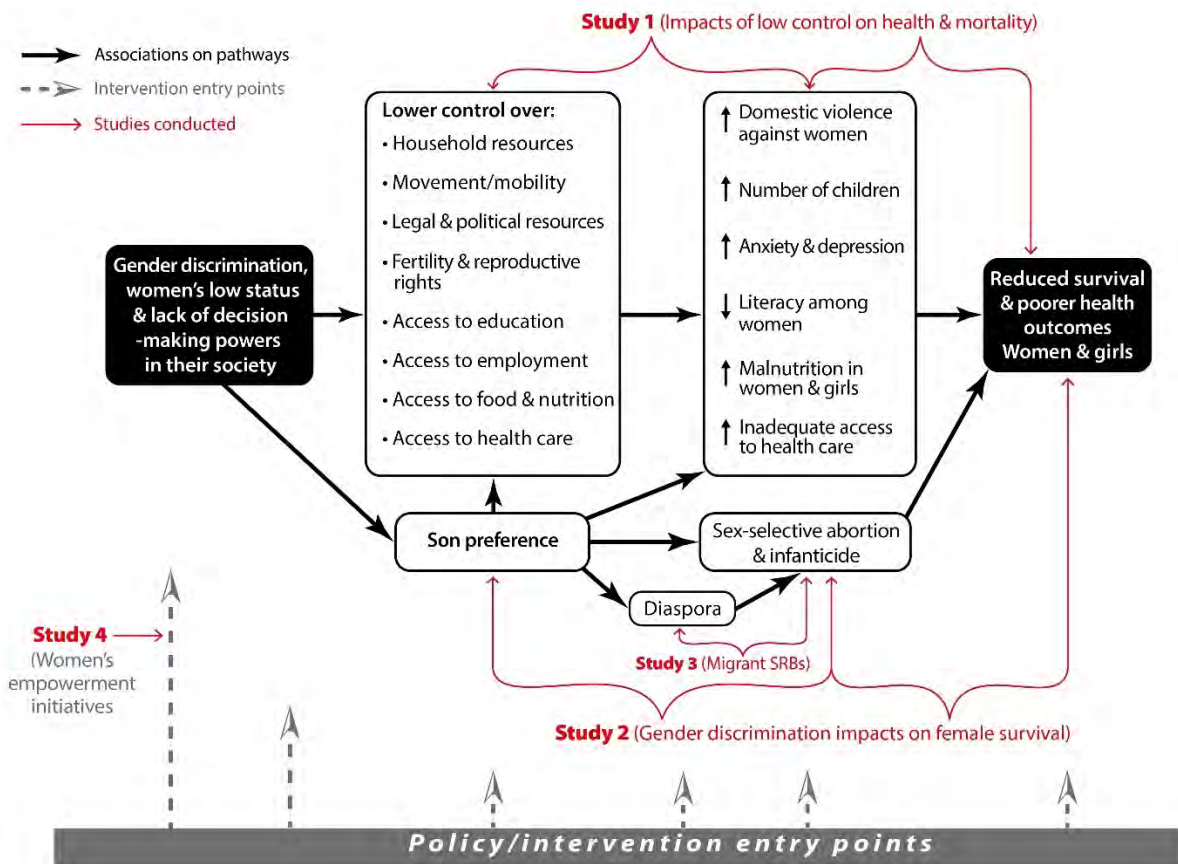
1.7 Structure of the thesis

Following this introduction to the thesis (Chapter 1), the subsequent chapters will cover:

- ➢ Chapter 2, the background review of theoretical literature, explores established underpinning theories on health inequalities, social determinants of health inequalities, fundamental causes, and gender discrimination and health inequality. It also explores the status of girls and women in son preference countries, the critical review of theories underpinning this research, gaps in the current evidence base, and policies and regulations promoting equality for girls and women.

- ➢ Chapter 3, describes the overarching methodological approach used in the research, including the utility of the methods and why they were selected, the objectives of the research and the research questions that directed the studies, and the systematic review methods used in studies 1 to 4.

➢ Chapter 4, reports the findings of a systematic review that investigated the empirical evidence base on the health impacts of women's low control in their living environment in son preference countries (Study 1).

➢ Chapter 5, reports the findings of a systematic review that investigated the empirical evidence on the impacts of profound gender discrimination and the low status of women on the survival chances of girls and women in son preference countries (Study 2).

➢ Chapter 6, reports the findings of a systematic review that investigated the empirical evidence on the potential 'migration' of son preference sex-selection practices among diasporas from son preference countries to high-income countries (Study 3).

➢ Chapter 7, reports the findings of a systematic review that investigated the empirical evidence on the health impacts of microfinance interventions for the collective empowerment of women (Study 4).

➢ Chapter 8, the Discussion, takes an overview across the findings of the four doctoral studies in relation to the research objectives, and draws out overarching insights from the evidence. This includes the identification of policy/intervention entry points, and potential related interventions. The overarching strengths and limitations of the evidence base, and the methodological advances made by the thesis research are highlighted. Important, priority areas for future research and implications for policy are then discussed.

➢ Chapter 9, describes the original contributions this these makes to the knowledge base, and reflections on my research journey.

➢ Finally, the Appendices, contain additional supplementary information on the methods and findings of the studies, and the publications stemming from this thesis.

Chapter 2 – Background

2.1 Introduction

The approaches in this research were underpinned by seminal theories on health inequalities, social determinants of health, fundamental social causes of inequalities in health, and discrimination and health inequalities. These theories and related concepts are outlined in section 2.2.

Section 2.3 provides definitions of key concepts related to gender.

Section 2.4 gives a brief overview of the cultural context that leads to discrimination against girls and women, in favour of boys and men, in son-preference countries.

Section 2.5 describes the findings of the critical review of theories, and the logic model (Figure 1), that guided the aims, research questions, methodological approaches, and interrogation of the evidence in this research.

Section 2.6 identifies important gaps in the current evidence base on the pathways and mechanisms between gender discrimination, women's low status and lack of decision-making powers, and reduced survival and poorer health outcomes for women and girls in son-preference countries. The gaps addressed by this thesis are then identified.

Finally, section 2.7 describes key examples of policies that illustrate the importance and relevance of this area of research to public health bodies, governments, and society.

2.2 Underpinning theories and concepts on social inequalities in health

2.2.1. Health inequalities

Whitehead and Dahlgren (2007) described the difference between natural variations in health status and social inequalities in health. Variations in health occur naturally within and across population groups because of biological (genetic and constitutional) differences. So, for example, older people as a population group, compared to younger people, will experience higher levels of ill health. Women, compared to men, have a natural, biological survival advantage at every stage of life (Drèze and Sen, 2002; Austad et al., 2006; Drevenstedt et al., 2008; Zarulli et al., 2018), and in high-income countries, in the absence of profound discrimination and social disadvantage, they live longer than men and make up an increasing proportion of the population

with age. Luck or chance also plays a role in people's exposure to health hazards and experience of ill health. While variations in health occur naturally, social inequalities in health and survival are systematic, socially produced, unfair, unjust, and unnecessary (Whitehead, 1990; Krieger, 2001; Whitehead and Dahlgren, 2007). As health inequalities are socially produced, they are in theory modifiable (Whitehead and Dahlgren, 2007).

2.2.2. Social determinants of health and inequalities

"*The social conditions in which people live powerfully influence their chances to be healthy. Indeed, factors such as poverty, social exclusion and discrimination, poor housing, unhealthy early childhood conditions and low occupational status are important determinants of most diseases, deaths and health inequalities*" (WHO, 2004).

Categories of conditions in society that are thought to influence health (the social determinants of health) are shown in Dahlgren and Whitehead's (1993) socio-environmental model of the determinants of health, which is also known as the Rainbow model of health (Figure 2). The model includes five categories or layers of influence (colours of the rainbow) which are all interrelated and determine health outcomes through combined and cumulative effects (in the same way the colours of the rainbow combine to produce white light). A large body of empirical evidence has demonstrated the existence and distribution of population health inequalities, and that the differential distribution of determinants of health within and across population groups leads to inequalities in health and wellbeing outcomes (for example, Black et al. 1980; Whitehead, 1992; Acheson et al., 1998; Evans et al., 2001; CSDH, 2007; Marmot et al., 2010). There is also evidence that interventions that improve social determinants of health (for example, targeting social, environmental, employment, and community decision-making determinants) can improve health and wellbeing outcomes and potentially reduce inequalities (for example, Bambra et al. 2008, 2015; Bagnall et al. 2018; Pennington et al. 2018a).

Figure 2. The socioenvironmental model of health (Dahlgren and Whitehead, 1993).

Source:
Dahlgren & Whitehead (1993)
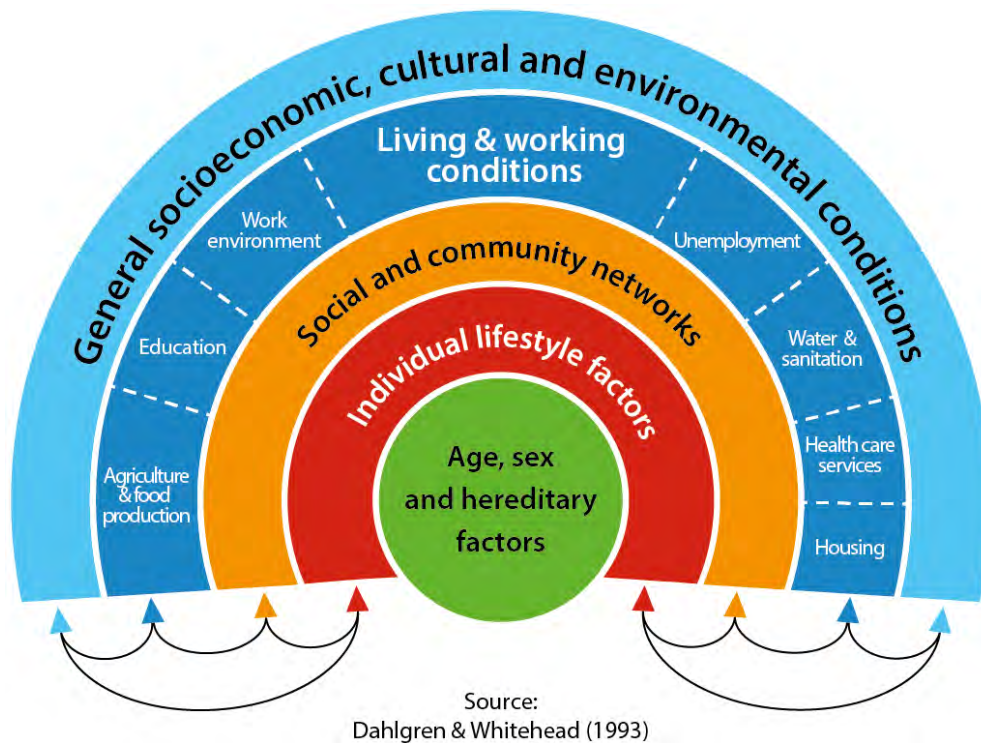
In son preference countries, it is postulated that the distribution of key determinants of health (beneficial and adverse) is distributed (or skewed) in favour of males at all stages of life, and at all levels of society - within individuals and families (micro), within communities and organisations (meso), and within social norms, structures, laws, and policies (macro).

This involves multiple pathways, at multiple levels, operating through a multiplicity of mechanisms. Each of many potential associations between variables may be confounded, modified, and mediated by other variables (Vanderweele, 2015). These relationships are therefore complex, intertwined, and multidirectional (Pennington et al., 2021).

2.2.3. Fundamental social causes of disease and inequalities in health

The theory of fundamental causes was first proposed by Link and Phelan in a seminal paper in 1995 entitled *Social Conditions as Fundamental Causes of Disease*. The theory explains why the association between lower socioeconomic status (SES) and higher mortality persists when the factors, or mechanisms, thought to explain it change radically over time. They also posited that other social factors such as gender (and race and ethnicity) may also be fundamental social causes of disease and health inequality (Link and Phelan, 1995; Phelan et al., 2010).

Link et al. (1998) argue that *'the persistence of the association between socioeconomic status (SES) and mortality is remarkable.'* …*'The risk factor mechanisms have changed while the SES association has persisted. This suggests that there is something fundamental about the association between SES and mortality that causes it to emerge under dramatically different health conditions.'* They posited that the association with mortality persists because social factors such as SES, ethnicity, and gender are consistently tied to resources including power, knowledge, money, prestige, and various forms of social support that can be adapted and utilised in changing circumstances by more advantaged members of society to protect against and/or avoid new risks for disease and mortality (Link and Phelan, 1995; Phelan et al. 2010).

Social factors (e.g., SES, gender), and resources such as power, status, and knowledge, are considered to be distal causes of disease and health inequality, compared to proximal causes/mechanisms such as lifestyle behaviours or exposure to various forms of pollution. Fundamental social causes can influence access to and control over important resources for health and wellbeing, and therefore have the potential to affect multiple disease pathways, mechanisms, and subsequent health outcomes. This limits the potential effectiveness of attempts to target proximal mechanisms because the mechanisms will change over time and the association with poorer health and survival will re-emerge. Link, Phelan and others argue that social epidemiologists should identify and seek to address both the distal causes and the proximal *'intervening mechanisms'* that create inequalities in health and survival. They argue that *'fundamental causes can defy efforts to eliminate their effects when attempts to do so focus solely on the* [proximal] *mechanisms that happen to link them to disease in a particular situation'* (Link and Phelan, 1985). Nancy Krieger (2008) argues that distal and proximal factors should not be viewed as separate determinants, that they are conjoined and that it is necessary to *'consider causal pathways operating at multiple levels and spatiotemporal scales, in historical context and as shaped by the societal power relations, material conditions, and social and biological processes inherent in the political economy and ecology of the populations being analyzed.'* Investigation of such complex relationships therefore require a broad approach to research that incorporates insights from theorical developments and empirical investigations across disciplines and over time, to identify, examine and understand potentially relevant pathways and mechanisms. Social epidemiologists emphasise the need for a clear theoretical framework to guide the process of untangling and understanding such complex pathways (Kouser et al., 2020). The methodological approach in this research was therefore guided by an explicit conceptual (logic) model on pathways from women's low status in society to poorer health outcomes (Figure 1) and investigation of a broad body of multi-disciplinary empirical research conducted over a long period (the thesis studies/systematic reviews including evidence from primary-level studies spanning ~40 years).

2.2.4. Gender discrimination and health inequality

This thesis focuses on the health and survival impacts/inequalities that arise from gender *discrimination* and the low status of women in son-preference countries. Population health inequalities research on the impacts of discrimination is relatively new (Krieger, 2014). The scope and methodological quality of social epidemiological research explicitly focussing on the aetiology, distribution, and impacts of discrimination against girls and women, in comparison to boys and men, is particularly limited.

The United Nations (1979) definition of gender discrimination is:
 "*Any distinction, exclusion or restriction made on the basis of sex which has the effect or purpose of impairing or nullifying the recognition, enjoyment or exercise by women, irrespective of their marital status, on the basis of equality of men and women, of human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field.*" United Nations, 1979.

Krieger (2014) argues that 'random acts of unfair treatment do not constitute discrimination. Instead, discrimination is a socially structured and sanctioned phenomenon, justified by ideology and expressed in interactions among and between individuals and institutions, that maintains privileges for members of dominant groups at the cost of deprivation for others'. According to Krieger, gender discrimination is underpinned by the justifying ideology of sexism, which is defined by the Cambridge English Dictionary as '*the belief that the members of one sex are less intelligent, able, skilful, etc. than the members of the other sex, especially that women are less able than men*.' She argues that property, gender roles, and religion are the material and social basis for this form of discrimination, and that there are characteristics of gender discrimination that are common to all forms of discrimination. All forms of discrimination involve systematic inequitable adverse treatment of a subordinated group (in this case women and girls) which benefit the dominant group (men and boys).

Krieger also identified measurable aspects that are common to gender and other forms of discrimination in the US (Box 1, adapted to the context of son-preference countries), and three forms of discrimination (Box 2).

Box 1. Measurable aspects of gender discrimination (adapted from Krieger, 2014)

Expression of Discrimination
• *Form*: interpersonal, organisational and institutional, structural; direct and indirect; overt and covert; legal or illegal.
• *Agency*: perpetrated by nonstate institutional or individual actors or by the state.

- *Expression*: from verbal to violent; mental, physical, or sexual.
- *Domain*: including at home; within family; within neighbourhoods and communities; within educational establishments; within employment settings; when gaining access to credit, housing, healthcare, social services, goods and other public or private services; within the media; within legal services, the police and/or the courts.
- *Level*: individual, residential, neighbourhood and community, societal; institutional, political jurisdictions, regional, and national economy.

Cumulative Exposure to Discrimination
- *Timing*: conception; infancy; childhood; adolescence; adulthood.
- *Intensity*: mild; moderate; severe.
- *Frequency*: acute; chronic.
- *Duration*: lifelong.

Box 2. Three forms of discrimination across society (Krieger, 2014)

i. **'Interpersonal discrimination** refers to directly perceived discriminatory interactions between individuals—whether in their institutional roles (e.g., employer/employee) or as public or private individuals (e.g., shopkeeper/shopper). In all cases, perpetrators of discrimination act unfairly toward members of socially defined subordinate groups to reinforce relations of dominance and subordination, thereby bolstering privileges conferred to them as members of a dominant group.'
ii. **'Institutional discrimination** typically refers to discriminatory policies or practices carried out by state or nonstate institutions.
iii. **Structural discrimination** refers to the totality of ways in which societies foster discrimination, via mutually reinforcing systems of discrimination (e.g., in housing, education, employment, earnings, benefits, credit, media, health care, criminal justice, etc.) that in turn reinforce discriminatory beliefs, values, and distribution of resources (Rothenberg, 2007)'

2.3 Definitions of key concepts related to gender

Working definitions of key concepts related specifically to gender in this thesis are outlined in Box 3. A crucial conceptual point from these definitions is that gender is a **social construct**:

"*Gender is a social construct that intersects with, but differs from, biological sex. It refers to the socially constructed norms, roles, behaviours, attributes and relations that a given society considers appropriate for women and men. These affect responsibilities assigned, activities undertaken, access to and control over resources, as well as decision-making opportunities. When individuals or groups do not fit established gender norms, roles and relations, they often face stigma and discriminatory practices and social exclusion.*" (WHO, 2019).

Gender operates as a key form of **social stratification**, and as such governs access to all sorts of resources and rights. This process of stratification results in g**ender discrimination,** which is the unequal or disadvantageous treatment of a person based on their gender. Women and girls are most likely to experience the negative impacts of gender discrimination (Östlin et al., 2001).

Gender discrimination has adverse impacts on the health of women and girls, leading to **gender inequity in health**, which has been characterised by WHO as "unequal, unfair, ineffective and inefficient" (Gita Sen et al., 2007). The converse - g**ender equity in health –** is more than equality or 'equal treatment'**:** it is the process of being fair to women and men, girls and boys, which in the health field may require different treatment for women and men, sensitive to their different needs in health (Gita Sen et al., 2002).

Box 3. Working definitions of key concepts surrounding gender

For this thesis, in the context of son-preference countries (although relevant to other contexts):

Sex refers to the biological and physiological reality of being males and females (UNICEF, 2017).

Gender is related to how we are perceived and expected to think and act as women and men because of the way society is organised, not because of our biological differences (WHO, 1998). "Gender is much more than the socialised relations between individuals, however. It is a key form of social stratification, which also determines unequal access to resources, biased public representation, and discriminatory institutional policies". (Östlin et al., 2001).

Gender norms/gender roles/ gender stereotypes describe how people of a particular gender and age are expected to behave in a given social context. Harmful gender roles result in many types of inequalities between girls and boys, women and men (Save the Children, 2023)

Gender bias refers to "Making decisions based on gender that result in favouring one gender over the other which often results in contexts that are favouring men and/or boys over women and/or girls." UNICEF, 2017.

Gender discrimination is the unequal or disadvantageous treatment of a person based on their gender. Women and girls are most likely to experience the negative impacts of gender discrimination.

Son preference refers to "the entrenched cultural preference for sons over daughters, which is a pervasive social norm in some societies and which leads on to discriminatory practices and behaviours." Pennington et al., 2023.

Gender equality refers to the concept that women and men, girls and boys have equal conditions, treatment and opportunities for realising their full potential, human rights and dignity, and for contributing to (and benefitting from) economic, social, cultural and political development. (UNICEF, 2017). It is therefore based on the universal principle of equality or 'sameness' – equal treatment of men and women. This is not the same as gender equity when it comes to health – see below.

Gender equity in relation to the health field differs from gender equality "because it cannot be based only on the principle of sameness, but must stand directly on the foundation of absence of bias" (Gita Sen et al., 2007). **Gender equity** is the process of being fair to women and men, girls and boys. In the health field, gender equity may require different treatment of women and men that is sensitive to their different needs in health (the most obvious being maternity) (Gita Sen et al., 2002).

2.3 The status of girls and women in son-preference countries

Son preference is an important part of a picture of profound and pervasive sexism and gender bias in certain countries. It is common in South, East and West Asia, North Africa, the Southern Caucuses, and the Balkans (Hesketh et al., 2011; Kumar and Sinha, 2019).

2.3.1. Cultural context of profound discrimination in son-preference countries

Son preference and the lower status of girls and women is thought to be the result of an interplay of long-established, culturally enshrined, pervasive attitudes and practices that result in systematic discrimination in the distribution of power, opportunities, and resources for life between men and women, boys and girls. Gender discrimination in based on sexist beliefs that girls and women are inferior to boys and men, and preconceived ideas about gender stereotypes which dictate the expected roles, functions and perceived relative value of men and women in society (the working definitions of concepts related to gender used in this doctoral thesis are in Box 3).

Den Boer and Hudson (2017) argue that son preference is rooted in the patrilineal organisation of society in son-preference countries. This involves (i) patrilocal marriage, where the couple resides in the home of the husband family after marriage; (ii) patrilineal inheritance, where titles, land and property are inherited through the male line only; and (iii) tracing of a family or clans decent through the male line only. This makes women financially dependent and subordinate to men. It allows groups of male relatives to become socially/politically powerful as part of an established group of allies that can be relied upon in times of conflict (Hudson et al., 2011). In addition to conflicts between groups of men, this may also include conflicts between men and individual or collectives of women attempting to resist their oppression. This culture of what Den Boer and Hudson (2017) call "inequitable family laws', reinforces and entrenches son preference across families, communities, and society over time, and occurs even in the presence of strong gender-equitable state laws. This may explain why practices, such as paying marriage dowries have persisted (and increased in terms of the value of payments according to Anderson, 2003) in the example of India, despite being outlawed for over 60 years (since The Dowry Prohibition Act, 1961 [Parliament of India, 1961]).

Boys and men are seen as having greater net utility in families than girls, as described by Arnold et al. (1998) in the context of India, and in a large body of other literature in India, China, and other countries with a culture of son preference such as Azerbaijan, one of a number of former Soviet states in the South Caucuses at the juncture of Europe and Western Asia (for example,

Guilmoto and Ren, 2011; Guilmoto, 2012a; Chaudhuri, 2012; Frost et al., 2013; Diamond-Smith and Bishai, 2015; Hu and Schlosser, 2015; Hussam 2015; Neogi et al., 2015; Atif et al., 2016; Huang et al., 2016; Urquia, 2016; Channon, 2017; Le at al., 2017; Den Boer and Hudson, 2017; UNFPA, 2022;. First, boys are seen as having higher economic utility because of gender differences in labour market productivity, support to parents during illness and old age in the absence of adequate social security protections, and through land and property inheritance and ownership systems. Second, boys are seen as having greater social utility by providing parents with higher status, and higher resources through dowry practices and payments. Third, boys are seen as having greater utility through their roles in religious ceremonies and functions, particularly following the death of parents. Whereas girls are seen as a drain on family resources through the high price of weddings and dowry payments. After marriage women become part of their husband's family, live patrilocally, and no longer have the responsibility of caring for their own parents. They are as a result often seen as a "poor investment" in comparison to males.

In son-preference countries millions of women are relatively powerless, defined by Albee (1981, In Wallerstein, 1992) as: "an objective phenomenon, where people with little or no political or economic power lack the means to gain greater control and resources in their lives". Östlin and colleagues (2001) maintain that power is the key in relation to gender. Women are relatively powerless in son-preference countries because gender is used as a "key form of social stratification, which also determines access to resources" (p.175). This social stratification process effectively puts women in inferior, powerless, positions in those societies and limits their rights and freedoms relative to men.

2.4 Critical review of theories underpinning this research

'*Theory is as a fundamental backbone of all academic disciplines [and] a vital component of public health research*.' (Gauffin and Dunvlay, 2021).

The logic model in Figure 3 illustrates the theoretical pathways and mechanisms that are the focus of this research. These pathways and mechanisms between gender discrimination, women's low status in society and lack of decision-making powers, and poorer health and survival outcomes were identified and synthesised in a critical review of theory that was initially published in a report for the former Public Health Research Consortium (now the NIHR Public Health Policy Research Unit, funded by the Department of Health and Social Care Policy Research Programme) in 2014, and then in a paper published as:

Whitehead M, Pennington A, Orton L, Nayak S, Ring A, Petticrew M, Sowden A, White M (2016) How could differences in 'control over destiny' lead to socio-economic inequalities in health? A synthesis of theories and pathways in the living environment. Health & Place. 39:51-61.

The logic model (Figure 1) was updated during the process of this research (Figure 3, Figure 12).

2.4.1. Overview of findings of theory review

'Gender is closely tied to resources such as status, power, and social connectedness'. Link and Phelan, 1995.

Low control for women in son preference countries

For women in son preference countries, gender discrimination and low status leads to low levels of control for women in comparison to men at micro, meso, and macro levels. In Whitehead et al., 2016, we used it to structure the organisation and synthesis of theories that describe pathways between low status or social position, low levels of control, and poorer health outcomes for certain groups (Table 1).

Table 1. The identified theories were conceptualised at three distinct explanatory levels (adapted from Whitehead et al., 2016).

Level	Description
1. Micro/personal	A person's social position influences the resources they have to control their destiny (in terms of money, power, information, prestige) and influence on critical decisions affecting their lives.
2. Meso/community	Notions of community/collective control go beyond individual circumstances to encompass the strength/power generated by joining together to have greater influence over material and social conditions in immediate neighbourhoods/living space.
3. Macro/societal	Cultural orientation towards different groups in the population (including gender bias) operate at the level of whole societies, influencing the degree of control that members of a society have over their lives.

For women in son preference countries, cultural orientation towards men at the macro/societal level (level 3 in Table 1) places women at lower status than men, which limits the level of control they have, or are permitted to have, over their lives and the lives of their children across all three interacting levels of society. This leads to poorer control over, and poorer access to, resources that are essential for both their own health and wellbeing and that of their children. At the personal/micro level, in addition to reduced access to key resources, described by Whitehead et

al., 2016, as 'real' or 'actual' control, an additional psychological pathway leads from a 'perceived' lack of control to adverse behavioural and physiological mechanisms and on to poorer health outcomes for women in comparison to men.

At the macro/societal level in son preference countries, we proposed two interrelated pathways between women's low control and poorer health outcomes, in comparison to men (Figure 3).

Figure 3 Logic model of pathways and mechanisms between women's low status in society and poorer health outcomes (updated from Whitehead et al., 2016).
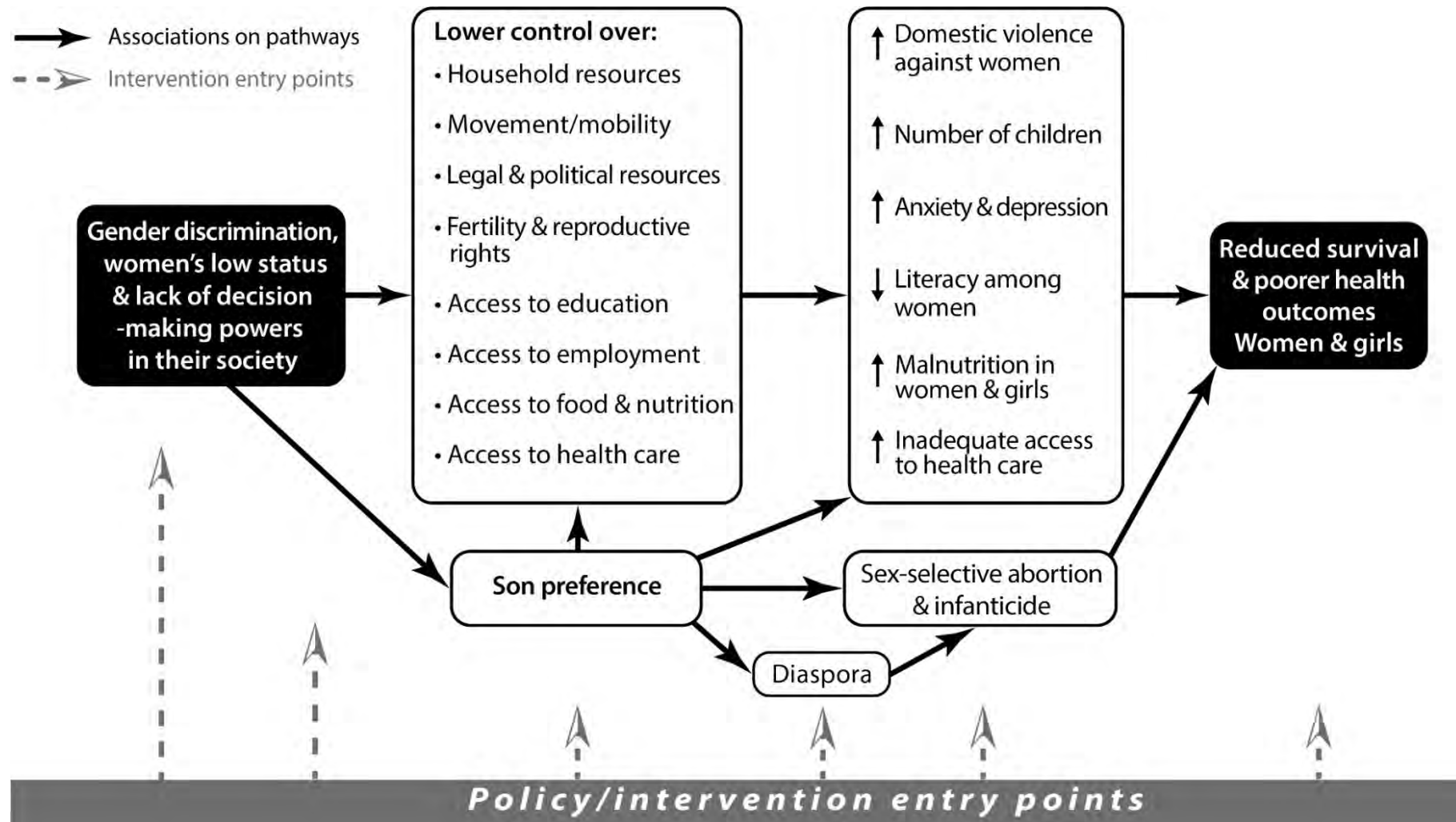
Pathway 1 – Lower control over key resources (determinants) for health and wellbeing (upper pathway Figure 3).

In son preference countries many women require permission or accompaniment from men to make decisions, conduct activities, and to move within their communities. Examples include their lower levels of control over decisions about where the family lives, property ownership and inheritance, accessing health services, reproduction, large and small household purchases, access to employment and education for themselves and their children, and their freedom of movement to visit shops, facilities, family, and friends. Reduced access to resources for health and wellbeing may in turn lead to poorer health outcomes including higher levels of anxiety and depression, malnutrition, domestic violence against women, higher rates of sexually transmitted infections, poorer neonatal, delivery and postnatal outcomes, health risks from greater numbers of pregnancies, and higher levels of childhood morbidity and mortality.

Pathway 2 – Son preference (lower pathway Figure 3).

In the mid-1980s, sex determination and selection technologies such as ultrasound became increasingly affordable and available in son preference countries, and the practice of sex-selective abortion started to become widespread (Banister, 2004). As will be shown in Chapter 5 (Study 2), greater numbers of girls than boys were aborted and population sex ratios at birth became distorted (skewed) in favour of boys. Preference for sons may also lead to preferential allocation of resources to boys over girls, as is shown in the link arrow between the lower (son preference) and upper (low control) pathways of Figure 3.

2.5 Gaps in the current evidence base

Sen's initial work initial work in the 1980's and early 1990's incited dozens of studies on sex-selective abortion, and others of the role of healthcare and nutrition as intervening mechanisms. Studies have also been conducted separately (i.e., not focussing explicitly on the 'missing women' phenomenon) that examined the associations between many of the factors/mechanisms shown in the logic model in Figure 3 and health, wellbeing and survival outcomes for girls and women. These include studies on the role of the control, empowerment, education, and employment in determining girl's and women's health outcomes in son-preference countries. The studies cut across a range of disciplines (e.g., demography, sociology, public health), but prior to this research they had not been systematically identified, organised, synthesised, and related to an overarching conceptual framework.

Empirical evidence has been shown to support Link and Phelan's (1995) theory that SES and racial discrimination are fundamental social causes of health inequalities (Phelan et al., 2010; Reich et al., 2016). Despite Link and Phelan's assertion that gender may also be a fundamental social cause, we are aware of no explicit attempt to date to ascertain the empirical support for this, particularly in the context of profound discrimination in son-preference countries.

The research reported in this thesis therefore seeks to address crucial gaps in the breadth, interrelationships, and depth of the knowledge base on the impacts of profound gender discrimination on girls and women in son-preference countries. It is argued that this is made possible only through a series of structured, theory-based systematic reviews of evidence from a range of sources and disciplines.

2.6 Policies and regulations promoting equality for girls and women

The political ambition to reduce profound discrimination, to improve the relative health and survival chances of girls and women in son preference countries, and to end practices such as sex-selective abortion, violence against women and girls, and various forms of exploitation, is manifest in high-level policies of organisations and governments across the world.

Chief among these international initiatives is the 2030 Agenda for Sustainable Development adopted by all member staties at the United Nations General Assembly in 2015 (UN, 2015).

This blueprint for action contains a series of Sustainable Development Goals (SDGs), 17 in total, of which SDG 5 expressly addresses gender discrimination and empowerment:

"SDG 5: Achieve gender equality and empower all women and girls".

It stipulates 9 targets for the achievement of the goal:

1. (SDG5.1) End all forms of discrimination against all women and girls everywhere.
2. (SDG5.2) Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation.
3. (SDG5.3) Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation.
4. (SDG5.4) Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate.

5. (SDG5.5) Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.

6. (SDG5.5) Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences.

7. (5.a) Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.

8. (5.b) Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women.

9. (5.c) Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels.

SDG 3 is also highly relevant: "Ensure healthy lives and promote well-being for all at all ages" as is the overarching pledge in the blueprint "to leave no one behind".This was underlined with a powerful statement on striving for gender equity from the UN General Assembly:

"*As we embark on this great collective journey, we pledge that no one will be left behind. Recognizing that the dignity of the human person is fundamental, we wish to see the Goals and targets met for all nations and peoples and for all segments of society. And we will endeavour to reach the furthest behind first.*"

"*Realizing gender equality and the empowerment of women and girls will make a crucial contribution to progress across all the Goals and targets. The achievement of full human potential and of sustainable development is not possible if one half of humanity continues to be denied its full human rights and opportunities.*" The 2030 Agenda for Sustainable Development, paragraphs 4 and 20.

This major global initiative is supported by complementary action plans focusing specifically on children, including the United Nations Children's Fund Gender Policy 2021-2030, operationalised in the Gender Action Plan 2022-2025 (UNICEF, 2021) and the Save the Children programme on leaving no child behind: "*Every last girl: free to live, free to learn, free from harm*" (Save the Children, 2016). The specific issue of sex selection is being tackled by initiatives such as that by UN Women on preventing gender-biased sex selection (WHO, 2011), and the Global Programme to Prevent Son Preference and Gender-biased Sex Selection (UNFPA, 2017).

Clearly, the global development community has recognised profound gender discrimination as one of the great public health challenges of today and has mobilised international plans to take on that challenge. The plans are based on sound theory. The empirical evidence on what works, how and in what context is, however, dispersed and patchy. There is a mammoth task to collate and synthesise this evaluation evidence around the many different policy entry points that the actions plans suggest. There are also gaps in the evidence base on the health impact of government policies initiated for completely separate purposes, for example population control policies, which may prove to have harmful effects on population health. This thesis makes a modest start on assessment of the intervention evidence, with a review of the impact of some large-scale women's empowerment initiatives. There is a major research agenda on further policy entry points still to do.

Chapter 3 – Methodology

3.1 Overarching methodological approach used in the research

Studies of downstream (or proximal), mechanisms are a *necessary* part of our understanding of the complex pathways between the social determinants of health and health outcomes that are experienced differentially across populations. Studies limited to individual or small numbers of mechanisms which are proximal to health outcomes are, however, *insufficient* to explain health inequalities that exist between population groups that persist over time (Link et al. 1998). A single health outcome can be influenced by multiple determinants, with complex interrelationships, and single determinants can influence multiple health outcomes (Link and Phelan, 1995b; Vanderweele, 2015). The scope of this research could not, therefore, be restricted to limited studies of downstream or proximal mechanisms. A more expansive overarching methodological approach was required to develop a more extensive understanding.

To address the main aims of this research and understand how the status of females in son-preference societies impacts on their health and survival, an understanding of complex multi-level pathways and potentially changing mechanisms that may be involved in the production of population health inequalities across these settings and over time was needed. First, theories informed by empirical evidence from disparate literatures across different disciplines were required to map out the potential pathways and mechanisms at play. Second, findings from a range of observational studies were needed to gauge the empirical support for the various pathways and to understand the scale, magnitude, and distribution of health, wellbeing, and survival outcomes. Third, interventional evidence was needed to gain an insight into whether and how interventions may improve the situation for girls and women in son preference countries.

Informed by theories and concepts on social inequalities in health described in Chapter 2 (Section 2.2, p.9), our critical review of theories had identified, synthesised, and mapped out potential pathways between the low status of women in son-preference and poorer health and survival outcomes in the framework of a logic model (Figure 1). This framework was used to identify, structure, and inform the key research objectives and systematic review questions, relevant studies for inclusion in the systematic reviews, and in the interrogation and interpretation of the evidence. The logic model was refined, iteratively during the doctoral studies.

3.2 Aims and objectives of the research

The aims of this thesis research are to synthesis the empirical evidence on the adverse health impacts of profound gender discrimination against girls and women in son preference countries and on the effectiveness of actions to tackle the problem.

The objectives are:

1. To conduct a systematic review and synthesis of observational evidence on the health impacts of women's low control/autonomy in societies with profound gender discrimination and gender bias (to be met by STUDY 1).
2. To conduct a systematic review and synthesis of the empirical evidence on the impacts of profound gender discrimination on the survival of girls and women in son-preference countries, including estimates of the numbers of 'Missing Women' over time (to be met by STUDY 2).
3. To elucidate whether the discriminatory practice of pre-natal sex selection 'migrates' with some diasporas from son preference countries to high-income destination countries without son preference. This will be achieved by conducting a systematic review of evidence on sex ratios at birth for infants of migrants from son-preference countries compared to sex ratios at birth in recipient countries without overt son preference (to be met by STUDY 3).
4. To conduct one or more systematic reviews of policies and interventions to tackle discriminatory practices that threaten female health and survival in son-preference countries, starting with schemes based on collective empowerment of girls and women (to be met by STUDY 4).
5. To draw together the insights from studies 1-4 and the wider literature for future research and policy implications.

The methods used for studies 1-4, to meet objectives 1-4, are outlined in general in section 3.5, with further details specific to each study described in the corresponding study Results chapter.

Objective 5 is met by considering the entire body of knowledge investigated during this research to identify priority implications for policy and for future research. The findings are discussed in Chapters 8.

3.3 Research questions

Aims and objectives 1 to 5 of the research were operationalised through a series of research questions:

1. What is the evidence on associations between women's low control in the living environment and health outcomes in the context of low and middle-income countries with strong gender discrimination (son preference countries) (The upper pathway in Figure 1). STUDY 1.

2. What is the evidence on the impacts of profound gender discrimination on the survival of girls and women in son preference countries? (The lower pathway in Figure 1). STUDY 2.

3. How do sex ratios at birth for infants of migrants from son-preference countries compare with sex ratios at birth in recipient countries without overt son preference in Europe, North America, and Australasia? (The lower pathway in Figure 1). STUDY 3.

4. What impact do collective empowerment-based microfinance schemes based on collective empowerment have on the health of women and their children in son-preference countries? STUDY 4.

5. What role does empowerment play in the pathways from microfinance to health impacts? STUDY 4.

6. Do the impacts of the schemes differ based on the ethnicity, sex and/or socioeconomic status of the members? STUDY 4.

3.4 Underpinning logic model

The research was guided by the logic model in Figure 1, developed from our critical review of theories linking 'control over destiny' to population health outcomes (Whitehead, Pennington et al., 2016). This framework was used to identify, structure, and inform the key areas of the research (including development of review questions, search strategies, and inclusion of studies), and in the interrogation and interpretation of the evidence.

3.5 Theory-based systematic reviews of empirical observational and interventional studies

3.5.1. Guidance on systematic review and reporting methods

The systematic review and reporting methods were informed by a range of guides and methodological papers. The main methodological and reporting guidelines that informed the approaches in the systematic reviews were the Centre for Reviews and Dissemination's guide to

undertaking systematic reviews, guidance on the Conduct of Narrative Synthesis in Systematic Reviews, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and PRISMA-Equity Extension (PRISMA-E) checklists and statements (CRD, 2009; Popay et al., 2006; Moher et al., 2009; Welsh et al., 2012; Page et al., 2021). The guides were selected as they provide appropriate guidance for conducting and reporting systematic reviews of evidence on complex social determinants of health inequalities and related interventions. The 2009 CRD guide is one of the four most influential handbooks for undertaking systematic reviews in the UK (Cooper et al., 2017). The other three most influential systematic review guides in the UK were not wholly appropriate given their focus on developing NICE guidelines (The National Institute for Health and Care Excellence [NICE] manual to developing NICE guidelines. NICE, 2014), and on reviews of evidence on more tightly conceptualised and defined interventions (The Cochrane Handbook for Systematic Reviews of Interventions [Higgins and Green, 2011]; The Campbell Information Retrieval Methods Group guide to information retrieval [Kugley et al., 2016]). Approaches were, however, informed by some, appropriate elements of the other guides, for example, the Cochrane handbooks section on 'When not to use meta-analysis in a review' (Higgins and Green, 2011 – Cochrane Handbook, Part 2, Section 9.1.4), and (more recently) Petticrew et al's guidance on the implications of a complexity perspective for systematic reviews (Petticrew et al., 2019). Guidance on narrative synthesis is not limited to textual ('storytelling') reporting of findings in the reviews, but also helped to instruct systematic approaches to searching and identification of studies, quality appraisal, synthesis, and presentation of findings. Narrative synthesis approaches (can and) were used across the systematic reviews of evidence from both observational and interventional studies (Popay et al., 2006).

The CRD's 2009 guide to undertaking systematic reviews, recommends, *inter alia*, iterative development of searches in databases based on pilot searches, identification, and examination of relevant sample papers for the extraction of relevant terms, and the use of supplementary search approaches to complement and refine search strategies to achieve an appropriate balance of sensitivity and specificity. These methods were used in all the systematic reviews (Studies 1 to 4).

PRISMA is an evidence-based approach to the transparent reporting of systematic review approaches and findings. It is the most established guide to reporting systematic reviews. Evidence from observational studies suggests that using the PRISMA (2009) checklist and statement is associated with better/more complete reporting of systematic reviews (Page et al., 2021). The main focus of PRISMA is on reporting of systematic reviews of interventions, although the later, 2020, version was adapted to better accommodate a wider range of observational evidence and study designs (Page et al., 2021). Not every element of the PRISMA checklists were

relevant to reporting in the systematic reviews of observational and interventional studies of complex social determinants of health, using the particular study designs, in this thesis. Relevant items of the checklist were therefore used and reported in each review. The two versions of the guidance (PRISMA 2009 and PRISMA 2020) were used across the timeline of the reviews, depending on the availability of the most recent version at the time of conducting a review. Both versions of the PRISMA checklists include 27-items that address the introduction, methods, results and discussion sections of a systematic review report and/or paper. The PRISMA 2020 added new reporting guidance in accordance with advances in approaches to identifying, selecting, quality appraising, and synthesising empirical studies (Page et al., 2021).

The PRISMA-Equity extension (2012) guidance is designed to help researchers identify, extract, synthesise, and report evidence in equity-focused systematic reviews. The PRISMA-Equity extension statement paper (Welch et al., 2012) defines 'health inequity' as 'unfair and avoidable differences in health', based on Whitehead (1992), and in keeping with the conception of health inequalities that is used in this thesis (Chapter 2, Section 2.2.1, Page9). The guidance, among other things, importantly, recommends the use of a logic model/analytic framework of the pathways through which an intervention is assumed to work, and a description of assumptions about mechanisms posited to affect health inequalities.

Measurement of health-related outcomes

Study 1 examines evidence on the impacts of women's levels of control in their living environment on their physical or mental health/wellbeing, and the health of their children. For women, health outcomes in the reviewed studies included measures of anxiety, anaemia and malnutrition, self-reported health, and mortality. For their children, measures included low birth weight, nutritional status/malnutrition, physical growth/development, diarrhea and infections, and under-5 mortality.

The reviewed studies in Study 1 also assessed degree of 'actual control' over everyday living, using a variety of indices which combined indicators of level of restrictions/degree of autonomy over common activities such as freedom to go outside the home, freedom to make decisions on seeking healthcare for self or children and so on. These proxies for 'actual control' were reasoned to better capture the external, societal level restrictions imposed on women that the participants were experiencing, rather than 'perceived control' or other measures such as 'control beliefs' or 'locus of control' which correspond to psychological concepts which may not capture societal discrimination.

Study 2 and Study 3 examined evidence on the impacts of son preference on sex-specific survival proxies from the demographic literature, which included comparisons of sex ratios at birth (study 2 and 3) and, for study 2 only, population sex ratios for other ages, and estimates of shortfalls of girls and women ('missing women').

The concept of 'missing women' refers to the number of females who would be alive in the absence of profound sex discrimination. It can also be thought of in terms of a *shortfall* in the actual number of women in a specified population compared with an expected norm derived from a reference population which does not have such discrimination against girls and women. In other words, how many girls and women would have to be added to the existing population to eliminate this shortfall? (Bongaarts and Guilmoto, 2015a). To derive the number of 'missing women', the method employed by the studies reviewed in Study 2 uses the **population sex ratio** (PSR), which refers to the total number of males for every 100 females in the population as a whole (i.e. all ages). The observed (actual) PSR in a country is compared with an 'expected' PSR that would prevail if both sexes were treated equally in their access to goods that influence survival. "If the actual ratio exceeds the expected, the additional females that would have to be alive in order to equate the actual with the expected PSRs, would then be the number of 'missing women' at this point in time" (Klasen and Wink, 2003).

Estimates of the number of missing newborn girls were derived from comparing observed and expected sex ratios at birth. The 'expected' ratio is based on the level that was observed in all countries prior to 1980, and in countries without profound discrimination since then. That is, a ratio in the range between 105 and 107, commonly taken as 105.9 in non-African countries. A slight adjustment is made for a lower natural SRB in sub-Saharan Africa.

Study 4 examined evidence on the health impacts of microfinance interventions and included (in some reviewed studies) measures of women's empowerment (for example, indices of 'actual' control, including measures of women's say in household decisions) and its relationship to measures of health determinants and physical health and/or wellbeing outcomes. These included measures of women's sexual health, emotional stress, experience of interpersonal violence, and use of healthcare services, and their children's nutritional status, morbidity, and mortality.

3.5.2. Study identification

3.5.2.1. Search term development

In accordance with CRD (2009) guidance, the identification and development of search terms and phrases, and adjacency and other search operators (including wildcards), and structures (dependent on search lines/'strings' and their combinations through AND, OR operators) were iterative. Relevant sample papers were first identified during the critical review of theories. The sample papers were carefully scrutinised to identify initial relevant search terms and phrases, and to inform the structure of the searches in the first reviews. We also drew on relevant results of an earlier search from a broader review of associations between control/empowerment and inequalities in health (Whitehead et al., 2014). In the first systematic review on the health impacts of low control for women in son-preference societies (Pennington et al., 2018b), pilot searches and scrutiny of further relevant sample papers helped in the refinement of terms and structure of the search. Free word searches across a range of databases proven to be effective at identifying relevant studies from a range of disciplines, while remaining manageable in terms of logistical constraints that affect all research, and the need to achieve a good balance between brevity and rigour (Pennington et al., 2018c). Individual search syntaxes (including search terms and phrases, adjacencies, and wildcards, and other search operators that structure and guide the search in a database) were carefully modified, piloted, and refined for use in specific databases, before being ran as title, abstract and (where appropriate) keyword searches. The subsequent systematic reviews drew on further sample papers and search terms and approaches from the earlier searches. This increased the sensitivity, specificity, and manageability of the searches as the reviews progressed.

3.5.2.2. Academic search engines and bibliographic databases

Searches were run across a carefully selected electronic academic search engines and bibliographic databases that included gold standard databases that were checked for suitability during pilot searches. Across the reviews, the selection of databases was modified to suit the evidence area and type in each review. They included specialist health (OVID Medline, OVID Medline In-Process and Other Non-Indexed Citations), health and social care (Cumulative Index to Nursing and Allied Health Literature: CINAHL Plus; Social Policy & Practice, via EBSCOHost), psychology databases (American Psychological Association [APA] PsycINFO, via EBSCOHost), and broader social science databases (Web of Science Social Sciences Citation Index, and Conference Proceedings Citation Index). Routine checks were made to see if the database searches had identified all the sample papers and, if not, investigations were conducted to identify why a

sample paper/s had not been picked (for example, if a journal was not indexed [included] in the specific database). Database and supplementary searches where then modified accordingly.

3.5.2.3. Supplementary searches

Supplementary search methods are an important way of identifying empirical studies that may be missed in searches of bibliographic databases (CRD, 2009). This is particularly so for systematic reviews focussing on complex social determinants of health and literature spanning multiple disciplines where the use of terminology is inconsistent (Cooper et al., 2017). Supplementary search methods across the reviews included backward and forward citation searches, hand searching of specialist databases, contact with experts and the authors of included publications, and advanced Google/Google Scholar searches that cover both bibliographic database and grey literature sources. Backward citation searches (also known as "citation snowballing") involved hand searching of the reference lists of publications included during full text screening to identify additional relevant publications. Forward citation searches were conducted through the Web of Science Core Collection database. Topic expert's websites were hand searched and they were contacted to identify additional relevant publications. Authors of included papers were also contacted to identify additional relevant publications and missing data. We also ran advanced Google/Google Scholar searches to identify any publications that may have been missed by previous searches. Advanced Google/Google Scholar searches incorporate some of the sophistication of gold standard academic databases – i.e., the use of Boolean operators (AND, OR) and the ability to limit results by publication date ranges. They also have greater coverage of published and grey literature compared to academic databases. Gehanno et al. (2013), for example, found that Google Scholar accessed 100% of the studies included within 29 systematic reviews that used gold standard databases such as PubMed and Cochrane. This therefore also extended the reach of our searches in terms of the coverage of the selected bibliographic databases. Google Scholar, with an estimated 389 million records in 2018, was the most comprehensive academic search engine in existence (Gusenbauer, 2019).

3.5.2.4. Search limiters

Searches in the reviews were limited to English language publications only for practical and logistical reasons. Multilingual reviews are difficult to conduct and extremely resource intensive. Although this is not explicitly recognised in current methodological papers and guides on systematic reviews, it is an important limitation in the practical realities of conducting reviews of evidence across multinational settings. Such reviews require advanced, technical multilinguistic abilities and understanding of national contexts to identify appropriate databases and other

sources, to design and implement multilanguage search syntaxes, and to extract data and other important information.

Searches for empirical studies were limited to publication dates from 1980 to capture a wide timespan of evidence (over 40 years in the most recent review) to help with understanding of how mechanisms and outcomes may have changed over time.

Where bibliographic database functionality permitted, searches were restricted to studies of humans only.

No further search limiters were applied. Limiters were kept to a minimum as experience of conducting multiple systematic reviews, and consultation with senior information scientists at EBSCOHost (a leading academic search engine provider) revealed occasional problems with erroneous indexing of some papers in databases. Indexing of limiters such as country of study and study design are more difficult for indexers to apply than the basic limiters we used. Papers that are indexed incorrectly by limiters can be missed from searches. Additional limiters were therefore avoided, and relevant studies were screened in/identified through manual screening assisted by systematic review management software.

3.5.2.5. Deduplication of search results

Results from the searches in each of the reviews were deduplicated in Endnote X9 reference management software in a three-stage process (one automatic stage [based on authors, title, and year of publication], and two manual stages to deduplicate the remaining articles), in-line with the process used by information scientists at the CRD in York. Results before and after deduplication were reported in PRISMA flowcharts showing the progression of studies through the reviews.

3.5.3. Study selection

Study inclusion and exclusion criteria were designed to focus on each review topic, based on the relevant pathways and mechanisms in the logic model (Figure 1). Study 1 focussed on the upper (low control) pathway, and studies 2 and 3 focused on the lower (son-preference) pathway. Study 4 focussed on evaluations of collective empowerment-based microfinance interventions in son-preference countries, that had the potential to influence both pathways and all mechanisms in the logic model through possible changes to sociocultural and material conditions affecting women and their children. Quantitative empirical studies and quantitative findings from mixed-methods studies were included. Qualitative components from included quantitative studies were

also included in the review of interventional studies in Study 4. Non-representative studies focussing on selective samples not representative of populations in their living environments were excluded on methodological quality grounds. Non-empirical papers such as discussion and opinion pieces were excluded from the systematic reviews.

Across the systematic reviews, studies were selected for inclusion in two stages: title and abstract screening, and full text screening. All articles deemed potentially eligible for inclusion after title and abstract screening were retrieved and screened as full texts. Screening was conducted independently by two reviewers in EPPI-reviewer 4 systematic review management software (Thomas et al., 2010). Lists of included studies, and reasons for exclusion of full texts were recorded and published in the papers associated with the studies in accordance with PRISMA guidelines, as were PRISMA the flow charts.

3.5.4. Data extraction and harmonisation

Data in the systematic reviews was extracted into pre-designed and piloted data extraction forms or tables. Data extractions were checked for accuracy and completeness by an additional reviewer. Across the reviews, extracted data typically included setting (country and/or region), study aims, study design, independent and dependent measures/variables of interest, population groups, and main findings. Information was also extracted on author identified study limitations and key points from discussions and conclusions.

Findings from studies were harmonised to be consistent in reporting of the evidence from different studies and disciplines, in line with international standards. For example, studies reporting sex ratios of new-born children in various formats were converted and reported as the international standard of sex ratios at birth (SRBs).

3.5.5. Methodological quality appraisal

There was a large amount of heterogeneity within and across the studies included in the systematic reviews - by study designs, settings, populations, measures/variables, and, in the interventions review, intervention types. Methodological quality varied substantially within and across the reviews because of the different types of study designs and sources of evidence from different disciplines. Details of approaches to appraising methodological quality are described in the relevant Results chapters (4, 5, 6, and 7) on the individual studies/systematic reviews.

In terms of the demographic evidence in studies 2 and 3, in the absence of a suitable validated tool for 'scoring' demographic studies, the novel approach we developed for quality-assuring the evidence entailed:

- Including only studies employing good quality national data sources (vital statistics, Census, high quality population surveys).

- Excluding single-centre studies and those with non-representative population samples.

- Excluding those in which the samples were too small for the sub-group analyses that the studies had undertaken (a particular problem for some analyses of sex ratios at birth for higher birth orders of some immigrant groups in destination countries).

- Excluding studies which pooled data inappropriately across too many years or across critical time periods when significant technological innovations had come into common use.

- Examining the theoretical basis for the choice of reference population and excluding those studies that had used an inappropriate reference against which to make comparisons (this was an issue particularly for immigrant groups from son preference countries to non-son-preference destination countries).

Commentary on the methodological strengths and limitations of the systematic reviews is reported in each related chapter in accordance with PRISMA guidelines, and examined further, and across the studies, in the discussion Chapter 8.

3.5.6. Data synthesis

The findings of the studies were synthesised narratively in accordance with the well-established guidance on the conduct of narrative synthesis in systematic reviews (Popay et al., 2006). Popay et al. (2006) describes narrative synthesis as:

'an approach to the systematic review and synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings of the synthesis. Whilst narrative synthesis can involve the manipulation of statistical data, the defining characteristic is that it adopts a textual approach to the process of synthesis to "tell the story" of the findings from the included studies.'

Narrative synthesis can be used in systematic reviews of evidence from both observational studies and interventional studies. The Popay et al. guidance informed methodological approaches across the systematic reviews including in the synthesis of findings from included studies. The structure of the narrative synthesis was informed by the structure of the pathways

and mechanisms in the logic model (Figure 1). Findings across the studies in the review were summarised, tabulated, and displayed visually through figures and charts, and higher quality studies were reported first and in greater detail – in-line with Cochrane guidance on synthesis, and the narrative synthesis guidance (McKenzie and Brennan 2022; Popay et al., 2003, 2006).

The high level of heterogeneity within the systematic review of intervention studies, in terms of the intervention types, populations, settings, study designs, measures, and results precluded the possibility of conducting quantitative meta-analyses of the findings (Higgins and Green, 2011; McKenzie and Brennan, 2019).

To address Objective 5 – to draw together insights from studies 1 to 4 and the wider literature for future research and policy implications - I adopted a qualitative approach to identify common or overarching themes, over and above those that could be gleaned from the findings of the individual studies. I immersed myself in the findings from each of the doctoral studies and ranged across them to gather higher order insights that advanced understanding of the central focus of the thesis.

From this overarching evidence synthesis, I then returned to the original logic model (Figure 3) on which the doctoral studies were based, and revised it in the light of the research findings, to depict the new pathway, potential policies/interventions that had been identified during the research (and a further, related intervention point), and ideas for future research that the findings had generated. This revised logic model is presented in Figure 12.

Chapter 4 – Findings of Study 1: The health impacts of women's low control in their living environment - A theory-based systematic review of observational studies in societies with profound gender discrimination

'…*those who discriminate restrict, by judgment and action, the lives of those against whom they discriminate*.' (Krieger, 2014)

This study was published as:

4.1. Abstract

Background

Theory posits that the low status of women, compared to men, in societies with profound gender discrimination leads to restricted autonomy and reduced control over important health determinants including household resources, movement/mobility, legal and political resources (including legal recourse for crime and injustice), fertility and reproductive rights, and access to food, education, employment and healthcare services. This in turn leads to poorer health for women and their children, and reduced survival as shown in the logic model in Figure 1. To gauge the empirical support for the upper pathway in Figure 1, a systematic review was conducted to explore the evidence on associations between women's low control in the living environment and health outcomes in the context of low and middle-income countries with strong gender discrimination (son preference countries).

Methods

Electronic databases MEDLINE and MEDLINE In-Process, PsycINFO, Social Science Citation Index, and Conference Proceedings Citation Index - Social Sciences and Humanities were searched for articles on the association between women's levels of control in their living environment and health-related outcomes. Backward citation searches ("citation snowballing") of included papers, and contact with experts, were conducted. Study identification and data interrogation was informed by the logic model (Figure 1).

Results

From an initial 2,443 unique publications identified in searches, thirty observational studies of varying methodological quality were included. Overall, the evidence suggests that women's lower control or autonomy (for example, lack of freedom of movement outside the home, lack of control over household resources, and lack of authority to access healthcare for themselves and their sick children) was associated with poorer physical and mental health for women and higher morbidity and mortality for their children, after adjusting for their socioeconomic circumstances.

Discussion

Overall, the evidence suggests that women's lower control or autonomy (for example lack of freedom of movement outside the home, lack of authority to access healthcare for sick children) was associated with poorer mental and physical health for women and higher morbidity and

mortality for their children, after adjusting for their socioeconomic circumstances. Further studies are needed to disentangle and understand the pathways between low control and health outcomes in contexts of profound gender discrimination. This systematic review highlighted the general low quality of the evidence base on this research question. It identifies the pressing need for high quality, longitudinal studies in future research.

4.2. Introduction

Aim

The aim of Study 1 is to explore the evidence base on associations between women's low control in the living environment and health outcomes in son preference countries - the upper pathway in the logic model in Figure 1.

Control, health, and social inequalities in health

According to Syme (1989), 'control over one's destiny' appears to be a fundamental determinant of health. Lack of control may be an underlying cause of social inequalities in health (Whitehead et al., 2014, 2016).

The global Commission on Social Determinants of Health (CSDH) concluded that differences in how much control people have over their lives plays an important role in creating social inequalities in health (CSDH, 2008). The 2010 Marmot Review, Fair Society, Healthy Lives, placed the recommendation 'enabling all children, young people, and adults to maximize their capabilities and have control over their lives' second in its six highest priority policy objectives. Syme, Sen and Marmot argue that control over your own life, your destiny, is a crucial to health and well-being (Syme, 1989; Sen, 1999a; Marmot, 2004). During his work on the 'capabilities approach', the Nobel Laureate, Amartya Sen, concluded that:

"*The success of an economy and of a society cannot be separated from the lives that members of the society are able to lead. Since we not only value living well and satisfactorily, but also appreciate having control over our own lives*." (Sen, 2003).

Empirical evidence on the relationships between levels of control and health inequality outcomes first emerged in studies set in the work environment in high-income countries. Methodologically strong observational studies conducted by Karasek and Theorell (1990), Marmot et al. (1997), Demerouti et al. (2001) and others (Van der Doef and Maes, 1999; Kuper and Marmot, 2003; Bosma et al., 2005; Kuper et al., 2005; Theorell et al., 2015), found that low levels of workplace control together with high levels of demand are stressors that may lead to mental or physical health conditions that include cardiovascular disease. There is evidence that lower skilled workers are more exposed to low control and high demand stressors, leading to social inequalities in health between different occupational groups and levels (Marmot et al., 1997).

This systematic review focussed on the disparate and less developed literature on control in the 'living environment', defined as '*the households, communities and societies in which people live and go about their daily lives outside paid work*' (Pennington et al., 2018b). A focus on the experience of women in son preference countries provides an insight into the most severe forms of restricted control for women, and the most extreme examples of population health impacts.

Low control for women in son preference countries

As outlined in Chapter 2, gender is closely tied to resources such as status, power, and social connectedness. For women in son preference countries, low status leads to low levels of control in comparison to men at micro, meso, and macro levels. For women in son preference countries, cultural orientation towards men at the macro/societal level (level 3 in Table 1) places women at lower status than men, which limits the level of control they have, or are permitted to have, over their lives and the lives of their children. This leads to poorer control over, and poorer access to, resources that are essential for both their own health and wellbeing and that of their children.

This systematic review considered evidence relating to the upper (control) pathway in Figure 1.

4.3. Methods

4.3.1 Study identification

Development of the search strategy

Development of the search strategy and interrogation of the evidence was informed by the logic model (Figure 1). Systematic review approaches were based primarily on the Centre for Reviews and Dissemination's guide to undertaking systematic reviews and PRISMA and PRISMA-E guidelines (CRD, 2009; Moher et al., 2009; Welsh et al., 2012). An initial set of search terms was identified through relevant sample papers in results from an earlier search from a broader systematic review of associations between control/empowerment and social inequalities in health, and relevant terms from the underpinning critical review of theories and concepts (Whitehead et al., 2014., Whitehead et al., 2016). Pilot searches in two gold standard databases (MEDLINE, Web of Science) were conducted to test the appropriateness and coverage of the search terms. After refinement to ensure a good balance of sensitivity and specificity in the searches, search syntaxes were tailored to specific databases (OVID MEDLINE and MEDLINE In-Process, APA PsycINFO, Social Science Citation Index, and Conference Proceedings Citation Index - Social Sciences and Humanities [via Web of Science]). Searches were conducted for English language articles published between January 1980 and December 2016 on the association between women's levels of control in their living environment and health-related outcomes.

Date of searches, search terms and syntaxes, databases searched, number of hits, keywords and other comments were recorded, so the searches were transparent, systematic and replicable as per PRISMA guidelines (Moher et al., 2009).

The results of the searches were downloaded into Endnote X9 reference management software for deduplication, before export into EPPI Reviewer 4 systematic review management software. Reference lists of included studies were scanned for relevant articles (backward citation searching). Evidence was also requested from researchers who had published on control and health-related outcomes. An example of the Medline search syntax is shown in Appendix 1.

4.3.2 Study selection

Study inclusion and exclusion criteria

Study inclusion and exclusion criteria, including publication characterises, are summarised in Table 2.

Table 2. Initial inclusion and exclusion criteria for review

	Included	Excluded
Measures of level of control	Measures of the degree of 'actual' control that woman exercise at the household level in the societies in which they live: e.g., freedom of movement outside the house; authority to take a sick child for medical treatment.	General perceptions of control or 'control beliefs' Measures of 'mastery' where it was conceptualised as self-control or mastery over one's own emotions, which implies restriction rather than freedom. Studies that examined perceived 'locus of control' of individuals as a personality trait, without reference to the living environment and status in society.
Health outcome measures	Outcomes measuring an individual's physical or mental health.	Outcomes that do not directly measure health outcomes, but only measure intermediate outcomes (e.g. levels of access to healthcare services).
Confounding	Studies that made some adjustment for potential socioeconomic confounders.	Studies that made no adjustment for potential socioeconomic confounders
Study designs	Quantitative observational studies analysing the extent and nature of relationships between women's low control over decisions at the household level and health-related outcomes.	Solely qualitative studies. Opinion or discussion pieces not providing empirical data.
Setting	Studies conducted on free living populations in households in the 'living environment'. All countries.	Studies conducted in the work environment, populations in institutions (e.g., prisons).
Time coverage	1980-2016	Pre-and post-1980-2016
Language	English-language studies.	Non-English language studies.

Only studies reporting empirical data from quantitative observational investigations in low and middle-income countries with strong gender discrimination were included. They also had to include each of the following three components:

a) A measure/s of women's level of 'actual' control in their living environment.
b) A measure/s of a physical or mental health outcome.
c) Adjustment for socioeconomic factors/circumstances that may influence the pathways to women's health.

a) **Level of 'actual' control**: Included studies had to measure the level of 'actual' control women could exercise in their day-to-day lives in their society. Examples include the level

of freedom/autonomy they had to access healthcare for themselves or take a sick child for treatment, the level of control they had over household decisions such as the purchase of large or small/everyday goods, and their freedom of movement outside home. Most of the studies used indices of autonomy that combined measures of what women were permitted to do in daily decision-making.

Studies were excluded if they only measured perceived control or control beliefs, not measures of 'actual' control. Studies on 'locus of control' as a personality trait were similarly excluded. Studies that solely focussed on the work environment were also excluded. A large body of literature on the survival impacts of son preference that did not measure levels of control were also excluded. These studies were, however, set aside for potential inclusion in the later doctoral Study 2 systematic review, on the lower pathway in Figure 1.

b) **Health outcomes**: Studies that measured women's physical or mental health or that of their children were included. Studies that only measured intermediate health-related outcomes depicted in Figure 1, for example, access to health care services, but not a related health outcome we excluded.

c) **Adjustment for socioeconomic status (SES)** Socioeconomic status (or position) is an important determinant of population health in its own right, with the poverty and material disadvantaged experienced by poor women in low- and middle-income countries directly causing higher morbidity and mortality (WHO, 2010). SES may also be a moderator in the pathway between control and health, and control may be a mediator in the pathway between SES and health (Figure 1). Studies therefore had to make some attempt to take SES circumstances and pathways into account in be included.

Screening for inclusion/exclusion

Studies were selected for inclusion through two stages (title and abstract screening, and full text screening). Titles and abstracts of all records retrieved from the searches were independently screened by two reviewers ('double screened') to identify potentially eligible studies based on the initial inclusion and exclusion criteria above (and shown in Table 2 together with publication characteristics inclusion criteria). All potentially eligible articles were retrieved in full text. Two reviewers then independently screened the full text of the articles using a pre-designed and piloted eligibility assessment form. The screening process was managed using EPPI-reviewer 4 systematic review management software (Thomas et al., 2010). Reasons for exclusion were

recorded. Any queries or disagreements in the screening process were resolved by discussion or recourse to a third reviewer.

4.3.3 Critical appraisal

Studies that met the initial inclusion criteria were assessed for methodological quality (critically appraised) using an adapted version of a tool tested for use in the appraisal of observational studies (Barker et al., 2000). Critical appraisals were independently conducted by two reviewers, with any disagreements resolved by discussion or recourse to a third reviewer. Studies were only included in the review if they met a set of pre-defined minimum quality criteria - in terms of selection bias, confounding, data collection and withdrawals/dropouts (Appendix 2).

4.3.4 Data extraction and synthesis

Reviewers extracted data from the included studies into pre-designed and piloted forms. Data extractions were checked for accuracy and completeness by a second reviewer. Extracted data included: study aims, study design, setting (country), measures of control/autonomy, adjustment for SES, health outcomes, and main findings. Reviewers identified a typology of appropriate quantitative observational study designs (following the approach outlined by Petticrew and Roberts, 2003) to help organise the evidence (shown in Appendix 2). Evidence from higher methodological quality studies were reported first and in greater detail. Studies were assessed to determine whether they provided any empirical evidence on the hypothesised pathways from women's low control at the household level to health-related outcomes shown in the logic model (Figure 1). Results were synthesised narratively (Mays et al., 2005; Popay et al., 2003, 2006; Whitehead et al., 2014).

4.4. Results

4.4.1 Results of the search

From an initial 2,443 unique records, 30 studies on women's low control in the living environment and health outcomes in low and middle-income countries with strong gender discrimination were included and synthesised. The flow chart in Figure 4 shows the progress of studies through the review.

Figure 4. PRISMA flow chart of the progression of studies through the review
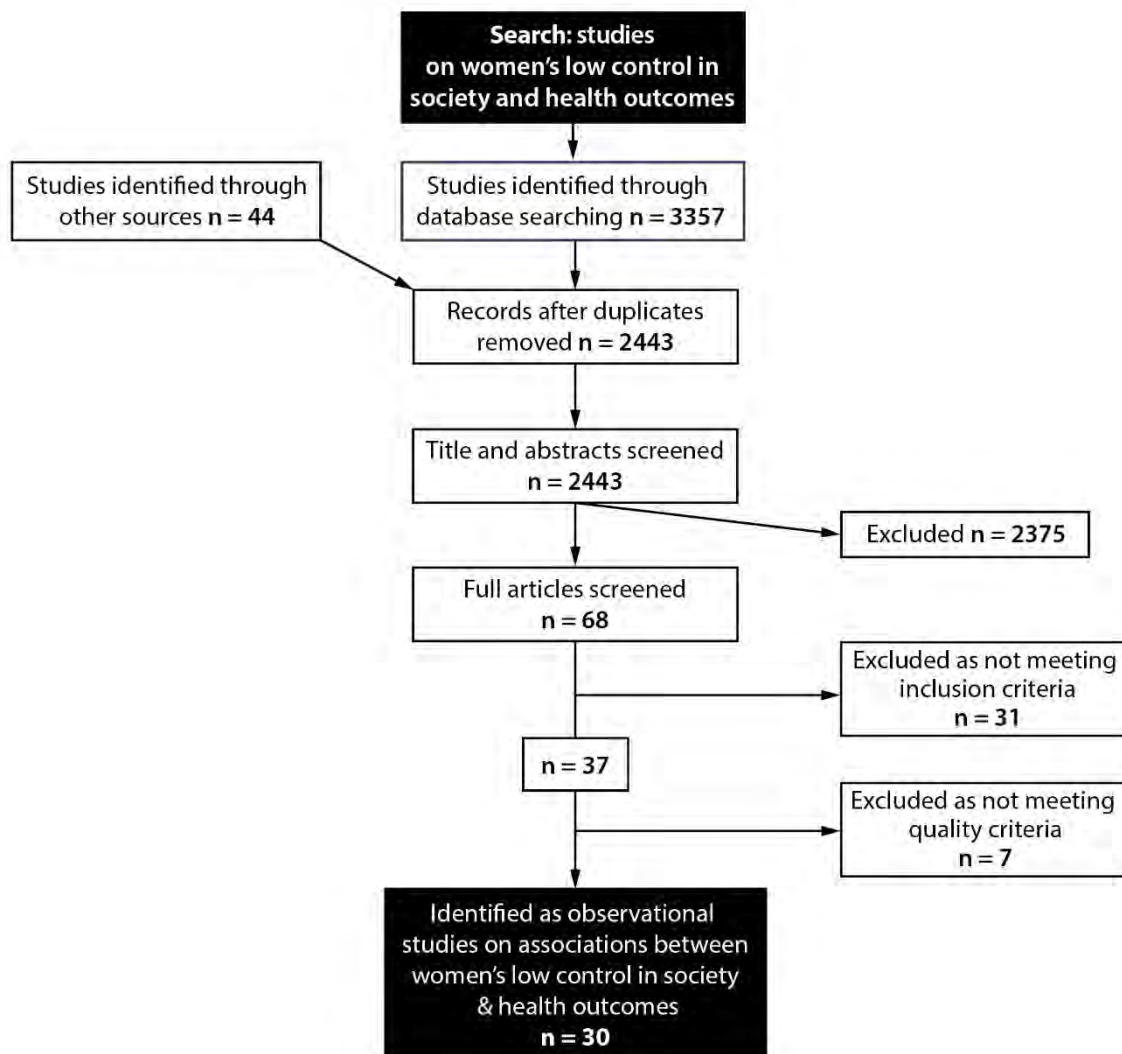
All thirty observational studies measured the degree of control that women could exercise in the living environment in the societies in which they lived, including measures of their autonomy in making decisions about household resources, sexual and reproductive decision-making, freedom of movement and control over decisions to seek healthcare. Many of the studies used indexes of

autonomy or combined them into indices of autonomy that covered a range of measures of what women were permitted to do in daily decision-making. Box 4 contains examples of the measures, indexes and indices of women's control/autonomy used in the studies.

Box 4. Examples of measures of women's control in the living environment in societies exhibiting strong gender discrimination

1. **Household decision-making measures**: whether a woman had the final say in decisions on - large household purchases, day-to-day household purchases, health care for herself, and visits to family and friends (Desai and Johnson, 2005).

2. **Women's autonomy index**: whether a woman's husband allows wife to work outside home, go out with friends, work in a male environment (prior to marriage) (Qadir, 2011).

3. **Women's autonomy indices**: household decision making autonomy, child-related decision-making autonomy, financial autonomy, mobility autonomy (Shroff, 2011).

The observational methodological designs used in the studies ranged from a higher quality longitudinal study using individual level data, to lower quality single time-point cross-sectional designs. A range of health outcomes was measured for women and for their children (as shown in Table 3 and Table 4). All the included studies adjusted for socioeconomic characteristics of the study participants to varying extent, as per the inclusion criteria.

4.4.2 Findings of higher quality studies

The three higher methodological quality longitudinal studies (Table 3) are described here.

Table 3. Higher quality studies of women's control in their living environment and health outcomes

Study (author, year)	Country	Measures of women's control	Health outcome measures	Summary of statistically significant results (associations, p ≤ 0.05)	Study design
Hossain et al., (2007)	Bangladesh	Household autonomy index; Household authority index	Neonatal, post-neonatal & childhood mortality (1 – 5 years)	Lower autonomy for women was associated with poorer health and survival for children	Longitudinal, individual-level, linked data
Yount et Al., (2014)	Egypt	Women's household autonomy measures	Generalised anxiety (women)	Mixed: Lower mobility autonomy for women was associated with higher anxiety; Lower	Longitudinal, individual-level linked data

Study (author, year)	Country	Measures of women's control	Health outcome measures	Summary of statistically significant results (associations, p ≤ 0.05)	Study design
				healthcare and major household purchasing autonomy associated with lower anxiety. No association between daily household purchase autonomy and anxiety	
Alemayehu et al., (2015)	Ethiopia	Household decision-making index	Infant Mortality	Lower empowerment for women was associated with poorer infant survival	Repeat cross-sectional, individual-level data, retrospective recall of infant death

Hossain et al. (2007) examined the association between women's level of control/autonomy over household decisions and infant and child mortality in Bangladesh. During the study period, Bangladesh was a society with a tradition of strong son preference were women's status and autonomy was severely constrained. Bangladeshi women are key decision-makers for children's access to preventive and curative health services, and levels of child nutrition. The study investigated the hypothesis that women's constrained authority and autonomy adversely affects the survival of their children, partly through reduced access and ability to use child health services. The study employed individual-level data from a demographic surveillance system in four rural areas (*thanas*). Using data from a 1988 cross-sectional survey, they constructed an indices of women's status made up of groups of indicators on women's autonomy, freedom of movement and authority to make household decisions relating to child healthcare, education and marriage of daughters. This was linked to data on the survival of 7,534 of the surveyed women's children over a 5-year period between 1988 and 1993. They statistically adjusted for demographic and socioeconomic characteristics of the mother and household by using data from previous survey (educational level of mother, father, and economic status of household based on dwelling space/area). Higher autonomy for women was significantly associated with lower post-neonatal mortality of their children (RR=0·88, p<0·05). Higher household authority for women was associated with significantly lower mortality of their children aged 1 to 5 (RR=0·84, p<0·05). These relationships did not differ significantly by gender of child, and the authors suggest that the

mechanisms associated with sex preference in children may be different from those that discriminate against adult women. While lower autonomy was generally associated with women from poorer households, the exception was for the custom of purdah, the most extreme form of restriction on women in this society. Purdah is, however, associated with higher status, richer, households, as the practice of placing extreme restrictions on women carries a financial cost that many families cannot meet, to such an extent that purdah was treated as a marker for household wealth in this analysis. Higher status women had the lowest levels of autonomy. The custom was weakly associated with decreased neonatal mortality, but not post-neonatal mortality of under-5 survival of children.

Yount et al., (2014) conducted a study in Minya, a rural area of Egypt, a society in which senior males disproportionately control many family resources and women's agency is severely restricted. They used individual level longitudinal data on a sample of 608 ever-married women aged between 22 and 65 from the 2005 Egypt Demographic and Health Survey, who were reinterviewed in 2012. They investigated the association between women's empowerment and their later mental health (generalised anxiety from the Kuwait University Anxiety Scale). They tested two hypotheses. First, that women's acquisition of pre-marital enabling resources would be negatively associated with their generalised anxiety at interview. Second, that women's post-marital agency (ability to make important household decisions independently) would be positively associated with their premarital enabling resources and would partially mediate the resources-anxiety relationship. The first hypothesis was confirmed - women's higher schooling attainment, premarital paid work, later age at first marriage, and greater proximity to birth family were significantly associated with lower generalised anxiety. The second hypothesis concerning post-marital agency was only partially supported. Making exclusive decisions about visits to family was associated with lower generalised anxiety, whereas making exclusive decisions about personal healthcare and major household purchases were associated with higher generalised anxiety. The mediation analysis indicated that women's post-marital agency may partly mediate the relationship between some of the measures of women's premarital enabling resources and their subsequent generalised anxiety. This study is unique in this review in incorporating a parallel qualitative study, which helped interpret the multivariate findings. The nuanced findings identified the importance of: pre-marital economic activity, particularly market work, for enhancing post-marriage agency and mental health; the women's birth family as a key extra-marital social resource, and the potential adverse costs of having decision-making power in terms of family reaction (Yount et al., 2014).

The third higher methodological quality study was conducted by Alemayehu et al. (2015) in Ethiopia, were women in general have a limited say in household-level decisions in a highly male-

dominated society. They examined the association between women's SES, measured by maternal education level, and infant death. They explored the potential mediation or moderation roles of women's empowerment and household wealth. Their investigation was based on the conceptual framework in Figure 5.

Figure 5. Woman's Education and Infant Survival, Conceptual Framework (Alemayehu et al., 2015)
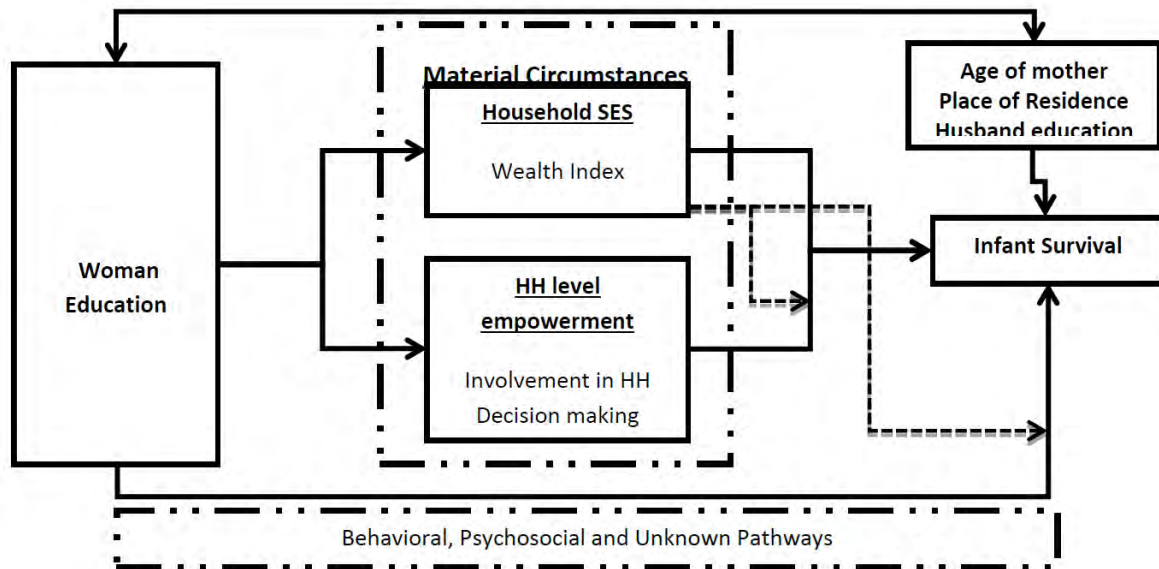
They carried out a secondary, repeat cross-sectional analysis of data on women aged 15 to 49 from three rounds of the nationally representative Ethiopian Demographic and Health Survey in 2000, 2005 and 2011. They surveyed 15,367 women in 2000, 14,070 in 2005, and 16,515 in the 2011, making a total of 45,952 respondents. The primary exposure was women's educational level (highest level of school completed – no education, primary, secondary, or higher-level education). Woman's and husband's educational status were analysed separately. A wealth index was based on measures of ownership of household assets, such as house construction materials, types of water and sanitation facilities, and ownership of goods such as televisions and bicycles (the importance of the latter should not be underestimated, as bicycles, compared with walking, can be an important form of transport that greatly reduces the time and labour required to retrieve essential supplies, such as water, that girls and women typically have the responsibility of locating and transporting).

An empowerment index, closely related to the concept of female autonomy, was based on measures of the level of involvement (participation) of the woman in household level decision-making about their own healthcare, major household purchases, and decisions about visiting family members. The primary outcome measure was the mother having experienced infant death at least once among births during five years prior to the survey. After controlling for the potential

confounders of age, type of residential area, and husband's educational status, women's educational status was significantly associated with their experience of infant death – with higher maternal educational status being associated with lower the risk of infant death.

Mothers who completed high school had a 31% lower risk of experiencing infant death compared to mothers with no education. Woman's empowerment was associated with woman's educational level, after controlling for the confounders, with greater empowerment associated with higher educational level. They conducted a mediation analysis which controlled for the three potential confounders and found the direct effect of woman's educational level on infant death was partially mediated by empowerment, producing a statistically significant 13% reduction in the initial association ($p<0.001$). Household socioeconomic status (measured using the Wealth Index) did not mediate the education-infant death association. In a stratified analysis by wealth index, however, degree of wealth was an effect modifier, and the effect of woman's education and empowerment on infant death was strongest for mothers from richer households and weakest for those from poorer households.

4.4.3 Findings from lower quality studies

Twenty-seven lower methodological quality studies provided weaker, but largely consistent, evidence of associations between lower levels of control for women in their living environment and higher risks of adverse health outcomes (shown in Table 4). These studies spanned a range of Asian, African, and South American settings, with varying degrees of strong gender discrimination and son preference. Box 5 shows the adverse health outcomes for women and their children associated with women's lower control/autonomy in the studies in Table 4.

Box 5. Associations between low control for women and adverse health outcomes identified in single-point cross-sectional studies in Table 4.

Higher rates of: • Infant, child and maternal mortality. • Malnutrition (for infants, children, and women). • Infant and child growth. • Gender disadvantage in childhood nutritional status/malnutrition (for girls). • Low birth weight. • Anaemia (for women). • Diarrhea and acute respiratory tract infections in children <2 yrs of age. *Lower levels of:* • Self-reported health status for women.

A high proportion of the lower methodological quality studies (21 of 27) found that lower control was associated with poorer health outcomes, after controlling for socioeconomic status. Three

found mixed results, with adverse and beneficial associations across different measures of control and health outcomes (Dancer and Rammahan, 2009; Hadley et al., 2010; Nankinga et al., 2016). Three studies found no evidence of significant associations (Sudha et al., 2007; Qadir, 2011; Ramaprasad et al., 2016). Individually these 27 lower methodological quality studies only provide weak evidence, but taken as a whole, they provide consistent evidence and point in the same general direction as the three higher methodological quality studies. The body of evidence shows that lower control for women is associated with significantly higher risk of adverse health outcomes for women and their children.

Table 4. Lower methodological quality studies of women's control in their living environment and health outcomes

Study (author, year)	**Country**	**Measures of women's control**	**Health outcome measures**	**Summary of results** (statistically significant associations, p ≤ 0.05)	**Study Design**
Fantahun, 2007	Ethiopia	Household decision-making index	Childhood mortality	Lower decision-making for women associated with poorer survival for children	Prospective case-control
Desai and Johnson, 2005	Benin, Malawi, Mali, Uganda, Zimbabwe, Egypt, India, Nepal, Haiti, Colombia, Nicaragua, Peru	Women's household decision-making authority measures	Child nutritional status (height-for-age); Childhood mortality (between 13 and 60 months)	Lower decision-making authority for women was associated with lower nutritional status in India and Malawi, and with higher mortality in Egypt, India, Mali and Nepal. No significant associations in other countries.	Cross-national ecological comparative (single point cross-sectional)
Hindin, 2006	Zimbabwe, Zambia, Malawi	Women's household decision-making measures	Women's anthropometric status (chronic energy deficiency/low BMI)	In Malawi, lower decision-making for women was associated with poorer health for women. In Zambia, lower decision-making for women was associated with poorer health for women in urban (but not rural) areas. No association in Zimbabwe	Cross-national ecological comparative (single point cross-sectional)
Agustina et al., 2015	Indonesia	Maternal agency measures	Diarrhea and acute respiratory tract infections in children <2 yrs of age	Low maternal agency associated with poorer child health (both outcomes)	Cross-sectional (two time-points)
Sudha et al., 2007	India	Women's autonomy index; Economic autonomy index	Reproductive Tract Infections	No associations	Single time-point cross-sectional
Nankinga et al., 2016	Uganda	Measure of women's involvement in decision-making about her own	Women's sexually transmitted infections	Mixed: Lower decision-making for women about own health care was associated with higher STI rates. Lower	Single time-point cross-sectional

		health care; Sexual empowerment index;		sexual empowerment for women was associated with lower STI rates	
Hadley et al., 2010	Uzbekistan	Women's autonomy measures (ownership autonomy; purchasing autonomy; travel autonomy; body-sex autonomy; final decision autonomy)	Depressive symptoms; systolic & diastolic blood pressure (women)	Mixed: Greater travel autonomy associated with lower odds of depressive symptoms, greater decision autonomy associated with higher odds of depression. No autonomy-depression association with ownership autonomy or control over purchases.	Single time-point cross-sectional
Qadir et al., 2011	Pakistan	Women's autonomy index	Women's psychological morbidity	No association.	Single time-point cross-sectional
Barchi, 2011	Botswana	Women's autonomy measures (freedom of movement, economic independence, control of household resources, household-related decision-making.	Women's self-reported health status (SRHS), depression, suicidal ideation	Lower autonomy for women (economic independence; control of household resources) was associated with lower women's SRHS, No associations between autonomy measures & depression or suicidal ideation	Single time-point cross-sectional
Mabsout, 2011	Ethiopia	Women's decision-making index	Women's low BMI; anaemia scores	Lower decision-making for women associated with poorer health for women	Single time-point cross-sectional
Hindin, 2000	Zimbabwe	Women's household decision-making measures	Women's anthropometric status (chronic energy deficiency/low BMI)	No say in decision-making for women associated with poorer health for women	Single time-point cross-sectional
Singh et al., 2015	Democratic Republic of the Congo, Egypt, Ghana, Liberia, Mali, Nigeria,	Women's household decision-making index	Women's low BMI	Low decision-making for women was associated with having low BMI	Single time-point cross-sectional (pooled data)

	Uganda, Zambia				
Sethuraman et al., 2006	India	Women's empowerment measures (household decision-making, mobility)	Maternal malnutrition and anaemia; Child nutritional status (malnutrition),	Lower empowerment for women (both measures) was associated with poorer health for children (aged 6 to 24 months)	Single time-point cross-sectional
Mashal et al., 2008	Afghanistan	Maternal autonomy measures (autonomy in seeking healthcare for herself and children)	Major child illness (acute diarrhoea, acute respiratory infection); Child nutritional status	A lack of maternal autonomy was associated with poorer child health (growth retardation, acute respiratory infection)	Single time-point cross-sectional
Rahman et al., 2015	Bangladesh	Mother's decision-making autonomy measures	Child nutritional status (growth stunting, wasting, underweight)	No say in decision-making for women was associated with poorer child health	Single time-point cross-sectional
Chakraborty and Anderson, 2011	India	Maternal autonomy index	Low Birth Weight	Low maternal autonomy associated with poorer health for new-borns	Single time-point cross-sectional
Roushdy, 2004	Egypt	Women's investment in children's human capital decision-making measures (schooling and nutrition)	Child nutritional status (growth stunting)	No association between women's autonomy and child health	Single time-point cross-sectional
Shroff et al., 2009	India	Women's financial and physical autonomy indices	Child nutritional status (growth stunting)	Lower autonomy for women associated with poorer health for children	Single time-point cross-sectional
Shroff et al., 2011	India	Women's autonomy indices	Infant nutritional status (malnutrition, wasting)	Lower autonomy for women associated with poorer health for children	Single time-point cross-sectional
Ramaprasad et al., 2016	India	Mother's decision-making autonomy measures	Child nutritional status (growth stunting, wasting, underweight)	No associations	Single time-point cross-sectional
Bose, 2011	India	Women's autonomy index (household decision-making; movement)	Child nutritional status (malnutrition); gender disadvantage in nutritional status (likelihood of girls being	Lower autonomy for women associated poorer health (higher malnutrition in all children), and with higher probability of girls being malnourished, compared to boys.	Single time-point cross-sectional

			malnourished compared to boys)		
Brunson et al., 2009	Kenya	Women's autonomy index	Child nutritional status (malnutrition)	Low autonomy for women was associated with poorer health for children aged 3-10 yrs. No association between women's autonomy and younger children's (aged 0–35 months) health.	Single time-point cross-sectional
Dancer and Rammohan, 2009	Nepal	Maternal autonomy measures (household decision-making; healthcare decision-making)	Child nutritional status (wasting; growth stunting)	Lower maternal autonomy associated with poorer health outcomes, particularly for girls.	Single time-point cross-sectional
Ross-Suits, 2010	Tanzania	Maternal autonomy measures (healthcare decision, financial autonomy)	Child nutritional status (malnutrition; growth stunting)	Low healthcare decision autonomy for women was associated with poorer child health outcomes (growth stunting). No associations between other variables.	Single time-point cross-sectional
Roy, 2013	India (state level)	Household decision-making measures	Neo-natal and Post neo-natal mortality	Lower decision-making for women associated with poorer health for infants	Single time-point cross-sectional
Hossain, 2015	Bangladesh	Measures of women's participation in household decisions; movement autonomy measures	Infant mortality	Lower decision-making for women was associated with higher infant mortality	Single time-point cross-sectional
David, 1999	Egypt	Personal autonomy measures	Childhood mortality	Lower autonomy for women associated with higher child mortality	Single time-point cross-sectional
Studies are ordered by health outcomes where possible (fourth column).					

4.5. Discussion

The review systematically identified and examined empirical evidence on associations between women's control in the living environment and health outcomes in societies exhibiting profound gender discrimination. Thirty observational studies in low- and middle-income countries that met strict inclusion criteria were included. Three were rated as higher methodological quality, 27 as lower quality.

The three studies of higher methodological quality, which provided more robust evidence, demonstrated a temporal relationship (part of the Bradford Hill Criteria for causation: Hill, 1965), with higher levels of control/autonomy for women being associated with a subsequent reduced risk of mortality for infants and children in Bangladesh, and better mental health of the women in Egypt (Hossain et al., 2007; Yount et al., 2014). There was also evidence that women's empowerment played a partial mediating role between women's educational status and infant death in Ethiopia, and that levels of household wealth acted as an effect modifier (Alemayehu et al., 2015). Yount et al. (2014) found evidence of a partial mediating role for women's post-marital agency between premarital enabling resources and subsequent mental health in Egypt.

Looking across the body of evidence, virtually all the studies found that women's low control in their living environment was significantly associated with worse health outcomes for women and for their children, after adjustment for socioeconomic status.

4.5.1 Limitations of the included studies

There were several limitations of the studies included in the review. Most of the studies (27 of 30) were lower methodological quality, single time-point cross-sectional designs that measured women's control and health outcomes at the same time. Single time-point cross-sectional studies are unable to establish a temporal causal relationship. In the absence of an established temporal relationship, it is possible that some of the associations were the result of reverse causation. Conclusions from the weaker methodological studies therefore had to be limited to whether or not statistically significant associations were established, and the direction of associations (beneficial or adverse), after controlling for socioeconomic circumstances. Higher weight is given to the three higher methodological studies, as they can establish temporal relationships between exposures and outcomes. They included two individual-level longitudinal studies and the one ecological longitudinal study. Further higher methodological quality, longitudinal studies are needed in the future.

It is particularly important to adjust for differences in socioeconomic circumstances in the living environment as these are important determinants of population health in their own right (CSDH, 2008). All the included studies did attempt to adjust for socioeconomic status, but adjustments for confounders, mediators and effect modifiers were relatively crude in most of the studies. There was still considerable potential for unmeasured effects.

The conceptualisation and measurement of control/empowerment in the studies was challenging. Most of the studies did, however, develop proxies for women's control or autonomy that were based on theory and succeeded to some degree in capturing 'actual' or 'real' control, as opposed to control beliefs or general perceptions of control. More robust measures of 'actual' control have been developed and used in studies set in the work environment in high-income countries (for example, Karasek and Theorell, 1990), and similarly robust measures should be developed for use in studies of control and health in the living environment.

4.5.2 Limitations of this systematic review

The systematic review had several limitations, predominantly related to the strict inclusion and exclusion criteria, which restricted the type and number of studies included.

First, this systematic review did not cover any studies on the lower pathway in the logic model in Figure 1 on son preference, mechanisms such as sex-selective abortion, and health and survival outcomes. This was because the studies did not measure women's level of control in their living environment and therefore did not meet the strict inclusion criteria for this review. The body of evidence on the lower pathway in the logic model is, however, the subject of the systematic review that is reported in Chapter 5 (Study 2).

Second, there is another large body of evidence linking low control to intermediate health-related outcomes, such as healthcare seeking behaviour. This body of evidence reveals important information about potential mechanisms that link low control in the living environment to poorer health outcomes, but the studies did not go on to measure health outcomes. They did not meet the full inclusion criteria for this review and were excluded.

Third, all the studies in the review measure women's control in the living environment within their households, but women also face regular restrictions on their freedom and autonomy in their neighbourhoods and communities in societies with profound gender discrimination. The search identified some studies which investigated relationships between women's control at the level of communities and health-related outcomes, but they were all excluded for two main

reasons. First, most only measured socioeconomic status proxies for control, such as rates of women's educational attainment, wealth, or employment status, and did not measure control directly. These socioeconomic status indicators are conceptually distinct from the notion of 'control' and, are known to be determinants of health in their own right, as control/autonomy may act as a mediator in the pathway between socioeconomic status and health outcomes. Second, all the community-level studies that were identified by the searches failed to measure health outcomes. They only measured impacts on intermediate outcomes, such as use of healthcare services. They were therefore excluded as not fully meeting the review's inclusion/exclusion criteria. This highlights the gaps in the observational evidence on women's community-level control and health outcomes. It also identifies the need for the development of robust measures of 'actual' control at the community-level for use in future research.

Forth, the review only included studies published in English. Some evidence may have been missed from non-English language publications, for example, in the son preference countries of China and India. Searches for publications in other languages would, however, require sophisticated multilingual skills and resources both to develop and implement search syntaxes, and to extract data and other information needed to interpret findings. These are resources which are rarely available to small teams of researchers. International collaborations between researchers could potentially address this issue in the future.

4.5.3 Putting women's low control in context

Key mechanisms indicated in the higher quality studies in this review need further teasing out in the light of specific societal contexts. First, is the finding that in the Ethiopian context that women's empowerment partially mediates the maternal education-infant death relationship, but still leaves the largest part of the mechanism unexplained (Alemayehu et al., 2015). The wealth of the household played no part in the mediation, but it did act as an effect modifier in a very intriguing way: both empowerment and education had the strongest inverse association with infant deaths among women from the richest households and weakest among those from poorest households. One possible explanation is that poverty and material deprivation experienced by the women in the poorest households has such an overwhelming effect on their access to the pre-requisites for health that empowerment can do relatively little to counter the effects of this deprivation. For women in the richest households, however, where poverty is not blocking access to healthcare, education, employment and so on, then differences in women's power may play a greater role in influencing the observed health outcomes between women with different degrees of control in their daily lives. Other studies have postulated the reverse: that women's higher levels of autonomy will have a greater effect on children's health in poorer households where

resources are severely constrained (Brunson et al., 2009). The nature of these differing mechanisms need unpicking further, and certainly points to the need for stratified analysis by SES in all such studies, as well as high quality qualitative studies to illuminate why the associations have developed.

Second, is the tricky issue of how to treat *'purdah'* in these analyses and how to interpret the results. In the Bangladeshi context, Hossain et al. 2007 contend that, while *purdah* can be seen as the most extreme manifestation of the subjugation of women, in practice the custom has been eroded in recent years. It has become increasingly associated with richer households, because the costs of *purdah* (additional clothing, transport, not being able to work outside the home) have become unsustainable for poorer households. In Hossain et al.'s analyses, the net effect of *purdah* is therefore taken to portray the effect of household economic status rather than women's level of control within the household. The finding that the index of purdah was weakly associated with lower neonatal mortality was speculated to be due to women in *purdah* acquiring access to antenatal and postnatal care that more deprived households could not afford. The effect wears off by the postneonatal and early childhood periods. Further studies, both quantitative and qualitative, are needed to disentangle the net effect of *purdah* from economic status.

Third, is the issue of whether women's greater autonomy can mitigate the effects of gender bias – son preference – and the selective deprivation of girls. In the Bangladeshi study, the hypothesis that the effects of gender bias on the autonomy and authority of mothers will be more harmful for the survival of girls than for boys was not supported (Hossain et al., 2007). The effect was similar for girls and boys. It may be that individual women's autonomy may be insufficient to affect the underlying dynamic that drives son preference in such a gender-biased society. On the policy front, this flags up the potential importance of societal level efforts to reduce or eliminate gender discrimination, which may then go on to influence the drivers of son preference. The health impacts of such societal level efforts need to be evaluated and, indeed, efforts in Bangladesh over the last two decades have shown marked success in improving the survival of girls, particularly poor girls who had the worst chances of survival, relative to rich girls and poor and rich boys (Bhuiya et al., 2001; Orton et al., 2016).

Finally, questions arise about the difficulties of conducting research of this nature and interpreting the results in the overarching societal context in which the reviewed studies took place. All the studies attempted to exploit the variation in levels of women's control or autonomy found in their study countries to assess associations with health outcomes. But it is likely that the degree of variation in women's autonomy is still relatively small in the societies with profound gender discrimination and gender bias. The variation may, therefore, be insufficient to detect an

effect on health, even if such an effect is present. Given this constraint, it is surprising that so many studies were able to detect an association, even if modest. One suggestion for further studies to address this issue is to compare meaningful jurisdictions within a society, such as comparisons of the experience of women in Indian states, known to differ significantly in terms of women's rights and status.

Chapter 5 – Findings of study 2: The impacts of profound gender discrimination on the survival of girls and women in son preference countries - a systematic review

This study was published as:

5.1. Abstract

Background

Amartya Sen first used the phrase 'missing women' to describe a survival disadvantage for women exposed to extreme gender prejudice in son preference countries. In 1989 he estimated that, despite considerable evidence of a biological survival advantage for females compared to males, there were 100 million fewer women in Asia and North Africa than expected. He concluded that gender discrimination in the provision of resources for health and survival were to blame - that women were at a social survival disadvantage. His work inspired decades of research into the scale, causes and impacts of the phenomenon of 'missing women'. The aim of this systematic review was to comprehensively identify, collate and synthesise the current body of demographic evidence on the impacts of profound gender discrimination on the survival chances of girls and women in son preference countries.

Methods

Six electronic databases (OVID Medline, OVID Medline In-Process and Other Non-Indexed Citations, APA PsycINFO, Web of Science Social Science Citation Index, Web of Science Conference Proceedings Citation Index - Social Sciences and Humanities, CINAHL Plus) were searched for articles published between 1980 and 2020 on son-preference, sex-selection, and 'missing women'. Backward citation searches ("citation snowballing") of included papers, and contact with experts, were conducted. After sifting titles and abstracts, eligible full-text articles from demographic studies of population sex ratios and estimations of 'missing girls' and 'missing women' were double-reviewed to extract data about 'missing women' estimates. Study identification and data interrogation was informed by a logic model.

Findings

From an initial 1,846 unique records, 34 demographic studies were included. Eighteen studies showed male-skewed SRBs in 14 son-preference countries in East and Southeast Asia, South Asia, West Asia, and Southeast Europe, with SRBs ranging from 108 to 115, against a naturally occurring SRB of 105.9. Gender imbalances in population sex ratios, favouring males compared to females, were particularly marked in China and India, where latest sex ratios at birth (male births for every 100 female births) were above 114 and 109 respectively. Male-to-female SRBs rose in son-preference countries from the 1980s onwards (consistent with the spread of the technology) and appear to have peaked in most of these countries during the 1990s and 2000s, before gradually reducing somewhat, but still remaining at high levels in the 2010s. The rapid rise

in SRBs in Vietnam during the 2010s is a notable exception. In contrast, sex ratios in South Korea have declined to reference levels since 2000, indicating the potential for reversal of the adverse trends. The estimates of the cumulative number of 'missing women' in the world have risen steadily from 61 million in 1970 to 126 million in 2010. The total number is predicted to continue increasing to 2050 with current trajectories.

Discussion

There is overwhelming evidence for lower-than-expected female survival in son-preference countries, particularly marked in China and India. The phenomenon of 'missing women' continues to exceed 100 million and is increasing in both relative and absolute terms globally. The survival disadvantage of girls increased significantly after the introduction of sex-selection technologies, which greatly compounded existing structural inequalities. Profound discrimination reduces female survival at every stage of life. Despite some improvements over time, male-skewed population sex ratios in many countries are still of concern. Time-series data and projections suggest the problem is getting worse in absolute terms as population levels increase in son-preference countries, which include the most populous nations of the world. New sex-selection technologies and economic downturns pose additional threats. Future research is needed to understand the impacts of these new threats to the survival chances of girls and women. Further research is also needed to disentangle and understand the complete pathways and mechanisms leading to poorer survival, and the major policy drivers of these trends, to devise the best possible ways of preventing the tragedy of 'missing women'.

5.2. Background

In 1986, Amartya Sen compared the ratio of women to men in China, India, Bangladesh and Pakistan with population sex ratios in Europe and North America. He estimated a population shortfall of over 75 million women in the Asian countries, where a preference for sons over daughters ('son-preference') and discrimination against women was profound. Sen proposed the shortfall of 'missing women' was the result of discrimination in the treatment of women in comparison with men. In 1989, he added other regions including West Asia (Middle East) and North Africa to produce an estimate of *'more than 100 million "missing women" in the world today'* (Sen, 1989).

Our 2016 critical review of theory on 'control over destiny' and social inequalities in health concluded that cultural orientation towards men and boys operates at the level of whole societies in son preference countries, influencing the degree of control that women feel they have, and actually do have, over their lives. The hypothesised pathways between women's low status and lack of decision-making powers in society and poorer health and survival outcomes for women and girls (compared with men and boys) include the upper 'control' pathway and the lower, connected 'son-preference' pathway in Figure 1. Empirical evidence on the upper 'control' pathway is considered in Chapter 4 and in Pennington et al., 2018b.

We also proposed that in societies with marked son preference, in combination with the impacts of lower control over resources, son preference leads to lower female survival rates through mechanisms such as infanticide of baby girls, relative neglect of girl children and, in recent decades through technological development (including ultrasonography), sex identification and sex-selective abortion of female fetuses (Banister, 2004; Whitehead et al., 2016).

The study presented in this chapter is a systematic review which examined the empirical evidence concerning the lower 'son-preference' pathway between women's low status in son-preference societies and survival outcomes/'missing women' in Figure 1. The review investigated the question:
What is the evidence on the impacts of profound gender discrimination on the survival of girls and women in son preference countries?

The aim was to synthesise the most up-to-date evidence on relative survival chances and how these have changed over time since Sen's seminal work in the 1980s.

5.3. Methods

5.3.1 Study identification

Development of the search strategy and identification of evidence

Development of the search strategy and interrogation of the evidence was informed by the logic model in Figure 1.

Six electronic databases (OVID Medline, OVID Medline In-Process and Other Non-Indexed Citations, APA PsycINFO, Web of Science Social Science Citation Index, Web of Science Conference Proceedings Citation Index - Social Sciences and Humanities, and CINAHL Plus [via EbscoHOST]) were searched for articles published in English between January 1980 and November 2020 on son-preference, sex-selection, and 'missing women'.

The theory-based systematic review approaches were based on the Centre for Reviews and Dissemination's guide to undertaking systematic reviews, guidance on the Conduct of Narrative Synthesis in Systematic Reviews, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and PRISMA-Equity Extension (PRISMA-E) guidance (CRD, 2009; Popay et al., 2006; Moher et al., 2009; Welsh et al., 2012; Page et al., 2021).

Search terms were identified through relevant sample papers in results from three related, preceding reviews (Whitehead et al., 2016; Orton et al., 2016; Pennington et al., 2018b). Pilots of the database searches in two gold standard databases (MEDLINE, Web of Science) identified that a single-tier search ('a broad net') using a range of highly relevant (specific) terms would provide the best balance of sensitivity and specificity. Search syntaxes were tailored and ran on specific appropriate databases. Dates of searches, search terms and syntaxes, databases searched, number of hits, keywords, and other comments were recorded, so the searches were transparent, systematic, and replicable as per PRISMA guidelines (Moher et al., 2009). An example of the MEDLINE search strategy is in Appendix 3.

The results of the searches were downloaded into Endnote reference management software for deduplication, before export into EPPI Reviewer 4 systematic review management software. Reference lists of included studies were scanned for any additional relevant articles (backward citation searching or 'citation snowballing'). We also ran advanced (Boolean and date-limited) Google searches to identify any publications that may have been missed by the database searches (but no further papers were identified). Finally, we contacted authors (experts in the field) to request missing or unpublished data for key papers and any additional relevant publications (we

received additional data [Kahlert, 2014, following contact with the author via Stephan Klasen; but no further papers were identified).

Study inclusion and exclusion criteria

Study inclusion and exclusion criteria focused on sex ratios in son-preference countries. Study inclusion and exclusion criteria are summarised in Table 5.

Table 5. Inclusion/exclusion criteria for systematic review of evidence on relative survival outcomes for girls and women in son-preference countries

	Included	Excluded
Population & setting	Populations in established son-preference countries. At national level.	Sub-national populations.
Studies and data of interest	Quantitative empirical representative population-level studies, including demographic studies of observed and expected sex ratios at birth and in adulthood.	Non-empirical studies (including evidence reviews). Qualitative studies. Studies on populations not representative of societal level. Opinion/discussion pieces not providing empirical data.
Outcomes	Sex-specific survival indicated by sex ratios at birth and other ages; estimates of shortfalls of women ('missing women') in the population of son-preference countries, derived from sex ratio data.	Studies not measuring survival outcomes.
Time coverage	1980 – 2020	-
Language	English-language studies.	-

Demographic studies reporting empirical data from quantitative investigations in low- and middle-income countries with a culture of strong gender discrimination and son preference were included. Studies that measured survival outcomes for females at any stage of life compared with males were included. Studies were only included if they used data from representative national population-level samples.

Screening for inclusion/exclusion

Studies were selected for inclusion through two stages (title and abstract screening, and full text screening). Titles and abstracts of all records retrieved from the searches were screened by two reviewers ('double screened') to identify potentially eligible studies based on the initial inclusion and exclusion criteria above (Table 5). All potentially eligible papers were retrieved in full text. Two reviewers then screened the full text of the articles using pre-designed and piloted eligibility assessment criteria (screening codes). The screening process was managed using EPPI-reviewer 4 systematic review management software (Thomas et al., 2010). Reasons for exclusion were recorded. Any queries or disagreements in the screening process were resolved by discussion or

recourse to a third reviewer. Appendix 4 shows a list of studies excluded at the full text screening stage, and reasons for exclusion. In practice 20 of the studies excluded as not being conducted in son-preference countries but otherwise meeting the remaining inclusion criteria were studies of diasporas from son-preference countries (India, China, etc.) that had migrated to high-income countries in Europe, North America, and Australasia; these studies were set aside for screening for a subsequent systematic review that is reported in Chapter 6 Study 3.

5.3.2 Data extraction

Reviewers extracted data from studies into pre-designed and piloted forms. Extractions were checked for accuracy and completeness by a second reviewer. Extracted data included: study aims, study design, setting/country, and main findings related to the review question.

5.3.3 Harmonisation of data on population sex ratios

Data on population sex ratios from individual studies were harmonised (using the standard of the number of males per 100 females, so a population sex ratio of 106 would represent 106 males for every 100 females, for example).

Studies in India typically use a different approach to reporting sex ratios at birth than the rest of the world. Data on sex ratios from studies conducted in India were therefore converted from the number of female births per 1000 males to the international standard of Sex Ratios at Birth (SRB), which equals the number of male births per 100 females, in the following way.

1000 divided by the value (number of girls per 1000 boys born) multiplied by 100. So, for example, 911 girls per 1000 boy births is $1000 \div 911 \times 100 =$ SRB 109.8.

All results were rounded to one decimal place for consistency. Results from one study on multinational sex ratios at birth (Chao et al., 2019), reported as the number of males per individual female birth, were multiplied by 100 to convert to the number of boy births per 100 girls.

5.3.4 Synthesis of results

Results were synthesised narratively (Mays et al., 2005; Popay et al. 2003, 2006; Whitehead et al., 2014).

5.3.5 Measurement of survival outcomes

Putting aside the impacts of social discrimination, females have a biological survival advantage at every stage of life after birth (Shkolnikov and Wilmoth, 2015). More males die naturally during infancy, childhood, and adulthood. A higher number of males are born, which acts as a natural balance over time across populations. The biologically normal SRB for a human population is around 105 males for every 100 female births, or ~51% male. There may be some degree of natural variation in sex ratios across different ethnic groups (and therefore countries/regions), and it can be difficult to establish an exact expected / biologically normal sex ratio for some populations.

5.3.6 Estimates of the number of 'missing women' in son-preference countries in the included studies

The concept of 'missing women' refers to the females who would otherwise be alive but for profound sex discrimination. This is a *shortfall* in the actual number of women in a specified population compared with an expected norm derived from a reference population without such profound discrimination against girls and women, i.e. how many girls and women would have to be added to the existing population to eliminate this shortfall? (Bongaarts and Guilmoto, 2015a).

To derive the number of 'missing women', the studies in this review use the population sex ratio (PSR), i.e. the total number of males for every 100 females in the population as a whole (all ages). The observed (actual) PSR in a country is compared with an 'expected' PSR that would prevail if both sexes were treated equally in their access to resources (e.g. nutrition, healthcare, education) that influence survival. "If the actual ratio exceeds the expected, the additional females that would have to be alive in order to equate the actual with the expected PSRs, would then be the number of 'missing women' at this point in time" (Klasen and Wink, 2003).

Choosing a comparable reference population to calculate the 'expected' PSR is crucial and must consider factors influencing the population sex ratio in addition to the profound sex discrimination under study. These factors include the age structure of the population (determined mostly by fertility patterns) and the overall mortality level (and biological differences in survival by sex over the lifecourse, resulting in female survival advantage in infancy and older age groups, as men suffer higher mortality rates than females at various ages). The PSR is also influenced by the natural sex ratio at birth (as described below), which exhibits a slight male excess in all populations, including non-discriminating societies.

The studies in this review took variations in population age structure and mortality level into account by applying modelling and model life tables to a reference group of countries with a wide range of mortality levels but presumedly without profound gender discrimination. The resulting expected age-specific sex ratios by age, country, and year can then be applied in comparing observed versus expected PSRs in countries with gender discrimination.

5.3.7 Estimates of the number of 'missing newborn girls' in son-preference countries *in the included studies*

Estimates are derived from comparing observed and expected sex ratios at birth. The 'expected' ratio is based on the level that was observed in all countries pre-1980 and in countries without profound discrimination since then, i.e. in the range between 105 and 107, commonly taken as 105.9 in non-African countries. A slight adjustment is made for a lower natural SRB in sub-Saharan Africa.

5.3.8 Data sources

The best source of data on sex ratios at birth comes from robust vital statistics birth registration data, when available. These data are annual and disaggregated by regions, which permits trend and geographical analysis. Census data are often used in the absence of vital statics, but censuses are conducted and reported far less frequently (typically every 10 years), and the data may also be slightly affected by differences in infant and child mortality and by misreporting of child age (Guilmoto, 2012a).

5.4. Results

5.4.1 Included studies

From an initial 1,846 unique records, 34 demographic studies on the relative survival impacts of discrimination against girls and women, compared with boys and men, at national level in son-preference countries were included (Figure 6). A list of included studies is available in Appendix 5.

Figure 6. PRISMA flow chart illustrating the progression of studies through the systematic review of evidence on relative survival outcomes for girls and women in son-preference countries, compared with boys and men
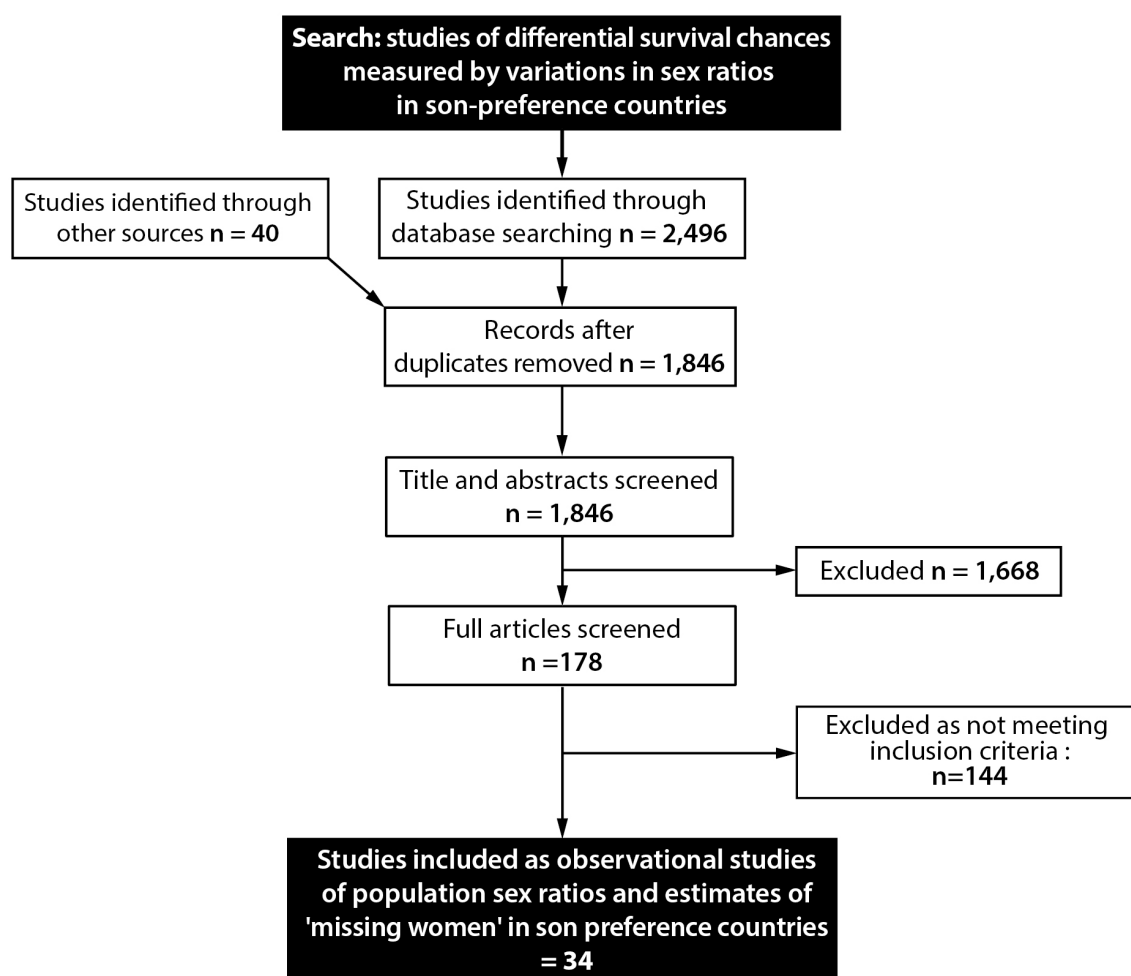
5.4.2 Evidence of lower-than-expected female survival

Sex ratios at birth may be influenced by sex-selective abortions, infanticide, and under-reporting of newborn girls.

Eighteen studies found evidence of elevated levels of male births in records of ratios of male-to-female births (SRBs) at national levels in 14 countries in East and Southeast Asia (China, Taiwan, South Korean Singapore, Vietnam), South Asia (India, Pakistan, Nepal), West Asia (Azerbaijan, Armenia, Georgia), and Southeast Europe (Albania, Montenegro, Kosovo). Elevated SRBs were up to 126, against a naturally occurring SRB of 105.9 (Table 6).

Table 6. National level evidence on trends in male-to-female Sex Ratios at Birth (SRBs) in son-preference countries, 1982 - 2017.

Study Country, Author/s, year (number of included studies)	Data sources	Results	
		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
EAST AND SOUTHEAST ASIA			
China *(n=9)*		1982-2017	*Highest = 121.2 (2010)*
Zeng et al., 1993	1982-87: Fertility and Contraception Survey; 1989: 10 Percent Sample 1990 Census	1982 1983 1984 1985 1986 1987 1989	107.2 107.7 108.3 111.2 112.1 110.8 113.8
Huang et al., 2016	National Maternal Near Miss Surveillance System	2012 2013 2014 2015	111.0 110.2 108.8 109.5
Jiang et al., 2017	Censuses; sample Censuses; survey data	1981 1986 1989 1993 2000 2005 2010	107.8 113.1 113.9 114.1 119.9 120.5 121.2
Jiang et al., 2012	Censuses	2000 2010	119.9 121.2
Bongaarts, 2013	United Nations (2011) World Population Prospects: The 2010 Revision ("author's calculations")	2011	119

Study Country, Author/s, year (number of included studies)	Data sources	Results	
		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
Guilmoto, 2012a	Annual estimate	2011	117.8
Rahm, 2020, p23	National statistics UNFPA (United Nations Population Fund)	2014-15	114.7
Tufuro & Guilmoto, 2020	2015 Inter-Census, National Statistical Office	2015	113.5
Chao et al., 2019	Various sources (including Census, vital registration, population surveys), identified in Chao et al., 2019	1981 1990 2000 2004 2010 2017	107.3 111.9 117.1 117.9 117.4 114.3
Taiwan *(n=1)*		1982-2017	*Highest = 110.0 (2004)*
Chao et al., 2019	Vital Registration (Demographic Fact Book)	1982 1990 2000 2004 2010 2017	106.9 109.8 109.3 110.0 108.6 107.6
South Korea *(n=8)*		1980-2017	*Highest = 116.5 (1990)*
Chun & Das Gupta, 2009	Vital statistics: Korea Statistical Information System (KOSIS), Korea National Statistical Office	1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004	105.3 107.2 106.8 107.4 108.3 109.5 111.7 108.8 113.3 111.7 116.5 112.1 113.6 115.3 115.2 113.2 111.6 108.2 110.1 109.6 110.2 109.0 110.0 110.7 108.2

Study Country, Author/s, year (number of included studies)	Data sources	Results	
		Year/s	**Sex Ratio at Birth (number of males born per 100 females born)**
		2005	107.7
Guilmoto, 2012a	Birth registration	2010	106.7
Yoo et al., 2017	National Survey on Fertility, Family Health & Welfare (NFFHS)	1990 2013	116.5 105.3
Jiang et al., 2017	Vital statistics	1990	116.5
Den Boer & Hudson, 2017	Korea Statistical Information Service	1981 1985 1990 2000 2007 2014	107.1 109.4 116.5 110.2 106.2 105.3
Rahm, 2020, p23	National statistics UNFPA	2015-16	105.1
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	1982 1990 2000 2010 2017	107.2 115.1 109.9 106.5 105.6
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2017	106.2
Singapore *(n=2)*		1990-2017	*Highest = 107.6 (2000)*
Guilmoto, 2012a	Birth registration	2009	107.5
Chao et al., 2019	Vital registration (United Nations Demographic Yearbook)	1990 2000 2010 2017	107.2 107.6 106.8 106.5
Vietnam *(n=6)*		1989-2017	*Highest = 112.6 (2012)*
Guilmoto et al., 2009	Annual population survey	1989 1999 2000 2001 2002 2003 2004 2005 2006	107 105.5 109 107 104 108 106 108 111.6
Guilmoto, 2012b	Censuses; National Family Health Surveys (NFHS); annual population surveys (including state-level analysis)	2005 2009 2010	110.0 110.6 111.2
Guilmoto, 2012a	Annual demographic survey	2010	111.2
Rahm, 2020, p23	National statistics UNFPA	2013-14	112.2
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	1990 2000 2001	106.5 107.6 107.6

Study Country, Author/s, year (number of included studies)	Data sources	Results	
		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
		2010	112.4
		2012	112.6
		2017	112.2
Tufuro & Guilmoto, 2020	Annual Population Survey	2016-17	112.1
SOUTH ASIA			
India *(n=7)*		1975-2017	*Highest = 113.1 (1994-96)*
Bhat & Zavier, 2007	Census	2001	110.4
Guilmoto, 2012a	Sample registration	2008-10	110.5
Bongaarts, 2013	United Nations (2011) World Population Prospects: The 2010 Revision ("author's calculations")	2010	108
Condorelli, 2015	Sample registration system	1982-1984	109.8
		1984-1986	109.5
		1986-1988	109.6
		1988-1990	109.8
		1990-1992	111.1
		1992-1994	113.0
		1994-1996	113.1
		1996-1998	110.9
		1998-2000	111.1
		2000-2002	112.1
		2005-2007	109.4
		2006-2008	110.6
		2007-2009	110.4
		2008-2010	110.5
		2009-2011	110.4
		2010-2012	110.1
Rahm, 2020, p23	National statistics UNFPA	2013-14	110.0
Tufuro & Guilmoto, 2020	Sample registration system, National Statistical Office	2014-16	111.3
Chao et al., 2019	Demographic and Health Survey (DHS) – Full Birth Histories	1975	106.1
		1990	109.6
		1995	111.3
		2000	111.3
		2010	109.8
		2017	109.8
Pakistan *(n=1)*		2007	*Highest = 109.9 (2007)*
Guilmoto, 2012a	Population and demographic survey	2007	109.9
Nepal *(n=1)*		2012-2016	*Highest = 110.6 (2012-16)*

Study Country, Author/s, year (number of included studies)	Data sources	Results	
		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
Tufuro & Guilmoto, 2020	DHS sample	2012-16	110.6
WEST ASIA			
Azerbaijan *(n=6)*		1990-2017	*Highest = 119 (2001-06)*
Duthe et al., 2012	Censuses; dsouemographic surveys	1999 2001-06 2011	112 119 117
Michael et al., 2013	DHSs; vital statistics	2005-09	116
Guilmoto, 2012a	Birth registration	2011	116.5
Rahm, 2020, p23	National statistics UNFPA	2014-15	114.6
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	1990 1991 2000 2003 2010 2017	106.6 106.8 115.5 117.1 116.6 113.4
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2017	113.5
Armenia *(n=6)*		2000-2017	*Highest = 126 (2000-05)*
Duthe et al., 2012	Census Demographic surveys	2001 2000-05	116 126
Michael et al., 2013	DHSs; vital statistics	2005-09	117
Guilmoto, 2012a	Birth registration	2010	114.9
Rahm, 2020, p23	National statistics UNFPA	2014-15	113.3
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	1990 1992 2000 2010 2017	106.6 105.9 117.6 116.6 111.7
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2017	109.8
Georgia *(n=6)*		1990-2017	*Highest = 122 (2000-05)*
Duthe et al., 2012	Census Demographic surveys	2002 2000-05	110 122
Michael et al., 2013	DHSs; vital statistics	2005-09	121
Guilmoto, 2012a	Birth registration (provisional)	2009-11	113.6
Rahm, 2020, p23	National statistics UNFPA	2010-16	108.0
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	1990 1992 2000	106.2 106.3 111.4

Study Country, Author/s, year (number of included studies)	Data sources	Results	
		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
		2003	111.5
		2010	108.1
		2017	106.5
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2017	107.9
SOUTHEAST EUROPE			
Albania *(n=4)*		2008-2017	*Highest = 111.7 (2008-10)*
Guilmoto, 2012a	Birth registration (provisional)	2008-10	111.7
Rahm, 2020, p23	National statistics UNFPA	2012-13	109.0
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	2017	108.3
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2017	110.6
Montenegro *(n=4)*		1980-2017	*Highest = 109-9 (1997 & 2012-14)*
Guilmoto, 2012a	Birth registration	2009-11	109.8
Rahm, 2020, p23	National statistics UNFPA	2012-14	109.9
Chao et al., 2019	Vital Registration (United Nations Demographic Yearbook)	1980 1990 1997 2000 2010 2017	105.6 109.0 109.9 109.8 109.0 107.2
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2015-17	107.4
Kosovo *(n=2)*		2014-2017	*Highest = 111.2 (2017)*
Rahm, 2020, p23	National statistics UNFPA	2014-16	110.9
Tufuro & Guilmoto, 2020	Birth registration, National Statistical Office	2017	111.2

Notes: *n=* in column 1 shows the number of included studies with data for that country. The range of years with available data is shown in column 3. SRB results in columns 3 and 4 are rounded to one decimal place where possible. "Highest" in column 4 refers to the highest observed/recorded SRB, for the most recent year/s recorded.

5.4.3 Trends in SRBs over time

SRBs varied within countries over time. Most studies, including all in China and India, show distortions in SRBs favouring boys that increased rapidly between the 1980s and 2000s after the introduction of prenatal diagnostic technologies, including ultrasonography, which are used for sex identification of foetus prior to sex-selective abortion. Although estimates differed across

data sources, looking across the studies, levels appeared to have peaked in South Korea in the mid-to-late 1990s, in India in the late 1990s, in China in the late 2000s, and in Vietnam in the mid-2010s (Table 6). Male-to-female SRBs remained elevated in all son-preference countries in the most recent data (typically 2017). Figures 7-9 show SRB trend data from studies conducted in China (Figure 7), India (Figure 8), and South Korea (Figure 9).

For China, the evidence consistently shows large increases in SRBs between the early-to-mid 1980s until a peak around 2010, followed by reductions to the mid-to-late 2010s. The levels rose from a level above the biologically normal range in comparable non-son preference countries and remained well above 'normal' at the end of the period (Figure 7). Three studies provide estimates from the start of the 1980s (1981-82) of SRBs between 107.2 and 107.8 (Zeng et al., 1993; Jiang et al., 2017; Chao et al., 2019). By the end of the 80s (1989-90) the same studies estimated that SRBs had increased sharply to between 111.9 and 113.9). By 2000, three studies (Jiang et al., 2012A, 2017; Chao et al., 2019) estimated that SRBs had continued to rise sharply to between 117.1 and 119.9. By 2010-11 SRBs appear to have peaked to between 117.4 and 121.2, based on data from five studies (Guilmoto, 2012; Bongaarts, 2013; Jiang et al., 2012A, 2017; Chao et al., 2019). By 2015, three studies estimated a decline in SRBs to between 109.5 and 114.7 (Huang et al., 2016; Tufuro & Guilmoto, 2020; Rahm, 2020). The latest data from a single study of China estimated the SRB as 114.3 in 2017 (Table 6).

Figure 7. Findings of included studies giving estimates of male-to-female Sex Ratios at Birth over time in China, compared with biologically normal (reference) range.
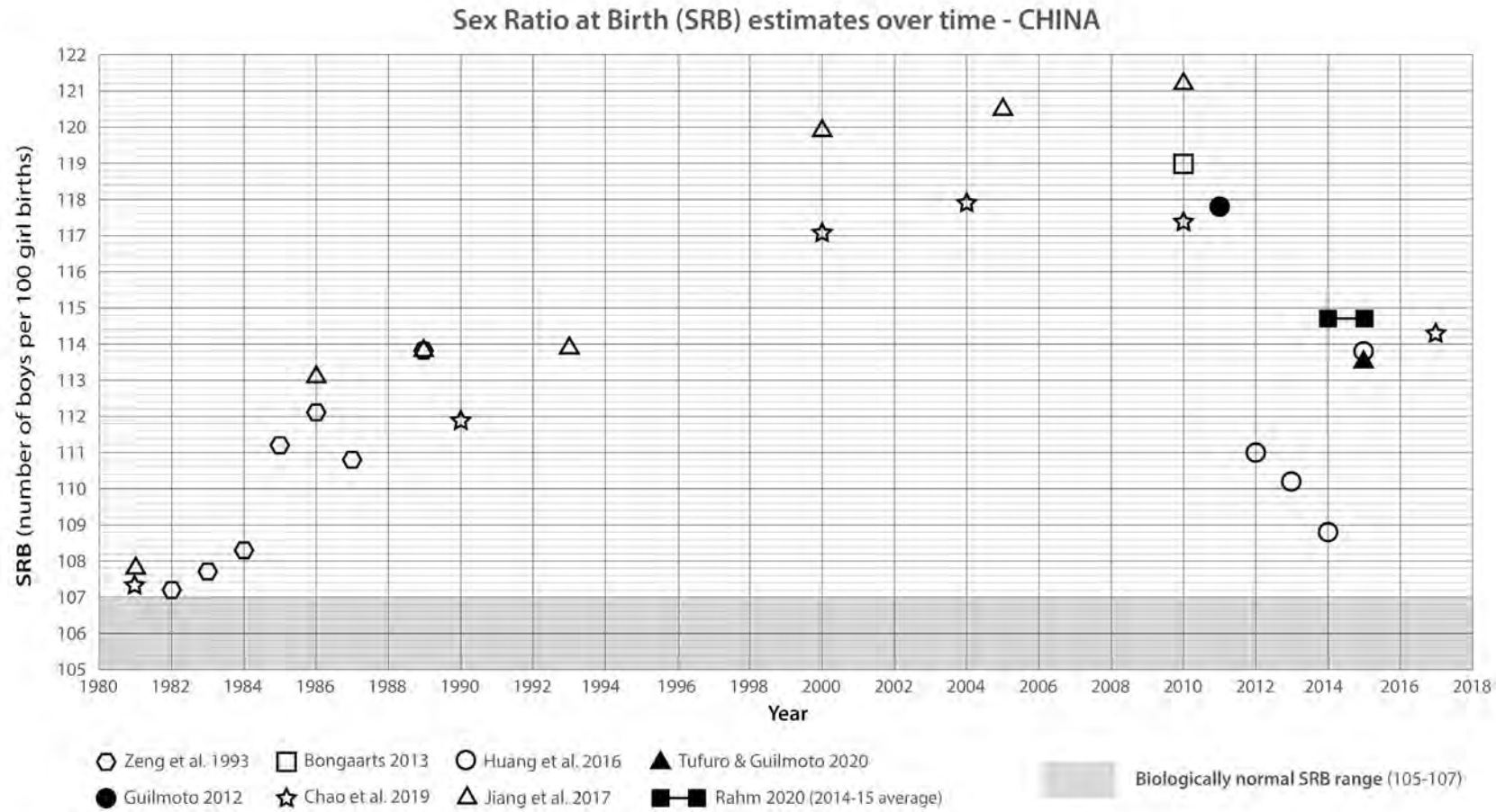
For India, the earliest data from 1975 (not shown in figure, but in Table 6) estimated an SRB of 106.1 (Chao et al., 2019). By 1990 two studies estimated an SRB of between 109.6 and 109.8 (Condorelli, 2015; Chao et al., 2019). By 2000-01 this had risen to a peak between 110.4 and 111.3, based on data

from 2 studies (Bhat & Zavier, 2007; Chao et al., 2019). More recent estimates vary between studies, but the rates appear to level off at ratios still very much above the biologically normal range during the 2000s and up to 2017 (Figure 8).

Figure 8. Findings of included studies giving estimates of male-to-female Sex Ratios at Birth over time in India, compared with biologically normal (reference) range.
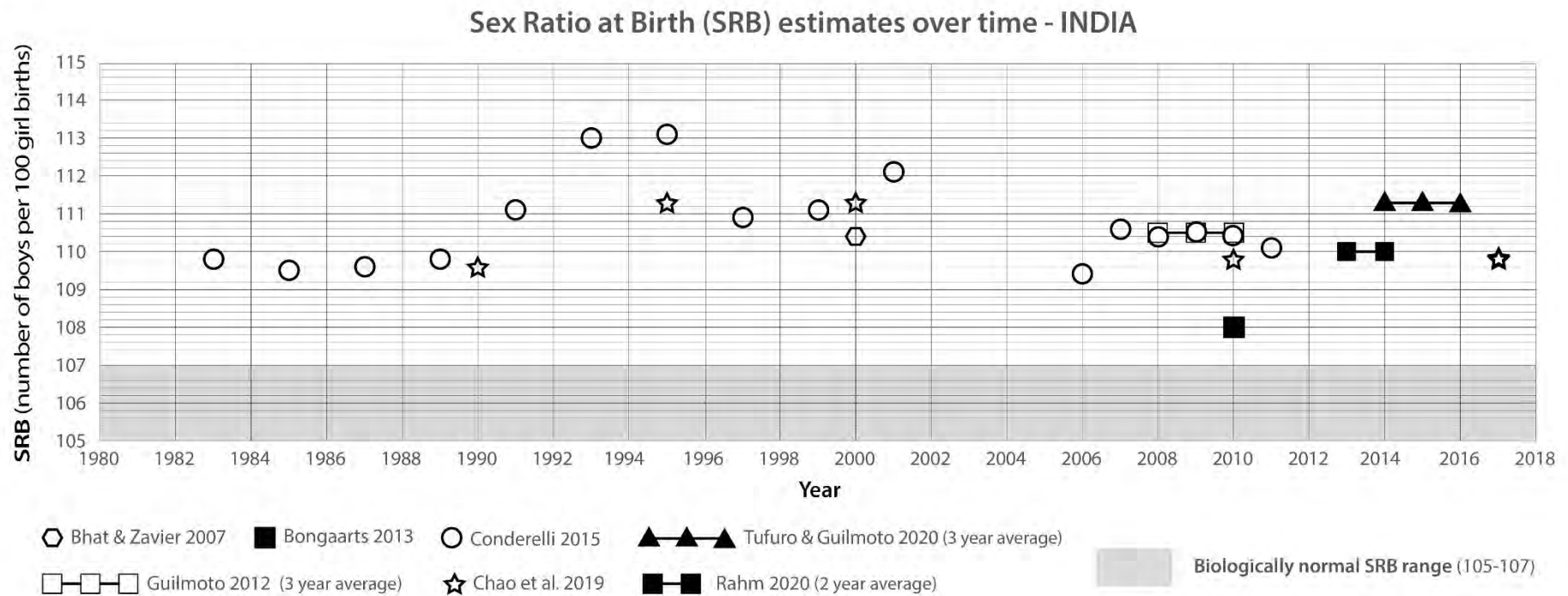
The ratios in South Korea are a notable exception. SRBs rose rapidly from the early 1980s to a peak in 1990 (SRB 116.5) before declining to, and remaining, around a biologically normal range (~106) since 2007 (Figure 9).

Figure 9. Findings of included studies giving estimates of male-to-female Sex Ratios at Birth over time in South Korea, compared with biologically normal (reference) range.

Sex Ratio at Birth (SRB) estimates over time - SOUTH KOREA
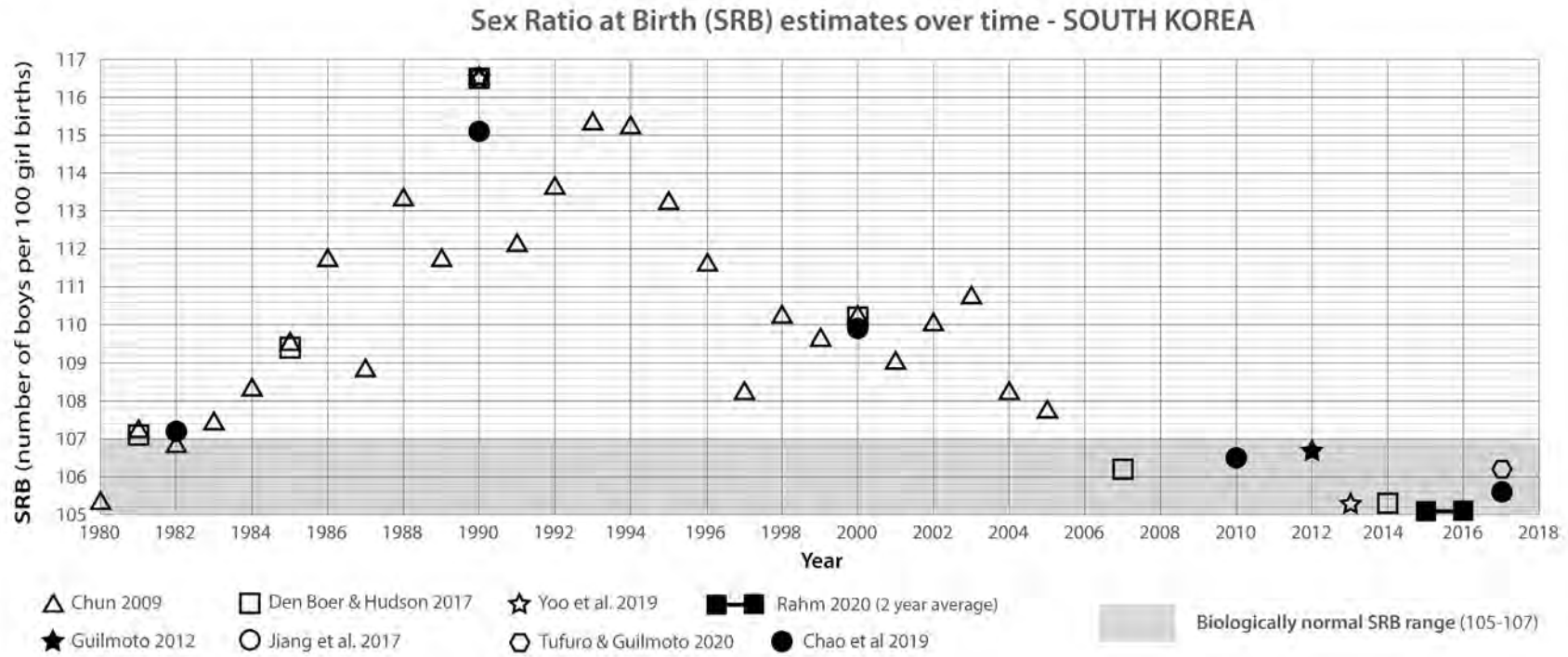
According to Chun and Das Gupta (2009) annual (fluctuations in) data on SRBs for some years in South Korean may be influenced by their use of the Chinese lunar calendar, as some years are considered particularly inauspicious for the birth of girls, and parents may therefore record births in the following year to avoid stigma.

5.4.4 Estimates of 'missing girls' at birth in son preference countries

Extrapolating from the skewed SRBs, four studies reported estimates of the number of 'missing girls' in and across son preference countries (Bongaarts, 2013; Grech, 2015; Bongaarts and Guilmoto, 2015b; Choa et al., 2019). They provide either single year estimates, or cumulative estimates of the total of 'missing girls' over time.

Single year estimates of 'missing girls' at birth

Bongaart's (2013) found that 12.7 and 1.9 percent of girls were 'missing' at birth in the single year of 2010 in China and India, respectively. It was estimated that approximately 1.43 million girls were 'missing' at birth globally in 2010 alone. According to Bongaarts and Guilmoto (2015a), virtually no girls were 'missing' at the end of the 1970s, but more than one million were 'missing' per year after 1990, and over 1.6 million were 'missing' at birth across son preference countries each year by 2010.

Cumulative estimates over time of population effects of 'missing newborn girls'

Annual numbers of 'missing newborn girls' accumulate over time. Based on data from 1985 to 2005, Grech (2015) estimated that a total of 48,734,993 girls were 'missing' at birth in low- and middle-income countries. The most recent global cumulative estimate of 'missing newborn girls' was based on data from vital registration systems, censuses, and surveys from 202 countries (Chao et al., 2019). They identified 11 countries (China, India, Albania, Montenegro, Tunisia, Armenia, Azerbaijan, Georgia, Vietnam, South Korea, Taiwan) with strong evidence of skewed SRBs resulting in an estimated cumulative total of 45 million 'missing newborn girls' globally between 1970 and 2017 (95% confidence interval (CI): 36.4-54.8 million). Most were 'missing' from China (23.1 million, 95% CI: 16.5-30.7 million) and India (20.7 million, 95% CI: 15.5-26.6 million).

5.4.5 Multinational and global estimates of total numbers of 'missing women'

Estimates of 'missing women' include prenatal shortfall in newborn girls plus postnatal shortfall in girls and women throughout the lifecourse. Discrimination against girls and women in son-preference countries reduces their survival chances at all stages of life, prenatally and from birth, through childhood, adolescence, and into adulthood and older ages. This relative survival disadvantage, compared with males, accumulates over time in populations and leads to the whole-population phenomenon of 'missing women'.

Ten included studies estimated the number of 'missing women' (within and across son-preference countries) (Sen, 1986, 1989; Coale, 1991; Klasen, 1994; Klasen and Wink, 2002, Klasen and Wink, 2003; Guilmoto, 2012a; OECD, 2014; Kahlert, 2014; Bongaarts and Guilmoto, 2015b). Sen's (1989) 'crude estimate' of over 100 million 'missing women' in son-preference countries was followed by studies that used more sophisticated demographic models (Table 7) (Coale, 1991; Klasen and Wink, 2003).

Table 7. Studies estimating the numbers and percentages of 'missing women' in son-preference countries and globally (in millions and percentages of total female population[i]), 1989-2015

	Sen 1989[ii]		Coale 1991		Klasen 1994		Klasen & Wink 2003		Guilmoto 2012a		Kahlert 2014[iv]		Bongaarts & Guilmoto 2015	
	Millions	%[iii]	Millions	%	Millions	%	Millions	%	Millions	%	Millions	%	Millions	%
China	50.0	9.1	29.1	5.3	40.1	7.3	40.9	6.7	66.2	10.3	35.1	5.4	62.3	9.5
India	41.6	10.2	22.8	5.6	35.9	8.8	39.1	7.9	43.3	7.3	32.4	5.5	43.3	7.4
Pakistan	5.2	13.1	3.1	7.8	4.1	10.2	4.9	7.8	2.9	3.4	4.8	5.6	4.4	5.2
Bangladesh	3.8	8.9	1.6	3.8	4.1	9.8	2.7	4.2	2.0	2.8	0.8	1.0	2.4	3.2
Nepal	0.6	7.5	0.2	2.4	0.5	7.1	0.1	0.5	0.1	-	-0.9	-6.3	-	-
Indonesia	-	-	-	-	-	-	-	-	-	-	-	-	1.7	1.5
West Asia[v]	4.7	8.5	1.7	3.0	3.0	5.5	3.8	4.2	-	-	9.7	8.4	-	-
Egypt	1.7	7.2	0.6	2.6	1.2	5.1	1.3	4.5	-	-	1.4	3.9	-	-
Nigeria	-	-	-	-	-	-	-	-	-	-	-	-	1.9	2.5
Sub-Saharan Africa	-	-	-	-	-	-	5.5	1.8	-	-	15.6	3.6	-	-
'Rest of world'	-	-	-	-	-	-	-	-	-	-	-	-	9.6	0.5
Total in 'comparable' son-preference countries[vi]	107.5	9.6	59.1	-	89.0	7.9	92.8	6.8	-	-	83.3	5.3	-	-
Global total in son-preference countries[vii]	-	-	-	-	-	-	101.3	5.7	116.7	7.7	99.6	4.7	125.6	3.7

Notes:

i. Figures are rounded. Subtotals include some countries not listed (for brevity and clarity). Estimates by Sen (1986), Klasen and Wink (2002), Organisation for Economic Co-operation and Development (OECD) (2014) are omitted to allow for easier comparison and to prevent duplication. Papers used latest United Nations Population Division and/or national level Census data, for example, Coale's 1991 estimates were based on Census data from between 1981 and 1991, depending on country.

ii. Figures as reported in Klasen 1994 paper.

iii. Percentage of the total population of women in specified territory.

`**iv.** Data time-points, sources, and data time-gaps (a minimum of 10 years for each country/region) between Klasen & Wink (2003) and Kahlert (2014) are shown in Appendix 6.

v. Turkey and Syria are included in West Asia.

vi. A set of 'comparable' countries (including China, India, Pakistan, Bangladesh, Nepal, West Asia, and Egypt) were used in studies by Sen, Coale, Klasen/Klasen & Wink, and Kahlert to allow for comparisons between studies and over time.

vii. In addition to the 'comparable' son-preference countries (note vi), some later studies also included a larger set of newly recognised son-preference countries in their analyses, adding: Taiwan, South Korea, Iran, Algeria, Tunisia, and Afghanistan, to estimate the 'global total' of 'missing women'.

Multinational estimates of 'missing women' across whole populations (all ages combined) ranged from 59 to 108 million across son-preference countries in 1989-94 (Sen, 1989; Coale, 1991; Klasen and Wink 2003), and from 100 to 126 million globally in 2010 (Kahlert, 2014; Bongaarts and Guilmoto, 2015b). Bongaarts and Guilmoto (2015a) found, based on time-series estimates, that the world total of 'missing women' rose steadily from 61 million in 1970 to 125.6 million in 2010. The rate of increase in 'missing women' between 1970 and 2010 was faster than global population growth, with 3.3 and 3.7 percent of women 'missing' in 1970 and 2010, respectively (Table 7) (Bongaarts and Guilmoto, 2015b). They projected that the numbers would rise to 136.2 million in 2015, peak at 149.9 million in 2035, before levelling off and gradually reducing to 142 million in 2050 (Table 8).

Table 8. Estimates of the total number and percent of 'missing women' across son-preference countries over time (1970 to 2010) and predictions to 2050

	Number 'missing' (millions)					Predicted (millions)		
	1970	1980	1990	2000	2010	2015	2035	2050
Total 'missing' across son-preference countries	61.0	72.2	87.6	105.9	125.6	136.2	149.9	142.0

Source: Bongaarts and Guilmoto, 2015b

5.4.6 Misreporting the number of girls born

Another factor that may contribute to male-to-female population figures is potential concealment of girl births from officials leading to 'hidden girls'. Self-reported birth data (including Census, survey, and vital registration data) may be deliberately misreported. As with any data, it may also be subject to some errors in reporting or recording. Large-scale underreporting of girl births may be a factor in China, where some authors attribute a proportion of 'missing newborn girls' to under-reporting by parents attempting to conceal girl births from officials to avoid heavy penalties under the (former) One-Child-policy (Johansson and Nygren, 1991; Zeng et al., 1993). The potential extent of underreporting in China is contested in included studies that investigated differential underreporting (Zeng et al., 1993; Cai and Lavely, 2003; Banister, 2004; Cai, 2017; Goodkind, 2011; Shi and Kennedy, 2016, 2017). Girls that are 'hidden' from officialdom during the early years of life may have limited or no access to key resources for health and wellbeing including healthcare, vaccinations, and education.

Shi and Kennedy (2016) argued that, in addition to explanations that include sex-selective abortion, '*the story of 'missing girls' is also an administrative one*' (p1018). They compared the SRBs for younger and older children in Census data from 1990, 2000, and 2010 and found evidence of dramatic increases in the number of reported females after the age of 10 (particularly after age 15). They originally estimated that 15 million of the girls 'missing' between 1990 and

2010 (of over 20 million) were not 'missing' but underreported (or 'hidden') by parents and local officials attempting to avoid penalties under the One-Child-Policy. Following criticisms by Cai (2017) who identified *'oversights in Shi and Kennedy's numeric analysis'* (p797), they revised the estimate to around 10 million 'hidden girls' (Shi and Kennedy, 2017).

5.5. Discussion

5.5.1 Summary of findings

There is consistent empirical evidence to support the direct son-preference pathway through prenatal sex selection leading to a shortfall in newborn girls. Eighteen studies showed male-skewed SRBs in 14 son-preference countries in East and Southeast Asia, South Asia, West Asia, and Southeast Europe, with elevated SRBs up to 126, against a naturally occurring SRB of 105.9. Male-to-female SRBs rose in son-preference countries from the 1980s onwards (consistent with the spread of the technology) and appear to have peaked in most of these countries during the 1990s and 2000s, before gradually reducing somewhat, but still remaining at high levels in the 2010s. The rapid rise in SRBs in Vietnam during the 2010s is a notable exception. In contrast, male-to-female SRBs in South Korea declined rapidly to reference (biologically normal) levels after 2000. From the SRB data, four studies estimated numbers of 'missing newborn girls' in son-preference countries. One estimate found that approximately 1.7 million newborn girls were missing across son-preference countries annually by 2010. The most recent estimate of the cumulative total over the years 1970 to 2017, identified 11 countries with strong evidence of skewed SRBs resulting in an estimated cumulative total of 45 million missing newborn girls across these countries.

There is also firm evidence for the operation of the postnatal pathway through corrosive gender discrimination affecting women from when they are born and right throughout their lives, leading to relative neglect and excess mortality across the lifecourse. Ten studies estimated the survival impacts of these two pathways combined, to produce figures for 'missing women' overall. Estimates of the number of 'missing women' across son-preference countries rose steadily from 61 million in 1970 to 126 million in 2010. The total number 'missing women' was predicted to continue increasing to a peak of 150 million in 2035. China accounted for 50 per cent (62.3 million) of the 'missing women' in the world, followed by India at 34 per cent (43.3 million).

5.5.2 Limitations of the reviewed studies

Besides known problems with data quality in low- and middle-income countries such as India and Pakistan (Hesketh and Xing, 2006; Bongaarts and Guilmoto, 2015b, Chao et al., 2019), demographic studies of SRBs were subject to difficulties in attributing differences in aggregate sex ratios to specific causes (sex-selective abortion, infanticide, or sex-selective under-reporting of girl births). The remarkably stable SRBs for most of human history until 1980 and the onset of increasing SRBs in son-preference countries coinciding with the advent of prenatal sex selection

technologies argue for a dominant role for sex-selective abortion rather than a sudden upturn in infanticide. There is debate about the possibility of under-reporting of girl births in China as a consequence of the One-Child policy, but studies of births reported by doctors in healthcare settings indicated skewed SRBs of similar magnitudes. There was no evidence that sex-selective underreporting of girl births was important in countries other than China (Bongaarts, 2013).

Calculation of skewed population sex ratios (PSRs) to estimate the number of 'missing women' rely on the selection of an appropriate comparison population without profound gender discrimination and son preference to derive an 'expected' population sex ratio. Potential bias can be introduced if a study failed to take account of three types of differences between populations that affect the level of PSR: the differing population age structure; the impact of the overall mortality level (and mortality differentials by sex); and the natural sex ratio at birth, which exhibits a slight male excess in all populations, including in societies without profound discrimination. All the studies in this review took account of these biases in the estimation of numbers of 'missing women' to varying levels of refinement and produced estimates that indicate the huge scale of the problem.

5.5.3 Limitations of this systematic review

The review only included English language studies. It is possible that some non-English language studies were missed by the searches. We are confident that this restriction would have had only a minimal effect on our ability to pick up relevant studies in relation to 'missing women' for two main reasons. First, we excluded sub-national studies from the review, which are sometimes published in the language of the study country, and only included national and multi-country studies, which are almost invariably published in English in the health field. Second, even though there is a burgeoning literature from China, it is common for Chinese academics to be incentivised to publish in English language peer-reviewed journals, reinforcing the convention of publishing national studies in English.

We used appropriate quality assurance tools in our systematic reviewing whenever available, but, unfortunately, no international standard has been developed for 'scoring' the types of demographic evidence in this review for risk of bias. Demographic studies present a layer of complexity for such scoring even beyond the tricky issues raised by more common types of observational study. Although the ROBINS-E tool (Risk of Bias in Non-randomised Studies of Exposures) was developed for use with observational studies of exposures, it built upon tools for risk of bias assessment in randomised trials, diagnostic test accuracy studies, and observational studies of *interventions*. It has been shown to be inappropriate for the task of evaluating

observational studies of exposures for questions of *harm relevant to public and environmental health* (Bero et al., 2018). In the absence of a suitable tool for 'scoring' demographic evidence, the approach we used for quality-assuring the evidence entailed selecting those studies employing good quality national data sources (vital statistics, Census, high quality population surveys) and removing single-centre studies and those using non-representative population samples.

5.5.4 Implications for research and policy

Several plausible mechanisms for the lower female survival in son-preference countries are postulated in the literature, which require further investigation. These include the growing effectiveness, affordability, and use of new technologies for prenatal sex selection and sex-selective abortion (Devaney et al., 2011; Karabinus et al., 2014), neglect of girls in relation to health care and nutrition, underreported or otherwise 'hidden girls', and the impact of mandatory population control/birth reduction policies.

The studies in this review consistently show large increases in male-to-female SRBs following the introduction and diffusion of prenatal diagnostic technologies in son-preference countries in the 1980s and 1990s. New pre-conception (e.g. sperm-sorting), pre-implantation (e.g. in vitro pre-implantation genetic diagnosis), fetal sex identification (including tests of foetal DNA in mother's blood) and abortion technologies (including inexpensive pharmaceutical drugs to induce abortion) may pose additional threats to female survival in son-preference countries as they become increasingly affordable and accessible. The impacts of emerging technologies for sex selection on relative female survival are currently unknown and need to be carefully studied.

The broad searches we conducted before this review identified a very large body of literature on the general health and wellbeing impacts of discrimination and neglect in the distribution of health care and nutrition to girls and women. This body of evidence requires review and synthesis.

Government population control policies introduced in China since 1980 are thought to be major contributors to the toll of 'missing women' in the country. In particular, the One-Child policy, rigorously enforced from 1980 to 2015, has led to far-reaching consequences, some unintended and unforeseen. These include being implicated in the rise of sex-selective abortions and abandonment of girl babies, the development of a thriving trade in commercial adoption services offering girl babies to overseas adoptive parents, and a shortage of women available for marriage (Bhattacharjya et al., 2008; Hesketh and Xing, 2006; Hesketh et al., 2011). On the other side of

the same coin are the large cohorts of 'surplus' young men in India as well as China now reaching adulthood who lack available women to marry and therefore may face marginalisation in society with long-term social consequences. Chakravarty and colleagues (2022) list some of those consequences as increased migration, bride trafficking, and bride-abduction. There are some indications that the introduction of the Two-Child policy in China from 2015 might soften the effect of the earlier One-Child policy, but it is too early to judge (Jiang and Zhang, 2021; Fan et al., 2020; Tang et al., 2022). Further evidence is needed on the impacts of such mandatory population control policies, including studies over time on SRBs by birth order and on the relative health and survival impacts on girls compared with boys over time.

Other countries, including India, have introduced policies to tackle son preference, including laws banning the use of prenatal sex selection technologies (Kumar and Sinha, 2019), but to date these have proved ineffective or relatively easy to bypass. For example, physicians might hint at the sex of the fetus to parents by using certain descriptors, without actually calling it male or female. Regulatory measures that aim to address the rise in prenatal sex selection need to be evaluated for their effectiveness in tackling the problem, including any unintended side-effects. More promising, according to Kumar and Sinha's policy analysis, are policies that indirectly raise the value of daughters, and there are good examples of such policies, including initiatives in Bangladesh. There is a paucity of causal studies in this field though and these policies need to be subjected to rigorous evaluation (Kumar and Sinha, 2019).

There are also lessons to be learnt from the favourable trends in South Korea. How did the country manage to reverse the trend and bring down the SRBs to normal levels?

5.5.5 The paradox of opposing forces affecting female survival?

Above all, the findings of this systematic review serve to highlight the tension that has built up between two opposing forces that appear to have been at work in maintaining the high numbers of 'missing women' in the world today. On the one hand, there has been a near universal improvement in female mortality in low- and middle-income countries over recent decades, influenced by improvements in the social determinants of health: reduction in poverty and improvements in nutrition and access to effective healthcare, aided by progress in access to schooling for girls and greater employment/economic empowerment of women. This has improved the survival chances of women throughout the lifecourse. On the other hand, this progress in female mortality rates has been counterbalanced by the widespread adoption of technological innovations, such as ultrasound scans in pregnancy, which have led to the rise of a new phenomenon in son-preference societies - the human manipulation of sex ratios at birth by

prenatal sex selection and sex-selective abortions. This adverse trend affecting the sex ratio at birth is not picked up by tools such as the Gender Inequality Index, which continues to show favourable changes in social norms towards women in many son-preference countries (UNDP, 2015). Paradoxically, the influence of the ancient tradition of son preference has become stronger, not weaker, over recent decades as a result of the new technological tools we have at our disposal. These opposing forces need to be considered together to make sense of the population trends and to devise the best possible ways of preventing the tragedy of 'missing women'.

5.6.   Conclusions

There is consistent evidence of a survival disadvantage for girls and women in son-preference countries. There are over 126 million girls and women 'missing' from the world today. The survival disadvantage of girls increased significantly after the introduction of sex-selection technologies, which greatly compounded existing structural inequalities. Despite some improvements over time, male-skewed population sex ratios in many countries are still of concern. Time-series data and projections suggest the problem is getting worse in absolute terms as population levels increase in son-preference countries, which include the most populous nations of the world. New sex-selection technologies and economic downturns pose additional threats. This review highlights, above all, that the phenomenon of 'missing women' is still one of the great inequalities of our time. Profound gender discrimination in son-preference countries has severe and large-scale adverse impacts on the survival of girls and women at every stage of life.

Chapter 6 – Findings of study 3: Migration of gender discrimination? A systematic review of evidence on sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia

6.1 Abstract

Background

Half the women on the planet live in countries that exhibit a strong preference for sons. Girls and women in these countries suffer profound gender discrimination, resulting in poorer survival at birth and poorer life chances throughout childhood and adulthood. One of the starkest indicators of the health damage caused by this discrimination is skewed sex ratios at birth, favouring males, which has, since the advent and proliferation of sex selection technologies such as ultrasound in the mid-1980s, been attributed to practices including widespread sex-selective abortion of female fetuses. The question arises whether this discriminatory pattern is severed when people migrate from son preference countries to ones without overt son preference and with biologically natural sex ratios. We conducted a systematic review to answer the question: in countries in Europe, North America, and Australasia without overt son preference, how do sex ratios at birth for the babies of immigrants from son preference countries compare with ratios for babies of parents born in the recipient country?

Methods

Six electronic databases were searched for articles published between 1980 and 2021 on son preference, and sex-selection. Backward and forward citations searches, and advanced Google and Google Scholar searches were also conducted. After sifting titles and abstracts, eligible full-text articles from studies of population sex ratios at birth were double-reviewed to extract data about 'missing women' estimates. Study identification and data interrogation was informed by a logic model. Results were narratively synthesised.

Results

From 2,078 unique records, 11 studies on sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia were included in the review. Nine of the 11 included studies found some evidence of significantly higher than expected levels of male births (in the UK, Greece, Spain, Canada, the US, and Australia) to mothers born in some son preference countries, compared with ratios for babies of mothers born in destination countries. There was evidence across these nine studies of male-to-female elevated ratios, either for all births or at later birth orders, for babies of Chinese, Indian, South Korean, South East Asian (as a region), and Albanian immigrants, though the results for population groups varied by setting. Two studies in the UK found conflicting results for babies of mothers who were born in India, but at different time points. Two studies in Italy and New Zealand found no evidence of elevated sex ratios at birth among babies of immigrant populations.

Discussion

This review found some evidence that the practice of sex-selective abortion persists among certain immigrant population groups after arrival in destination countries in Europe, North America, and Australasia. Further higher methodological research is required, including more studies, in general, in some countries, on further immigrant groups, utilising more recent data, over time, and potentially, if data permits, across generations after arrival. Research on the impacts of new technologies for sex identification and selection is urgently required.

6.2 Background

Half the women on the planet live in countries that exhibit a strong preference for sons. Countries in Asia and North Africa are particularly affected, including the most populous countries of China and India which alone represented approximately 36 percent of the world's population in 2022 (UNFPA, 2023) Women in these countries suffer profound gender discrimination, resulting in poorer survival at birth than their counterparts in societies without overt son preference and poorer life chances throughout childhood and adulthood (Sen, 1990; Klasen and Wink, 2003; Bongaarts and Guilmoto, 2015).

One of the starkest indicators of the health damage caused by this discrimination is skewed sex ratios at birth, favouring males. The ratio of boys to girls at birth in countries without son preference is in a narrow range around 105 to 107 male births to every 100 female births, but in son preference countries the sex ratio can go above 107 and up to 126 male births to every 100 female births (Pennington et al., 2023). These skewed population sex ratios indicate poorer survival chances for girls and have been attributed to such practices as infanticide, underreporting/under-registration of girl babies, birth stopping and, with advances in technology, sex-selective abortion.

The question arises of whether this discriminatory pattern is severed when people migrate from son preference countries to ones with different cultural contexts, without overt son preference and with biologically natural sex ratios, such as are found in many countries in Europe, North America, or Australasia. We conducted a systematic review to answer the question: in countries in Europe, North America, and Australasia without overt son preference, how do sex ratios at birth for the babies of immigrants from son preference countries compare with ratios for babies of parents born in the recipient country? This is the first systematic review of evidence on the persistence of sex-selection practices among immigrants from son-preference countries living in countries in Europe, North America, or Australasia.

6.3 Methods

Studies included in this review were identified as part of the broader systematic review of evidence on the survival impacts of profound gender discrimination in doctoral Study 2, Chapter 5 (and Pennington et al., 2023). Approaches to study identification, data extraction, and methodological quality appraisal were carefully, iteratively developed over time across the related reviews, as described below.

6.3.1 Search strategy

Six electronic databases (OVID Medline, OVID Medline In-Process and Other Non-Indexed Citations, American Psychological Association (APA) PsycINFO, Web of Science Social Science Citation Index, Web of Science Conference Proceedings Citation Index - Social Sciences and Humanities, and CINAHL Plus [via EbscoHOST]) were searched for articles published in English between 1st January 1980 and 31st December 2021 on son preference, and sex-selection.

Systematic review approaches followed the Centre for Reviews and Dissemination's guide to undertaking systematic reviews, and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (CRD, 2009; Moher et al., 2009; Page et al., 2021). Appropriate search terms were identified through relevant sample papers in results from three preceding, related reviews of theory (Whitehead et al., 2016) and empirical evidence (Orton et al., 2016; Pennington et al., 2018b). Pilots of the database searches identified that a single-tier search ('a broad net') with highly relevant (specific) terms provided the best balance of sensitivity and specificity. Search syntaxes were then tailored and ran on specific appropriate, identified databases (an example of the MEDLINE search strategy is in Appendix 7).

The results of the searches were deduplicated in Endnote X9 reference manager before being exported into EPPI Reviewer 4 systematic review management software. Forward and backward citation searches were conducted (former through citation scanning/'snowballing', latter through Web of Science forward citation searches). We also ran advanced (Boolean and date-limited) Google searches to identify any publications that may have been missed (but no further papers were identified).

6.3.2 Study Identification

Study inclusion and exclusion criteria

Study inclusion and exclusion criteria focused on sex ratios at birth among immigrants from son preference countries to countries in Europe, North America, and Australasia (Table 9).

Table 9. Inclusion/exclusion criteria for review of sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia

	Included	**Excluded**
Population & setting	Births among immigrant populations originating from son-preference countries living in countries in Europe, North America, and Australasia.	Studies of sex ratios by race/ethnicity not involving immigrants.
Studies and data of interest	Quantitative empirical demographic studies of observed sex ratios at birth.	Non-empirical studies (including evidence reviews). Interventional studies. Qualitative studies. Opinion/discussion pieces not providing empirical data.
Outcomes	Measures of sex ratios at birth or odds ratios or relative risks of male-vis-à-vis female births for all births or birth orders (Sex Ratio at Birth [SRB], Odds Ratio [OR], Relative Risk [RR]).	Child sex ratios, adult sex ratios, whole population sex ratios.
Comparison	Sex ratio at birth (or related OR, RR) for destination countries (all population or all non-migrant population, for all births or birth orders)	-
Publication types	Peer reviewed papers in academic databases	-
Time coverage	Published 1st January 1980 to 31st December 2021.	-
Language	English-language studies.	-

Observational demographic studies reporting empirical data from quantitative investigations of sex ratios in countries in Europe, North America, and Australasia among migrants from low- and middle-income countries with a culture of strong gender discrimination and son preference were included. Studies that measured sex ratios at birth or related ORs or RRs were included. Publications that were not peer reviewed (e.g., conference extracts, pre-print publications) were excluded for methodological quality assurance. Studies that did not use appropriate comparison/reference populations in analyses (i.e., either the destination country average SRB or non-migrant population SRB, and/or related ORs, RRs, for relevant birth orders or all births),

and studies with non-representative population samples were also excluded for quality assurance purposes.

Screening for inclusion/exclusion

Studies were selected for inclusion through two stages (title and abstract screening and full-text screening). Titles and abstracts of all records retrieved from the searches were independently screened by two reviewers to identify potentially eligible studies based on the inclusion/exclusion criteria (Table 9). All potentially eligible papers were retrieved in full text. Two reviewers then independently screened the full text of the articles in EPPI-reviewer 4 (Thomas et al., 2010). Reasons for exclusion were recorded (Appendix 8). Any queries or disagreements in the screening process were resolved by discussion or recourse to a third reviewer. A list of included studies can be found in Appendix 9.

6.3.3 Data extraction and synthesis

Reviewers extracted data from studies into a pre-designed and piloted data extraction tables. Extractions were checked for accuracy and completeness by a second reviewer. Extracted data included: study aims, study design, setting/country, and main findings related to the review question. Any queries were resolved by involvement of a third reviewer. Results were synthesised narratively (Mays et al., 2005; Popay et al., 2006; Whitehead et al., 2014).

6.3.4 Measurement of sex ratio at birth outcomes

Estimates of elevated sex ratios at birth (SRB) and comparisons with destination country SRBs

For most of human history, before the advent and proliferation of sex determination and sex-selection technologies in the mid-1980s (e.g. ultrasound), sex ratios in virtually all countries, including son preference and non-son-preference countries, were fairly stable at a biologically natural range of between 105 and 107 males for every 100 female newborns (median 105.9) (Hesketh and Xing, 2006). Slightly more boys than girls are born, which appears to be nature's way of compensating for women being hardier than men and surviving better at all ages if they are given similar care and attention. There are a few known natural ethnic exceptions, but not in the countries of interest in this study (Zarulli et al., 2018). Between the late 1980s and 2000s, sex ratios at birth in many son preference countries became rapidly male-skewed as new sex-selection technologies and the practice of sex-selective abortion for social (discriminatory) reasons became widespread. It was estimated, for example, that sex ratios at birth peaked in

India at 113.1 between 1994 and 1996, and China peaked at 121.1 in 2010 (Pennington et al., 2023). Studies in this review used data on Sex Ratio at Birth (SRB), i.e. the number of males for every 100 female live births, or related male-to-female odds ratios and relative risks. Estimates of elevated (or skewed) male-to-female (henceforth 'elevated') sex ratios are derived from comparing observed and 'expected' male-female sex ratios at birth. The included studies made comparisons between sex ratios of babies of migrant populations from various countries or groupings of countries (latter to compensate for small sample sizes in some migrant populations in some countries) with national (biologically natural) 'expected' sex ratios and/or non-migrant babies' sex ratios for the destination country.

Sources of sex ratio data

The best source of data on sex ratios at birth comes from robust vital statistics birth registration data. These data are annual and disaggregated by regions, which permit trend and geographical analysis. Census data are often used in the absence of vital statistics, but censuses are conducted and reported far less frequently (typically every 10 years) (Guilmoto, 2012a).

6.4 Results

6.4.1 Included studies

From an initial 2,078 unique records, 11 studies (listed in Appendix 9) on sex ratios for babies of migrants who were born in son preference countries living in Europe, North America, and Australasia were included in the review. Figure 10 shows the progression of studies through the review process.

Figure 10. PRISMA flow chart illustrating the progression of studies through the systematic review of sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia
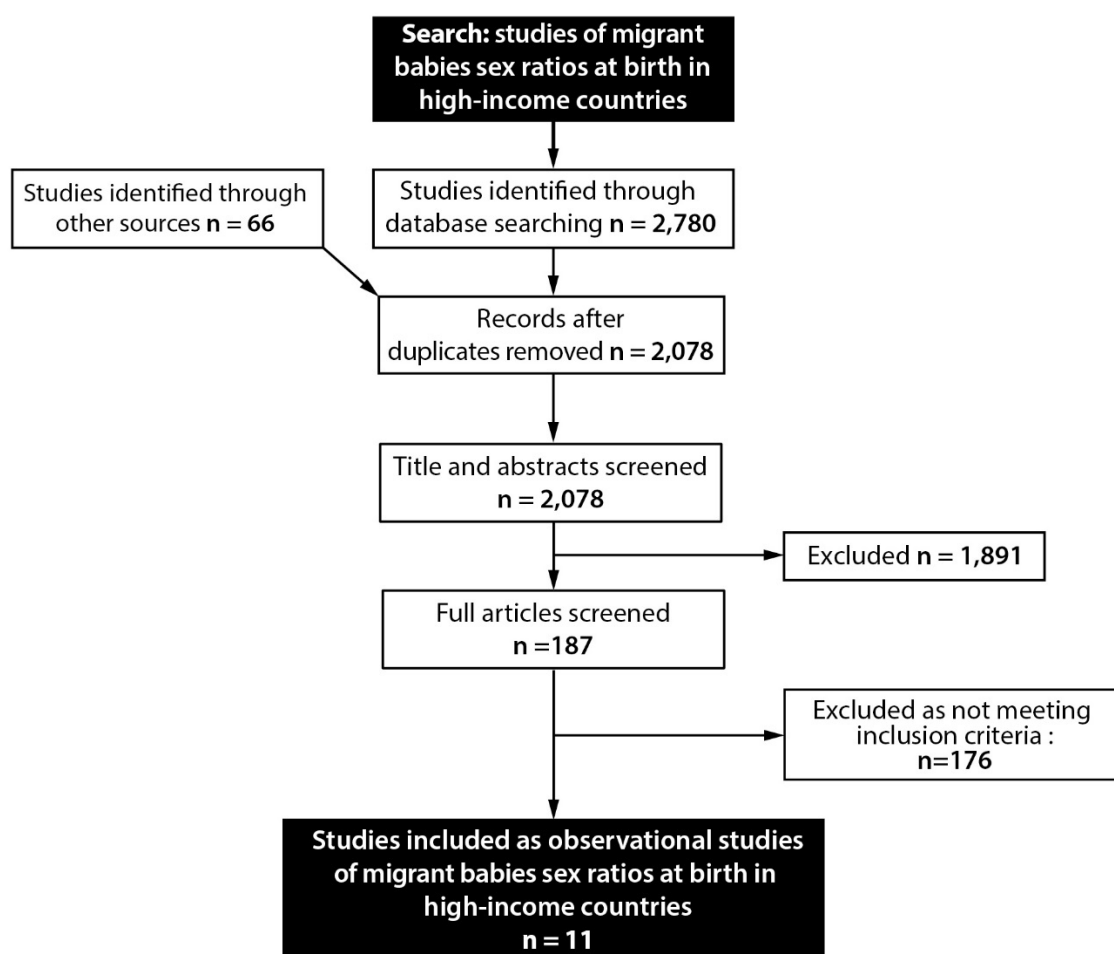
6.4.2 Evidence of lower-than-expected survival of newborn females

Of the 11 included studies, 9 studies found some evidence of significantly higher than expected levels of elevated births in records of male-to-female births for children of mothers born in son preference countries in Asia.

The studies provide evidence of elevated SRBs for mothers born in son preference countries, living in eight countries in Europe, North America, and Australasia: in two studies in the UK (England and Wales) (Dubuc & Coleman, 2007; Smith & Fogarty, 2014), one in Greece (Verropoulo & Tsimbos, 2010), one in Spain (Castelló et al., 2019), two in Canada (Ray, 2012; Urquia et al., 2016); one in the US (Lhila & Simon, 2008), and two in Australia (Edvardsson et al., 2018; 2021). One study in Italy (Festini, 2003) and one in New Zealand (Simon-Kumar et al., 2021) found no evidence of elevated sex ratios at birth (Table 10).

Table 10. Studies examining sex-ratios of births among diasporas from son preference countries in Europe, North America, and Australasia

Study (author/s, year)	Country of residence (national, unless specified)	Data source, type[1], period	Comparison/reference population: Sex Ratio at Birth (SRB) of babies of mothers born in	Any evidence of elevated sex-ratios at birth (Yes, No)?	Evidence (of elevated male-to-female sex ratios) for babies of mothers born in (Birth Order [BO]; 95% confidence intervals [CI], unless stated)	
					Male-to-female SRB	**Male-to-female Odds Ratio (OR) at Birth**, unless specified
Dubuc & Coleman, 2007	UK. (England & Wales)	Birth statistics, 1969-2005	United Kingdom (SRB=105.6)	**Yes**	**India** All births = 107.9, 99% CI: 106.3-109.6 (1990-2005); 108.3, 99% CI: 106.3-110.3 (1995-2005) BO≥3 = 114.4, 99% CI: 107.9-121 (2000-2005) Bangladesh, Pakistan, others = not significant	-
Smith & Fogarty, 2014	UK. (England & Wales)	Birth statistics, 2007-2011	United Kingdom (SRB=105.4)	**Yes**	**India** All births = not significant **SE Asia** SRB 108.7 **Bangladesh, Pakistan, Middle East** All births = not significant	**India** All births = not significant **SE Asia** All births = OR 1.03, CI: 1.01-1.05 **Bangladesh, Pakistan, Middle East** All births = not significant
Festini et al., 2003	Italy (Tuscany)	Neonatal cystic fibrosis screening programme[2], 1992-2002	Non-Chinese mothers born in Tuscany	**No**	**China** All births = not significant	-
Verropoulou & Tsimbos, 2010	Greece	Birth statistics, 2006	Greece (SRB=105.4)	**Yes**	**Asia** All births = 129.0 **Albania** All births = 109.5	**Asian** All births = 1.250 CI: 1.100-1.398 **Albania** All births = 1.047, CI: 1.004-1.091 Bulgarian, Romanian, former USSR, 'all other foreign citizens' = not significant
Castelló et al., 2019	Spain	Birth statistics, singletons, 2007-2015	Spain (non-immigrant) (SRB=107 [106, 107])	**Yes**	**India** All births = 121, CI: 114-128	-

					BO2 = 129, CI: 117-142; BO≥3 = 213, 168-272 When all previous births were female: All subsequent births = 151, CI: 123-187 **China** All births = not significant BO≥3 = 118, CI: 112-125 **Rest of Asia; North Africa** All births = not significant	
Ray et al., 2012	Canada (Ontario)	Birth statistics, singletons, 2002-2007	Canada (SRB=105 [105-106])	**Yes**	**India** BO1 = not significant B02 = 111, CI: 107-115 BO3 = 136, CI: 127-146 BO≥4 = 125, CI: 109-143 **South Korea** BO1 = not significant BO2 = 120, CI: 109-134 BO3, BO4 = not significant **Pakistan, Rest of South Asia, China, Rest of East Asia, Other Countries** BO1, BO2, BO3, BO4 = not significant	-
Urquia et al., 2016	Canada (Ontario)	Birth statistics, singletons, 1993-2012	Canada (BO1 SRB=105 [104-105])	**Yes**	**India** BO1 = not significantly higher BO2 = not significant when grouped by sex of previous births BO3 = 196, CI: 175-221 (Canada BO3 = 104, CI: 101-106) if 2 previous births were girls (but other groups = not significant)	-

					China, Other South Asia, Other Asia, Rest of the World BO1 = not significant BO2, BO3, BO4 = not significant when grouped by sex of previous births	
Lhila & Simon, 2008	US	Birth statistics, singletons, 1989-2001	US (SRB=105)	**Yes**	**India** All births = 107 (p < 0.01) BO1 = not significant BO2 = 107 ((p < 0.05) BO3 = 117 (p < 0.01) BO4 = 114 (p < 0.01) BO5 = not significant BO≥6: 126 (p < 0.05) **China** All births = 109 (p < 0.01) BO1 = 108 (p < 0.01) BO2 = 108 (p < 0.01) BO3 = 113 (p < 0.01) BO4 = 119 (p < 0.01) BO5, ≥6 = not significant	-
Simon-Kumar et al., 2021	New Zealand	Birth statistics, 2003-2018	New Zealand (European origin / 'Pākeha') (SRB=105.5)	**No**	**China and India** BO3, when both previous births were female: = not significant	-
Edvardsson et al., 2018	Australia (State of Victoria)	Birth statistics, live or stillbirth singletons or multiples, 1999-2015	Australia (SRB=105.3 [104.8-105.7)	**Yes**	**China** (1999-2015) All births = 109.0, CI: 106.2-111.8 Singletons = 109.2, CI: 106.4-112.0 BO2 = 110.6, CI: 106.0-115.4 *2005-10* All births = 111.0, CI: 105.7-116.6 *2011-15* BO≥3 = 124.8, CI: 107.4-144.9 **India** (1999-2015) All births = 107.9, CI: 105.7-110.1 Singleton = 107.6, CI: 105.4–109.8 Multiple = 120.4, CI: 105.4-137.5	**Relative Risk** (RR) **China** (1999-2015) All births = RR 1.017, CI: 1.005-1.030 **India** (1999-2015) All births = 1.012, CI: 1.001-1.022

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					BO2 = 110.6, CI: 106.7, 114.5 ***2005-10*** All births = 109.8, CI: 105.8-113.9 BO1 = 111.3, CI: 106.3-116.5 ***2011-15*** BO2 = 112.4, CI: 107.5-117.6 BO≥3 = 121.8, CI:108.5-136.6 **Vietnam, Rest of SE Asia, and other regions** (1999-2015) All births = not significant	**Vietnam, Rest of SE Asia, and other regions** (1999-2015) All births = not significant
Edvardsson et al., 2021	Australia	Birth statistics, singletons or multiples, 1997-2016	Australia (105.6 [105.4, 105.9])	**Yes**	**China** All births = 108.4, CI: 107.1-109.7 BO3 = 117.5, CI: 112.0–123.1 **India** All births = not significant BO3 = 114.6, CI: 109.0- 120.4, respectively **North Africa & Middle East, Other North East Asia, Other Oceania, Other Central & Southern Asia, South East Asia, Sub Saharan Africa, other regions** All births and BO1, BO2, BO3, BO4 = not significant	-
[1] All studies used data for live births unless specified. [2] This programme covered 99.9% of newborns.						

In the **United Kingdom**, Dubuc and Coleman (2007) used birth registration data for England and Wales to compare SRBs for babies of mothers who were born outside versus inside the UK between 1969 and 2005. They reported a statistically significant increase in SRBs of babies of mothers born in India between 1990 and 2005, from 104.1 (99% confidence interval [CI]: 103.0-105.2) between 1969 and 1989 to 107.9 (99% CI: 106.3-109.6) between 1990 and 2005, averaging 108.3 between 1995 and 2005 (99% CI: 106.3-110.3). For higher birth orders (3rd and above), SRBs for Indian born mothers increased significantly from 104 in 1980-1989 (99% CI: 101-107) to 114.4 in 2000-2005 (99% CI: 107.9-121.4). They found no such evidence for babies of immigrant groups from other son preference countries or country groupings (Bangladesh; Pakistan; Far East; Southern Africa; East Africa; Rest of Africa). They were unable to assess SRBs of babies of mothers born in China because of data issues (Chinese-ethnicity mothers being in unknown numbers in two UK Office for National Statistics aggregations of territories – 'Far East' ['overseas Chinese'] and 'Rest of World' [China-born]). Using birth data from 2007 to 2011 on all births (i.e. no disaggregation by birth orders), Smith and Fogarty (2014) found no evidence that mothers born in India, Pakistan, Bangladesh, or the Middle East were more likely to give birth to boys than mothers born in the UK (male-to-female odds ratio [OR], 95% CI: 1.00, 0.98-1.02; 0.98, 0.7-1.00; 0.98, 0.96-1.00;1.02, 1.00-1.05, respectively). They did, however, find that mothers born in South-East Asia were likely to give birth to a disproportionately higher proportion of boys (SRB 108.7; OR 1.03, 95% CI: 1.01-1.05).

One study in Tuscany in **Italy** of SRBs of the babies of Chinese-born mothers found no evidence of significant imbalance in the sex-ratios (Festini, 2003).

One study in **Greece** found evidence of significantly elevated SRBs of babies of mothers who were Asian- (SRB 129.0; OR 1.250, 95% CI: 1.100-1.398) or Albanian-born (SRB 109.5; OR 1.047, CI: 1.004-1.091), but not for Bulgarian, Romanian, former 'USSR', or 'all other foreign citizenships' immigrants (Verropoulou and Tsimbos, 2010), compared with mothers born in Greece (SRB 105.4).

One study in **Spain** (Castelló et al., 2019) found elevated SRBs for all births to mothers born in India (SRB 121, 95% CI: 114-128). They also found specifically that when all previous births were female, *subsequent* births were significantly more likely to be male for all births to mothers born in India (SRB 151, CI: 123-187), and for birth orders 2 (SRB 129, CI 117-142) and ≥3 (SRB 213, CI: 168-272), and also for birth orders ≥3 for babies of mothers born in China (SRB 118, CI: 112-125).

Two studies in **Canada** found evidence of elevated sex-ratios at birth in Ontario. Ray et al. (2012) found this for the second-born of mothers born in India (111, 95% CI: 107-115) and South Korea (120, CI: 109-134), compared with SRBs of Canadian-born mothers. The male-to-female SRB was also significantly elevated for birth order 3 and ≥4 for mothers born in India (SRB 136, CI: 127-146; SRB 125, CI: 109-143, respectively) but not for other country groupings and countries (Europe, South, Korea, China, Philippines, rest of East Asia, Pakistan, rest of South Asia, and "other"). Urquia et al. (2016) used birth data, between April 1993 and March 2012, for women who had up to 3 consecutive singleton births (with at least one live birth between April 2002 and March 2012, to ensure

completeness of birth records). For women who immigrated from India and had previously given birth to 2 girls, they found that the male-to-female SRB for third births was elevated (SRB 196, 95% CI: 175-221), compared with Canadian women (SRB 104, CI: 101-106) for birth order 3. The odds of having a male baby were even higher for Indian-born women if the two previous girl births were followed by one or more induced abortions (SRB 3.26, CI: 2.53-4.21).

In the **United States**, based on birth registration data between 1989 and 2001, Lhila and Simon (2008) found significantly elevated SRBs among mothers born in India for all births, and at birth orders 2, 3, 4 and 6 and above (SRB all births: 107, order 2: 107, order 3: 117, order 4: 114, orders ≥6: 126), compared with births to non-immigrant mothers. They also found elevated SRBs among mothers born in China for all births (SRB: 109), and birth orders 1, 2, 3, and 4 (SRB 108, 108, 113, 119, respectively).

One study in **New Zealand** (Simon-Kumar et al., 2021) found no evidence of imbalanced SRBs for mothers who were born in India or China in birth registration data (between 2003 and 2018).

Two studies in **Australia** (Edvardsson et al., 2018, and 2021) found evidence of elevated SRBs in birth registration data (for 1999-2015 Victoria and 1997-2016, respectively) on children of mothers born in China and India. Compared with the SRB for babies of Australian-born mothers, Edvardsson et al. (2018) found that SRBs for mothers born China were significantly elevated for all births between 1999 and 2015 (SRB 109.0, 95% CI: 106.2-111.8), singleton births (SRB 109.2, CI: 106.4-112.0), at birth order 2 (SRB 110.6, CI: 106.0-115.4), all births between 2005 and 2010 (SRB 111.0, CI: 105.7-116.6), and at birth orders ≥3 (SRB 124.8, CI: 107.4-144.9). SRBs for babies of mothers born in India were between 1999 and 2015 were elevated for all births (SRB 107.9, 95% CI: 105.7-110.1), singleton births (SRB 107.6, CI: 105.4-109.8) multiple births (SRB 120.4 (105.4-137.5), at birth order 2 (SRB 110.6, CI: 106.7, 114.5), for all births between 2005 and 2010 (SRB: 109.8, CI: 105.8-113.9), at birth order 1 (SRB: 111.3, CI: 106.3-116.5), and between 2011 and 2015 at birth order 2 (SRB 112.4, CI: 107.5-117.6) and at birth orders ≥3 (SRB 121.8, CI:108.5-136.6). SRBs for babies of mothers born elsewhere in South-East Asia were also elevated for all birth and birth order 2 between 2005 and 2010 (SRB 112.3, CI: 106.5-118.3; 117.9, CI: 107.5-129.2, respectively). Sex ratios were not, however, significantly elevated for the country groupings of East Europe, or Sub-Saharan Africa, and other, non-son preference groupings. Edvardsson et al. (2021) found evidence of elevated SRBs for all births to mothers born in China (SRB 108.4, 95% CI: 107.1-109.7), and at birth order 3 (SRB 117.5, CI: 112.0-123.1), and for births to mothers born in India at birth order 3 (SRB 114.6, CI: 109.0-120.4), but not for all births, compared with the sex-ratio of births to Australian-born mothers.

6.5 Discussion

6.5.1 Summary of findings

Most studies in this systematic review found some evidence of male-to-female elevated sex ratios of newborn babies of some immigrant groups born in son preference countries. Looking across the studies, although there is some variation in results by birth order (and all births combined), studies in Canada, the US, Australia, Greece, and Spain all found some evidence of significantly elevated sex ratios in relation to immigrants who were born in India and China. There was also some evidence of elevations for migrant populations aggregated across regions including son preference countries (e.g., SE Asia), for babies of South Korean immigrants living in Canada, and for babies of mothers living in Greece who were born in Albania (one of several son preference countries in the Southern Caucasus. Pennington et al., 2023). Two studies in the UK found conflicting results for SRBs of babies of mothers born in India, with the earlier one showing significantly elevated sex ratios and the more recent one not, but at different time points. Neither study examined sex ratios for babies of mothers born in China because of peculiarities with data collection/aggregation in relation to Chinese immigrants in the UK. The New Zealand study found no evidence of elevated SRBs for babies of mothers born in China or India, and the study in the Tuscan region of Italy also found no significant evidence for all births to Chinese-born mothers.

6.5.2 Limitations of the reviewed studies

There are current limitations and gaps in the methodological quality, geographical, and population group coverage of the current primary study-level evidence base.

Evidence from four countries (US, New Zealand, Spain, Greece, and Italy) was limited to single studies, and the findings in two studies in the UK were contradictory. No firm conclusions can be drawn from single studies in countries, or the two contradictory studies in the UK.

Small sample sizes for relatively small migrant populations in some countries present a substantial methodological challenge for research on the sex ratios of the babies of migrant populations in some countries, particularly for higher order births. This is an important limitation that should be explicitly considered in all future such studies. It may prevent valid analysis of higher birth order sex ratios, or potentially all birth sex ratios, for relatively small migrant population groups in some countries. Researchers have attempted to overcome this through two forms of data aggregation – pooling data over time, or across larger population groups. However, aggregating data over many years may miss important changes over time, and aggregating data

to much larger migrant population groups covering multiple, different countries (e.g., all Asia) may miss important national-level variations between immigrant groups and lead to underestimation of effects. Studies that only examine data for all births/birth orders combined may also miss significant elevations in specific (typically later) birth orders, or elevations in sex ratios following previous births of only girls; both of which have been shown to be issues in son preference countries. Studies should, therefore, routinely examine data on sex ratios by birth orders, and according to sex compositions of previous births, where possible.

6.5.3 Limitations of this systematic review

The review only included English language studies. It is possible that some non-English language studies were missed by the searches. We are confident that this restriction would have had only a minimal effect on our ability to pick up relevant studies. Most papers from countries in Europe, North America, and Australasia are published in English language journals. Papers in other languages typically publish titles and abstracts also in English to reach a wider audience. Our title and abstract screening, and forward and backward citation searches, identified no additional foreign language papers that met the full inclusion criteria.

There is no international standard for 'scoring' the types of demographic evidence in this review for risk of bias, and general methodological and reporting quality. These studies include a level of complexity that goes the beyond the issues of scoring more common forms of observational studies. Although the ROBINS-E tool (<u>R</u>isk <u>o</u>f <u>B</u>ias in <u>N</u>on-randomised <u>St</u>udies of <u>E</u>xposures) was developed for use with observational studies of exposures, it was based on tools for risk of bias assessment in randomised trials, diagnostic test accuracy studies, and observational studies of *interventions*. It has been shown to be inappropriate for appraising observational studies of exposures for questions of harm relevant to public and environmental health (Bero et al., 2018). The pragmatic approach we used for quality-assuring the evidence, in the absence of an appropriate tool, involved only including studies from publications that had undergone academic peer review, and only including studies with representative samples and an appropriate comparison/reference population (the sex ratio at birth of the relevant destination country).

6.5.4 Implications for research and policy

Further research is needed to replicate the single studies in New Zealand and Italy that found no evidence of elevated SRBs among immigrant groups from selected son-preference countries. If confirmed (and extended to studies of other major immigrant groups in these countries) further

investigations are needed on the context, policies and processes that may have contributed to weakening the link to past son preference.

The mixed results in the UK in relation to Indian immigrants also need further clarification. Smith and Fogarty (2014) suggest the contradiction in findings for migrants to the UK from India at different times points (using data between 1990 and 2005, and 2007 and 2011, respectively) may be the result of changes in the nature of migrants leaving India in more recent times. Future research should investigate the possibility of a period effect. Their evidence on elevated SRBs for the children of mothers born in Southeast and Western Asia may reflect the known rises in SRBs in other son preference countries such as Vietnam during the later period (Chao et al., 2019). Future studies should include migrant populations from son-preference countries with more recent evidence of elevations in sex ratios including Vietnam, Nepal, Azerbaijan, Armenia, Georgia, Albania, Montenegro, Kosovo (Pennington et al., 2023). Small sample sizes may present methodological challenges in some settings. Robust methodological quality studies on the persistence of sex-selection practices across generations are also needed, as we were unable to include any such studies on methodological quality grounds. Studies utilising more recent sex ratio at birth data are also required to ascertain whether sex-selection practices have persisted among South Korean immigrants despite ratios returning to natural levels in South Korea around 2007.

The findings of this review raise the important policy question of how elevated sex ratios at birth persist among some immigrants to these non-son-preference countries in Europe, North America, and Australasia. There is a growing body of evidence that sex selective abortion, following ultrasound sex determination, has played an increasing role in generating elevated SRBs in the countries of origin of some of the immigrant groups (Pennington et al., 2023). It has been claimed that some mothers travel to India for abortions when their request is refused in the UK (McDougall, 2006, In Dubuc and Coleman, 2007). Pertinent research questions arising from this review include: Are abortion laws being broken by health professionals in the recipient countries? Is there evidence that expectant parents travel overseas for sex-selective abortions? Or are other birth control mechanisms, such as birth stopping, coming into play? To what extent do more recent pre-conception (e.g. sperm-sorting), pre-implantation (e.g. in vitro pre-implantation genetic diagnosis), home fetal sex testing kits (relatively inexpensive finger prick blood tests at around 8 weeks), and home abortion technologies (including inexpensive pharmaceutical drugs to induce abortion) now play a role? Unfettered access to affordable home fetal sex testing kits and home abortion pills may present the greatest and most immediate new threat to the survival chances of large numbers of unborn girls, by potentially bypassing all regulation of sex identification and sex-selective abortion. There is a pressing need for research on the impacts of

these new technologies as they are rapidly becoming more affordable and widespread. Results will feed into debates in each recipient country about the policy responses to tackling the migration of gender discrimination at the level of basic survival of girl babies.

6.6. Conclusions

This review found evidence that the practice of sex-selective abortion persists among certain immigrant population groups after arrival in destination countries in Europe, North America, and Australasia. Further research is required, including in some countries, on more immigrant groups, utilising more recent data, over time, and potentially, if data permits, across generations after arrival. Research on the impacts of new technologies for sex identification and selection is urgently required.

Chapter 7 – Findings of study 4: The impacts of empowerment interventions for women

'The rationale for studying discrimination and health, like that for studying any societal determinant of health, is …to generate knowledge useful for guiding policies and actions to prevent and rectify harm and advance health equity.' (Krieger, 2014)

This study was published as:

7.1. Abstract

Background

Microfinance initiatives represent the largest experiment in the empowerment of millions of disadvantaged women in the world. They are popular interventions for promoting economic development and tackling entrenched social norms in low- and middle-income countries. They are seen as having the potential to improve material and social determinants of health, and health and wellbeing outcomes, for women and their children. We conducted a systematic review of global evidence on the beneficial and adverse health-related impacts of such schemes, the role of empowerment in the pathways to health, and the distribution of impacts by sex, ethnicity, and/or socioeconomic status of members.

Methods

We searched seven electronic bibliographic databases for articles published between January 1980 and February 2016, and conducted supplementary searches (citation searches, contact with key informants and experts) to identify relevant publications. After sifting titles and abstracts, eligible full-text articles from studies evaluating group-based microfinance schemes were double-reviewed, data extracted, and critically appraised. Results were synthesised narratively.

Results

31 reports, covering 23 studies, met the inclusion criteria. All were set in low- or middle-income countries, mainly in Asia. This included one cluster-randomized control trial and 22 quasi-experimental studies. Results of higher quality studies indicated an association between microfinance scheme participation and benefits to the health of women and their children. This included improvements to maternal and infant mortality, better sexual health, and reductions in levels of violence against women over time. Some studies measured changes to women's levels of control/empowerment (e.g., involvement in household decision-making). Membership of large and well-established schemes generally increased empowerment, but this did not always translate into improved health outcomes. Qualitative evidence indicated that empowerment may have contributed to increased use of contraceptives, reduced levels of stress, and reduced risk of violence against women from intimate partners.

Discussion

Membership of the larger, well-established group-based microfinance schemes was associated with some beneficial impacts on health outcomes. Future studies need to be better designed to

cope with the complexity of such interventions and bias, and to routinely assess potential adverse as well as beneficial social, health, and wellbeing impacts, and wider impacts on communities.

7.2. Introduction

Doctoral Study 4 was a systematic review of interventional evidence that focussed on evaluations of empowerment-based microfinance schemes for two important reasons. First, relative levels of control and empowerment are posited as key resources that are systematically distributed differently between men and women in son preference (and other) societies. This was identified as a key element in the critical review of theories (and the logic model) that underpins this research. Women's empowerment interventions target the first intervention entry point in Figure 1. Upstream interventions at this point may, arguably, have the greatest impact as they have the potential to affect the entirety of the pathways and mechanisms between upstream causes of discrimination and the downstream health and survival outcomes. Levels of control were posited as a key resource for health and wellbeing that may explain the health inequalities between women and men in son preference countries, and the persistence of these inequalities despite potential changes in intervening mechanisms over time (Link and Phelan 1995). It was therefore essential to investigate interventions that attempted to measure and understand the role of control and empowerment in the posited pathways. Second, the schemes appear to be the largest experiment in empowerment of disadvantaged women in the world to date, covering millions of women in multiple countries with cultures of profound gender discrimination. The large scale and nature of the schemes (empowerment based), their focus primarily on disadvantaged women in societies with profound gender discrimination, and the size of the body of empirical evidence made them an ideal target for review and synthesis.

Collective empowerment-based microfinance schemes are popular interventions for promoting rural economic development and tackling entrenched social norms, particularly in low- and middle-income countries. They are seen as having the potential to improve material and social conditions for women and their children through improvements to household welfare and by raising women's bargaining power within their families and communities (Sengupta and Aubuchon, 2008; Ngo and Whahhaj, 2012). In 2006, Muhammed Yunus and the Grameen Bank microfinance scheme were jointly awarded the Nobel Peace Prize for contributions to alleviating poverty and empowering poor women in Bangladesh.

The schemes attempt to harness the power of collective mutual support. Group members, the vast majority of whom are women (97% in the case of Grammen Bank by 2022 [Grameen Foundation, 2022]), pool their savings and use them to make small loans to each other so they can set up and run small businesses. Members are offered literacy classes, and social, legal, and empowerment training, together with technical and marketing support for their small businesses. The aim of many of the schemes is to increase the employment opportunities and economic

power of women, and to tackle profound and pervasive discriminatory attitudes towards women in their families and communities. Microfinance initiatives are seen as a 'ground-up' approach to improving social and economic conditions for women and their children.

Roughly 5 million poor rural women in Bangladesh were involved in microcredit programmes in 2016, most of them with the Grameen Bank or BRAC (originally known as the Bangladesh Rural Advancement Committee) microfinance schemes, which are the largest such initiatives in the world. Money saved by a group is used to make small loans to members to support income-generation activities such as cottage industries or raising poultry. The elements of training and support (empowerment training, marketing support etc) and loans are sometimes combined with extensive 'bolt-on' health promotion interventions for women and their children, targeting public health issues that include prevention of violence against women, family planning, malaria, HIV, childhood vaccinations and nutrition interventions. These interventions may extend the benefits of microfinance beyond the immediate targets of women and their children to their wider communities (Leatherman et al., 2008; Dworkin and Blankenship, 2009; Caldas et al., 2012).

The schemes aim to reduce women's financial dependence on men, to raise their relative bargaining power and strengthen their positions within families, and to increase their movement outside the home by drawing them into the public sphere and exposing them to education and new ideas. The initiatives are based on theory that the multifaceted scheme may influence health in different ways by, for example, increasing demand for family planning services, leading to fewer, healthier children and better maternal health. They may also lead to improvements in the care and nutrition of children and thereby contribute to reducing childhood morbidity and mortality, including higher rates in girls relative to boys. Improving child health benefits both children and their parents, directly and indirectly, including by reducing out-of-pocket healthcare expenses that are common strains on family resources in low- and middle-income countries.

Microfinance schemes explicitly try to harness the collective power of mutual support to promote the development of women's self-esteem and social networks. They attempt to alleviate poverty and, importantly to the context of this thesis, promote social emancipation and empowerment of women within their communities (de Haan et al., 2010; Whitehead et al., 2016). Some of the schemes facilitate school attendance for girls and attempt to change attitudes to the paid employment of women outside their homes, which, in addition to potential benefits from empowerment, educational and employment gains, can increase their mobility and social connectedness with their communities which are also known to be associated with health, particularly in the context of societies with cultures of profound and oppressive gender discrimination (Chapter 4, and Pennington et al., 2018b).

Collective empowerment-based microfinance schemes may lead to improved health outcomes for women through both the upper and lower pathways of Figure 1, by raising the social status of women, and by increasing their bargaining power/control over key determinants for health and wellbeing (such as mobility/movement outside the home, and access to nutrition and healthcare) in their living environments. Advocates of microfinance have emphasised potential benefits to health outcomes such as reducing gender-based violence, improving reproductive and child health, and combating infectious disease, for poor rural women and their children (Schuler and Hashemi, 1994; Schuler et al., 1997).

Interventional research should always consider the potential for well-intended interventions to have unintended adverse impacts on some participants or wider members of society, as well as the effectiveness of interventions in achieving intended (and potentially unintended) beneficial impacts. Unintended adverse impacts of similar interventions have been observed in other contexts. A systematic review in 2018 found evidence that 15 of 29 evaluations of community empowerment interventions in high-income countries had some unintended adverse health or wellbeing impacts on some participants. The adverse impacts appeared to be associated with poorly designed and implemented interventions that failed to meet the particular needs of certain participants (Pennington et al., 2018a). A systematic review of evidence on the impact of microfinance interventions in sub-Saharan Africa (with 15 studies that met their inclusion criteria) found evidence of both beneficial and adverse impacts (Van Rooyen et al., 2012). Some have argued that the enthusiasm for microfinance has outstripped evidence of its effectiveness (Adams and Raymond, 2008). Schemes that were set-up with the intention of reducing poverty and empowering the most vulnerable in society can suffer from so called 'mission drift' and end up preferencing more credit-worthy members of communities while excluding the ultra-poor (Mersland and Strom, 2009; Nawaz, 2010; Serrano-Cinca and Gutierrez-Nieto, 2014). The imposition of a business model on poor female members of microfinance schemes may also lead to increased debt, repayment stress, and exploitation (Bateman, 2012; Taylor, 2012). This may cause the exacerbation of health and wellbeing inequalities when the intention was to reduce them.

Questions remain as to the potential impacts of collective empowerment-based microfinance schemes on health and wellbeing/inequalities. We therefore conducted a systematic review of evidence on group-based microfinance schemes based on collective empowerment that covered all health outcomes, in all countries, and assessed the evidence on both positive and negative impacts on health and wellbeing. We addressed three questions:

i. What impact do group-based microfinance schemes based on collective empowerment have on health and wellbeing?

i. What role does empowerment play in the pathways from microfinance to health and wellbeing outcomes?

ii. Do the health and wellbeing impacts of the schemes differ based on sex, ethnicity, and/or socioeconomic status of the members?

7.3. Methods

We systematically reviewed interventional studies/evaluations of collective empowerment-based microfinance in any country, using published systematic review methods (CRD, 2009), and assessed the quality of each relevant study using procedures tailored to social interventions in community contexts (Lorenc et al., 2013).

7.3.1. Study identification

Search term development

Search terms, phrases, and syntaxes were developed iteratively. They were initially draw from scrutiny of sample papers identified in proceeding broader reviews of theory and evidence on associations between control/empowerment and inequalities in health (Whitehead et al., 2014; Whitehead et al., 2016). Pilot searches in gold standard databases (MEDLINE and Web of Science) and Google and Google scholar search engines identified additional sample papers to inform the development of terms, phrases and search syntax structure. Searches syntaxes were tailored to specific databases and tested for effectiveness during further pilot searches.

Academic bibliographic database searches, and supplementary searches

We searched seven electronic bibliographic databases (MEDLINE and MEDLINE In-Process; EMBASE; PsycINFO; Social Policy & Practice; Social Sciences Citation Index; Conference Proceedings Citation Index – Social Sciences and Humanities; and Conference Proceedings Citations Index – Science) for articles published between January 1980 and February 2016. We also conducted supplementary searches through backward citation searches ('citation snowballing'), and contacted key informants/experts (policy makers and academics) in appropriate fields to help identify relevant papers in press and in the grey literature. An example of the Medline search syntax can be found in Appendix 10.

Inclusion and exclusion criteria

Inclusion and exclusion criteria for the systematic review are shown in Table 11.

Table 11. Inclusion and exclusion criteria for review

	Included	Excluded
Setting	All countries (low-, middle-, and high-income).	-
Population of interest	Free-living populations in their living environments in community settings.	Studies conducted in work environment, educational, healthcare, or other

		institutional environments (e.g., prisons).
Studies of interest	Experimental or quasi-experimental studies (including: RCTs, controlled observational studies, before and after studies, interrupted time-series studies, and natural policy experiments); or qualitative studies related to an included interventional study. Studies that disaggregated data by some measure of socioeconomic status.	Studies without an appropriate comparator/control group or pre- and post-intervention data.
Type of intervention	Group-based microfinance schemes targeted at groups with some form of disadvantage (including women in cultures in which they are discriminated against and minority ethnic groups who occupy low social positions). Schemes that focussed on poverty alleviation and group solidarity and empowerment as an approach to improving social and material conditions.	Individual loan schemes that focussed solely on poverty alleviation. Schemes with restrictions on how loans could be used.
Outcomes	Outcomes measuring an individual, group or populations physical, mental and social health or wellbeing or determinants clearly linked to health or wellbeing outcomes (for example, contraceptive use).	-
Language	English language studies	-
Publication time coverage	1980-2016.	-

A report was only included if it described an experimental or quasi-experimental evaluation of a group-based microfinance scheme that:

   i. Employed collective empowerment strategies.
   ii. Targeted a group with some form of social disadvantage.
   iii. Was delivered among a free-living population in a community (living environment) setting.
   iv. Disaggregated data by some measure of socioeconomic status.
   v. Described at least one health-related outcome.

We also included qualitative reports that related to an included study. No country restrictions were applied. We excluded reports of individual loan schemes that focused solely on poverty alleviation but did not promote group solidarity and empowerment, and reports on schemes that included restrictions on how loans could be used.

Screening and selection of studies

Titles and abstracts were screened before potentially eligible reports were retrieved in full text and assessed independently by two reviewers. Reasons for exclusion were recorded. Disagreements were resolved by discussion or by recourse to a third reviewer.

7.3.2. Data extraction and critical appraisal

A single reviewer extracted data from each included report and applied a modified version of the 'Quality assessment for the systematic review of effectiveness' tool developed by Lorenc et al. (2013). A copy of the modified tool can be found in Appendix 11. Studies were scored and rated as lower, higher, and highest relative methodological quality (Table 12). Extracted data included: study aims, study design, setting/country, and main findings in relation to research questions. Qualitative studies were assessed using the criteria of Mays et al's (2000) tool for 'Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field'. All extractions and appraisals were checked for accuracy and completeness independently by a second reviewer. The differential distribution of impacts by sex, ethnicity, and socioeconomic status were identified.

7.3.3. Evidence synthesis and reporting

Results were synthesised narratively. Within the sections below on different types of impacts, higher methodological quality studies are reported first and in greater detail (Mays et al., 2005; Popay et al., 2006). Reporting was based on PRISMA and PRISMA-Equity extension guidelines (Moher et al., 2009; Welsh et al., 2012).

7.4. Results

7.4.1. Included studies

From an initial 4,050 records, 31 reports, covering 23 studies, were identified that met the inclusion criteria. Figure 11 shows the progression of studies through the review.

Figure 11. PRISMA flow diagram depicting the flow of studies through the review
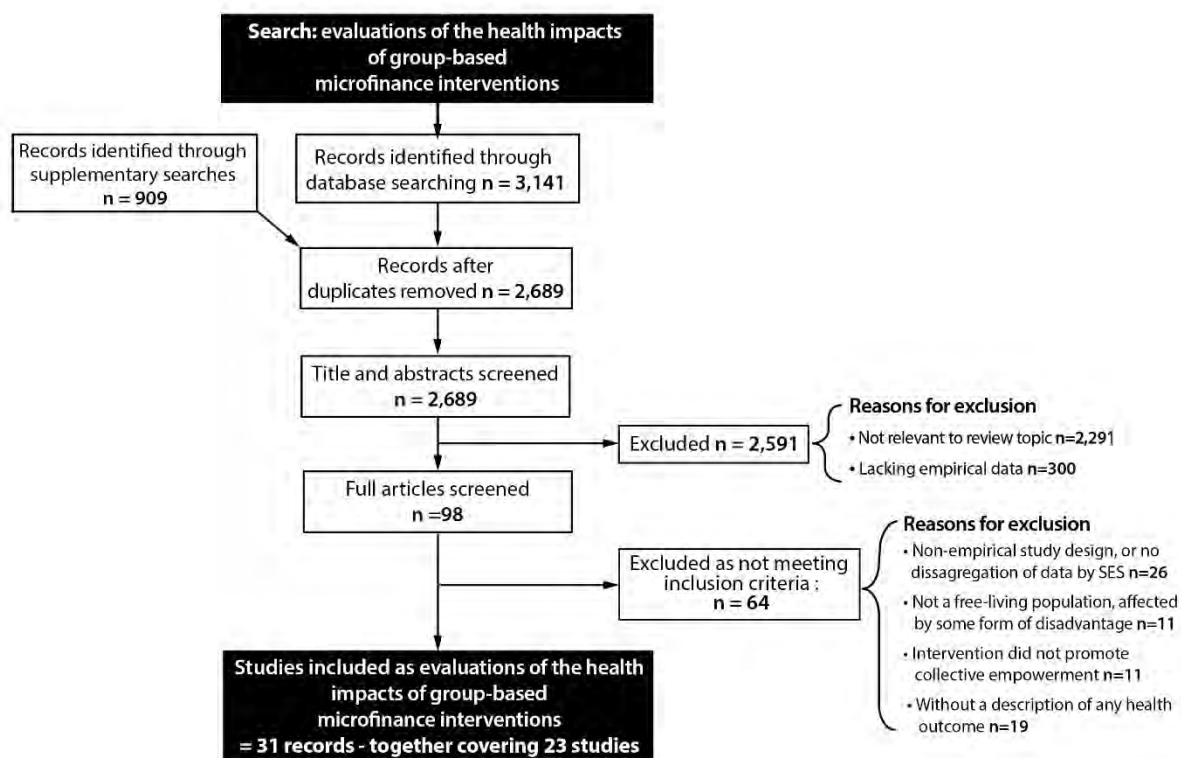
The included studies comprised one cluster-randomized controlled trial (cluster-RCT) and 22 quasi-experimental studies that took advantage of naturally occurring comparisons and pre-existing data, for example, from demographic surveillance systems and demographic and household health surveys. The characteristics and results of the included studies are summarised in Table 12.

Table 12. Summary of the studies included in the systematic review of collective empowerment-based microfinance schemes

Study no.	Study	Country and study design	Follow-up period	Intervention and target population	Study participants	Comparison group(s)	Outcome measures	Quality[a]
1	Bhuiya and Chowdhury, 2002	Bangladesh, controlled before-and-after study	1988–1992 and 1993–1997	BRAC,[b] poor women	13549 children of poor women	Children of poor non-members and children of rich non-members	Infant and childhood mortality rates, recorded as survival status on set date for two birth cohorts	Higher
2	Bhuiya et al., 2001	Bangladesh, controlled before-and-after study	1982–1996		Children of poor women from 12000 households	Children of poor non-members	Childhood mortality rates, recorded as cumulative child survival probability by household	Higher
3	E-Nasreen et al., 2006	Bangladesh, case–control and qualitative case studies	NA	BRAC, poor women	117 neonates born 1999–2000 who died within first 28 days of life	Live children	Neonatal death	Lower
4	Ahmed et al., 2001	Bangladesh, post-intervention study	NA	BRAC, poor women	Poor women from 3817 households	Non-member households that met eligibility for BRAC, and rich non-eligible households	Self-reported illness episodes over last 15 days and health- seeking behaviour	Lower
5	Hamad and Fernald, 2015	Peru, post-intervention study	NA	PRISMA,[c] poor households	1593 adult female members	Long-duration members and short-duration members	Depressive symptoms, contraceptive use, cancer screening: in last year, self-reported days sick in last month	Lower

	Moseson et al., 2014				511 adult female members and 596 of their children aged < 5 years		Child length-for-age, weight-for-age, anaemia, questions on respiratory infections and diarrhoea in child last 6 months, food security	Lower
	Hamad and Fernald, 2012				1593 adult female members		Age-adjusted BMI, haemoglobin levels and food insecurity	Lower
6	Pronyk et al., 2006	South Africa, cluster-RCT with qualitative component	2 years	IMAGE,[d] poor women	5156 residents of intervention villages aged 14–35 years	Matched controls from waiting-list villages	Rate of unprotected sex: occurrence at last intercourse with a non-spousal partner in past 12 months, HIV incidence	Highest
	Pronyk et al., 2008				220 female members aged 14–35 years		HIV-related communication, access to voluntary counselling and testing, rate of unprotected sex at last intercourse with non-spousal partner	Highest
	Kim et al., 2007				860 women from intervention villages, as 430 matched pairs of members and non-members		Physical and sexual violence by spouse or other intimate partner within last year, women's empowerment	Highest
7	Schuler and Hashemi, 1994	Bangladesh, controlled before-and-	Single time-points in 1991 and 1993	BRAC and Grameen	1305 poor rural married	Eligible non-members and non-	Respondent or partner currently using any form of contraception	Higher

	Schuler et al., 1997	after study with ethnographic component		Bank,[e] poor women	women aged < 50 years	eligible non-members	Relative mobility, economic security, ability to make purchases, freedom from domination and violence, political and legal awareness, participation in political spheres	Higher
8	Souverein et al., 2013	India, longitudinal study	2005–2008	Pragati,[f] female sex workers	20 330 female sex workers	No comparator – women followed up from first point of contact with scheme until last point of reported contact	STI incidence from syndromic surveillance data, condom use at last paid sex	Higher
9	Amin et al., 1996	Bangladesh, post-intervention study	NA	5 small or medium-sized credit NGOs that adopted loan system of Grameen Bank, NS	3564 rural women, aged < 50 years	Non-loanees from NGO areas and women from non-NGO areas	Current contraceptive use, freedom to manage household expenses, autonomy in movement, authority in family affairs	Lower
	Amin and Li, 1997						Child immunization, infant and child mortality rate	Lower
10	Desai and Tarozzi, 2011	Ethiopia, controlled before-and-after study	2003–2006	Two credit schemes combined with family planning activities, poor women	6440 women aged 15–49 years from poor households	Just the family planning component and just the credit component	Contraceptive use	Lower

11	Schuler et al., 1996	Bangladesh, controlled before-and-after study with ethnographic component	Single time-points in 1991 and 1993	BRAC and Grameen Bank, poor women	1305 poor rural married women aged < 50 years	Eligible non-members and non-eligible non-members	Physical beating by husband in last year, relative mobility, economic security, ability to make purchases, freedom from domination and violence, political and legal awareness, participation in political spheres	Higher
12	Chin, 2012	Bangladesh, post-intervention study	NA	BRAC, BRDB and Grameen Bank schemes, NS	1843 rural women	Eligible non-members and non-eligible non-members	Spousal violence directed at women – ever and in last year	Lower
13	Ahmed, 2005	Bangladesh, post-intervention study	NA	BRAC, poor women	2044 poor women who were or had been married	Non-member households that met eligibility for BRAC	Violence against women from their husbands in preceding 4 months	Lower
14	Dalal et al., 2013	Bangladesh, post-intervention study	NA	BRAC, BRDB, Grameen Bank, PROSHIKA or any microcredit organization, NS	4465 women aged 15–49 years who were or had been married	Non-members	Moderate physical, severe physical, sexual and any interpersonal violence in last year, economic empowerment	Lower
	Dalal et al., 2012				4925 women aged 15–49 years who were or had been married		Last delivery at home without skilled birth attendant or with institutional delivery services, economic empowerment	Lower

15	Bajracharya and Amin, 2013	Bangladesh, post-intervention study	NA	BRAC, BRDB, Grameen Bank, PROSHIKA or any microcredit organization, NS	4195 married women aged 15–49 years	Matched non-members	Physical and sexual against women by their husbands in last year	Lower
16	Imai and Azam, 2012	Bangladesh, household panel survey	1997–1998, 1998–1999, 1999–2000 and 2004–2005	Any microfinance scheme, NS	Women from > 3000 households in 91 intervention villages	Women from neighbouring villages without microfinance	BMI	Higher
17	Khatun et al., 2004	Bangladesh, controlled before-and-after study	3 time-points in 1995–1996	BRAC, poor women	576 children of poor women, aged 6–72 months	Children of poor non-members and children of rich non-members	Stunting, recorded as height-for-age compared with reference median	Higher
18	Jalal and Frongillo, 2013	Bangladesh, controlled before-and-after study	3 time-points in 1995–1996	BRAC-based CFPR-TUP initiative, poor women	3551 women and 4131 children from households with child aged 6–60 months	Children and women from non-member households	Nutritional status of women and pre-school children	Higher
19	Deininger and Liu, 2013	India, pipeline comparison of current and future members	NA	Indhira Kranthi Patham programme,[g] poor women	Poor women from 1964 households	People who later joined programme when it came to their village	Energy intake, protein intake and food consumption over last 30 days, social capital, economic empowerment, political empowerment	Higher

20	Doocy et al., 2005	Ethiopia, post-intervention study	NA	WISDOM World Vision Microfinance Institution,[h] poor households	Clients from 819 rural households and their children aged 6–59 months	Similar incoming clients and community controls	Arm circumference	Lower
21	MkNelly and Dunford, 1998	Ghana, repeat cross-sectional study	1993–1996	Credit with Education scheme, poor rural households	308 mother-and-child pairs from poor rural households that had participated in scheme for at least 1 year, with each child aged < 3 years	Non-participants in microfinance areas and waiting-list controls	Child's weight-for-age and height-for-age plus maternal BMI, self-confidence, vision for the future, status and bargaining power within the household, status and networks in the community	Lower
22	Mohindra et al., 2008	India, post-intervention study	NA	Self-help groups, poor women	928 poor women aged 18–59 years	Women who had been members for > 2 years, women who had been members for < 2 years, non-members living in house with a member and non-members living in a house without a member	Self-assessed physical and mental health, exclusion from health care in last year, whether or not husband is sole decision-maker	Lower
	Mohindra, 2008	India, qualitative survey					NA	Higher

| 23 | Ahmed et al., 2000 | Bangladesh, post-intervention study | NA | BRAC, poor women | Poor women, from 3624 households, who were or had been married | Non-member households that met eligibility for BRAC and rich non-eligible households | Three specific questions about emotional stress and its consequences | Lower |

NOTES: BMI: body mass index; BRDB: Bangladesh Rural Development Board; CFPR-TUP: Challenging the Frontiers of Poverty Reduction – Targeting Ultra Poor; HIV: human immunodeficiency virus; IMAGE: Intervention with Microfinance for AIDS and Gender Equity; NA: not applicable; NGO: nongovernmental organization; NS: not specified; RCT: randomized controlled trial; STI: sexually transmitted infection.

a. Assessed using procedures tailored to social interventions in community contexts (Lorenc et al., 2013).

b. The aims of the BRAC scheme are to improve health and socioeconomic condition through group formation, skill training and collateral-free loans for income-generating activities.

c. Scheme based on loan groups run by a nongovernmental organization.

d. Includes a large health promotion component related to human immunodeficiency virus.

e. The Grameen Bank is a bank for poor rural people that focuses on women.

f. Multicomponent microfinance scheme with empowerment approach.

g. Largely based on the creation of self-help groups.

h. Promotes community banking and solidarity group lending.

All the interventions targeted poor women living in low- or middle-income countries. Most of the studies were based in Bangladesh and many focused on women in rural communities. Although we identified some studies of microfinance schemes in central and south America, all but one was excluded because they did not meet all of the inclusion criteria.

Methodological quality assessment of the studies revealed that even the higher quality studies were potentially at risk from several forms of selection bias.

The results are summarised below by impacts on types/categories of outcome (violence against women, nutrition, healthcare use, women's sexual health, wellbeing, morbidity and mortality). Higher methodological quality studies are reported first within the outcome category sections.

7.4.2. Violence against women

The impacts of microfinance interventions on interpersonal violence against women were reported in seven evaluations conducted in South African (1 study) and Bangladeshi (6 studies). The study rated as highest methodological quality (a cluster-RCT with qualitative component) found that after two years levels of violence against women decreased in all four study villages covered by the intervention (South African Microfinance for AIDS and Gender Equity), while they remained constant or increased in four control villages (Kim et al., 2007). Improvements in all nine indicators of women's empowerment that were investigated were observed. Women microfinance members had a greater say over household decision-making, felt more able to challenge the acceptability of violence, to expect and receive better treatment from their partners, to leave abusive relationships, and to raise public awareness of interpersonal violence against women in their community. Women's membership in the microfinance scheme was also associated with a reduced risk of exposure to violence (adjusted Relative Risk: 0.45; 95% CI: 0.23–0.91).

One study, rated as higher methodological quality, measured violence within intimate partner spousal relationships in Bangladesh. Women who participated in the BRAC or Grameen Bank schemes, and women who were non-members but lived in Grameen Bank villages, were found to be less likely to be physically assaulted by their husbands than women in control villages (Schuler et al., 1996). The role of women's empowerment in the association was unclear, and the effect of women's independent economic contribution to the family on violence was not found to be statistically significant. Ethnographic data indicated that in richer households' women's membership of a scheme may have initially led to an increase in violence as their involvement in family finances increased, and their roles and status were redefined, which may have led to

conflict over control of household finances. Initial increases in violence, however, dissipated over time.

Five other studies in Bangladesh, rated as lower methodological quality, produced mixed results. One study found that microfinance participation was associated with a 6.8% reduction in the likelihood of interpersonal violence against women (Chin, 2003). In contrast, after controlling for confounders, two other studies found no statistically significant association between microfinance participation and current experience of interpersonal violence against women (Ahmed et al., 2000, 2005). Another lower quality study in Bangladesh found that the better educated women experienced increased exposure to interpersonal violence following membership of a microfinance scheme. This study was, however, poorly adjusted for bias (Dalal et al., 2013). A further study in Bangladesh, that used propensity score matching to construct an appropriate comparison group of non-members, revealed that levels of interpersonal violence did not differ significantly between members and non-members (Bajracharya and Amin, 2013).

7.4.3. Nutritional status

Impacts on nutritional status of participation in microfinance schemes were reported in seven evaluations in Bangladesh, India, Ethiopia, Ghana, and Peru. The findings across the studies were mixed. Some found that scheme membership improved nutritional status, mostly for the children of scheme members, but others revealed no statistically significant effects. Results also varied within the studies across different nutritional status outcome measures.

Three of the studies were rated as higher methodological quality. All three were conducted in Bangladesh. One study found that the prevalence of childhood growth stunting was lower among the children of BRAC microfinance scheme members (67.3%) (and rich non-members: 69.4%) than among children of poor non-members (84.6%) (Khatun et al., 2004). A second study found Weight-for-height z-scores of children aged 24–35 months from BRAC households were significantly higher ($P < 0.05$) than those of their counterparts from control households. They found no statistically significant differences between member households and non-member households, however, in terms of three other indicators of nutritional status (in relation to growth and body-composition) in pre-school children and women (Jalal and Frongillo, 2013). A third higher methodological study found that women from villages with any microfinance scheme, and women from neighbouring villages without any scheme, showed similar increases in their body mass index (Imai and Azam, 2013).

Four studies on the impacts of microfinance programmes on nutritional status were rated as lower methodological quality. One study was from India (Deininger and Liu, 2013), one from Ethiopia (Doocy et al., 2005), one from Ghana (MkNelly and Dunford, 1998), and one from Peru (reported in two publications: Moseson et al., 2014; Hamad and Fernald, 2012). A variety of nutritional status outcomes were measured, including children's and women's anthropometry, body mass indexes, food security, food consumption, and blood haemoglobin levels. Although the findings across the measures within the studies were mixed, all the studies found some benefits for microfinance members for some nutritional status outcomes measures.

Two of the lower quality studies of impacts on nutritional status also examined impacts on women's empowerment-related outcomes in India and Ghana. One adjusted for self-selection bias, and one did not (Deininger and Liu, 2013; MkNelly and Dunford, 1998, respectively). They both found that microfinance membership was associated with improvements in several empowerment-related measures for women. Deininger and Liu (2013), for example, found a significant association between microfinance membership and increased economic empowerment, political participation, and social capital.

7.4.4. Women's sexual health

Five evaluations of microfinance interventions in Bangladesh, India, Ethiopia, and South Africa reported impacts on sexual health outcomes. Of these evaluations, one study, rated as highest methodological quality, assessed the impacts of the South African Microfinance for AIDS and Gender Equity intervention on women's sexual health in South Africa (Pronyk et al., 2006, 2007, 2008). This was a prospective, matched, cluster-randomized controlled trial that also had a strong qualitative component. The microfinance interventions included a large HIV health-promotion element (a component based on the Grameen Bank model), and a so-called Sisters-for-Life gender-focused training component. The intervention was not associated with any significant changes in rate of unprotected sex with a non-spousal partner (relative risk [RR]: 1.02; 95% confidence interval [CI]: 0.85–1.23) or HIV incidence (RR: 1.06; 95% CI: 0.66–1.69) (Pronyk et al., 2006). In analysis stratified by age, there was evidence of several beneficial impacts on younger participants following two years of participation in the microfinance programme. For example, compared to women from control villages of the same age and poverty level, female participants aged 14–35 years were more likely to have accessed voluntary counselling and HIV testing (adjusted risk ratio, [aRR]: 1.64; 95% CI: 1.06–2.56), exhibited greater levels of HIV-related communication (aRR: 1.46; 95% CI: 1.01–2.12), and were at reduced risk of having had unprotected sex during previous intercourse with a non-spousal partner (aRR: 0.76; 95% CI: 0.60–0.96). Qualitative data demonstrated that the intervention led to higher acceptance of within-

household communication about sexuality and HIV, and increased confidence and skills that appeared to have supported the introduction of condoms in sexual relationships (Pronyk et al., 2008).

Findings about impacts on women's sexual health that were assessed in two studies in Bangladesh, rated as higher methodological quality, were mixed. In one of the studies, women in villages who participated in the Grameen Bank scheme were more empowered (P < 0.01) and more likely to use contraceptives than women in villages without the microfinance scheme (59% compared to 43%, respectively; P < 0.01). No statistically significant association, however, was found between BRAC membership and contraceptive use (Schuler and Hashemi, 1994). Ethnographic data (in Schuler et al., 1997) indicated that the Grameen Bank scheme may have increased contraceptive use partly by increasing women's empowerment and economic roles, and partly by promoting family planning and influencing community norms. Members of microfinance schemes showed relatively high scores for economic security, contribution to family support, freedom and mobility, and freedom from domination (Schuler et al., 1997). A further longitudinal controlled study in India, rated as higher methodological quality, evaluated the three-year impact the Pragati microfinance and health-promotion intervention for female sex workers. They found that the frequency of condom use during last paid sex increased, and the incidence of sexually transmitted infections decreased as length of participation in the microfinance intervention increased over time (Souverein et al., 2013).

Three lower methodological quality studies also assessed impacts on women's sexual health-related outcomes. One study in Bangladesh found significant associations between microfinance membership and higher contraceptive use (Amin and Ahmed, 1996; Amin and Li, 1997). Two studies in Ethiopia and Peru found no statistically significant associations between microfinance membership and women's health sexual health outcomes (Desai and Tarozzi, 2011; Hamad and Fernald, 2015).

7.4.5. Wellbeing and healthcare use

One study, rated as higher methodological quality, evaluated a microfinance programme in Kerala in India known as Self Help Groups. They found that membership was associated with significant reductions in emotional stress and significant increases in the use of health care (Mohindra et al., 2008). A beneficial spillover effect was also found for non-participants who lived in the same households as members. They found no associations, however, between participation and self-assessed health or exposure to health risks. They excluded a group of women known to be socially marginalized from their analysis as they detected that the (Paniya)

women "were rating their health in a distinct way that underestimated their health". Women members used loans to help cover their health expenditures (Mohindra, 2008).

One study in Bangladesh, rated as lower quality, revealed associations between microfinance membership and increased levels of emotional stress, but only for other non-members of households that had received loans (Ahmed et al., 2001). A second lower methodological quality study found a significant association between membership and increased use of maternal delivery care (Dalal et al., 2012). A third lower quality study from Peru found that length of participation in a microfinance scheme had no significant association with women's number of sick days or their access to screening services for cancer (Hamad and Fernald, 2015).

7.4.6. Morbidity and mortality

Two longitudinal studies in Bangladesh, rated as higher methodological quality, found that rates of mortality were significantly lower for infants and children of members of the BRAC microfinance programme than they were for infants and children of non-members (Bhuiya et al., 2001; Bhuiya and Chowdhury, 2002) The decline in the risk of infant death observed over a 10-year period was greatest (53%) for infants of mothers who joined the BRAC programme, followed by the infants of rich non-members (41%), and then infants of poor non-members (31%) (Bhuiya and Chowdhury, 2002). Risk of mortality for the infants of poor BRAC members reduced over time to the level recorded for the infants of relatively rich non-members. No association was found between BRAC membership and survival rates of children aged 1–5 years. In a similar study by the same authors, however, the survival of children aged 1–5 years from poor households was found to be significantly improved for children of mothers who were BRAC members (Bhuiya et al., 2001).

Two studies of the impacts of BRAC membership, rated as lower methodological quality, found an association between membership and lower maternal morbidity and lower child mortality (Ahmed et al., 2000). A third lower quality study in Peru found no evidence of associations between duration of group-based microfinance membership and maternal depression, or childhood morbidity (Hamad and Fernald, 2015; Moseson et al., 2014, respectively).

7.5. Discussion

This was the first systematic review to assess the impact of collective empowerment-based microfinance on health outcomes across all country settings. Although we searched for evaluations of schemes that covered any disadvantaged group in any country, all the studies that met our inclusion criteria were concerned with the empowerment of poor women in low- or middle-income countries, mainly in Asia. It was also the first review that focused on attempting to understand the role of empowerment in the pathways between microfinance interventions and health outcomes, and to highlight health equity impacts by evaluating differential outcomes by sex, ethnicity, and socio-economic status.

7.5.1 Summary of main findings

There was clear evidence of improvements in some important maternal and child health outcomes associated with membership of the long-established BRAC and Grameen Bank microfinance schemes in Bangladesh, including better child survival (Bhuiya et al., 2001; Bhuiya and Chowdhury, 2002) and use of contraceptives (Schuler and Hashemi, 1994).

Results from studies of impacts on nutritional status, and the general health of women who were members of microfinance schemes in a range of countries, were equivocal. Membership of a scheme specifically for female sex workers in India was associated with decreases in sexually transmitted infections and increases in condom use during paid sex (Souverein et al., 2013). A complex picture emerged on the impact of microfinance interventions on interpersonal violence. The evidence suggests that while microfinance interventions may eventually lead to a reduction in violence against women, violence may initially increase as gender norms are challenged and begin to change. The most methodologically robust study, a cluster-randomized controlled trial, showed that microfinance schemes can reduce the risk of physical or sexual violence by an intimate partner over time (Kim et al., 2007).

The few included studies that measured indicators of women's levels of empowerment in their families and communities generally found that membership of a major microfinance scheme was associated with increased levels of empowerment (Schuler and Hashemi, 1994; Schuler et al., 1997; MkNelly and Dunford, 1998; Kim et al., 2007; Deininger and Lui, 2012). Although increases in empowerment did not necessarily translate to improvements in health outcomes (Schuler and Hashemi, 1994).

Others have warned that the provision of credit to women does not guarantee their control over the use of the credit, and it may lead to increased anxiety over pressure to pay back loans, which may reduce rather than increase their sense of empowerment (Kim et al., 2007). The included studies that had a strong qualitative component provided some of the most convincing evidence on the role of empowerment in the generation of beneficial effects from microfinance schemes. In the study of the South African Microfinance for AIDS and Gender Equity intervention, participants revealed how reductions in violence resulted from changes to responses, some of which were linked to increased levels of empowerment and confidence of the women in handling flash points that can lead on to violence (Kim et al., 2007). Microfinance programmes in Bangladesh appear to have empowered women by strengthening their economic roles, increasing their say over household decisions, and by changing cultural norms within their families and communities (Schuler and Hashemi, 1994).

No relevant studies on the impact of collective empowerment-based microfinance schemes on ethnic inequalities in health were identified. Evidence on how microfinance schemes may help to reduce gender and socioeconomic inequalities in health was identified. Most notably, evaluations in Bangladesh indicated that the BRAC microfinance scheme may help to narrow the inequalities in health between boys and girls and between richer and poorer groups (Amin and Li, 1997; Khatun et al., 2004). These initiatives do not only appear to lead to improvements in health for girls by raising the economic conditions and status of mothers who are members, but also through cultural changes in the way girls are valued and nurtured, leading to additional gains for poor girls in relation to poor boys.

The potential for microfinance schemes to have adverse health impacts was not explicitly explored in most of the evaluations included in our systematic review. Although there were indications of increased violence between intimate partners as the result of women's empowerment promoted by microfinance, the most robust relevant studies showed overall reductions in violence against women, at least in the long term (Kim et al., 2007; Schuler et al., 1996). Potential adverse health impacts of microfinance schemes resulting from potential debt-related stress associated with the repayment of loans have yet to be investigated in detail (Hishigsuren, 2007; Bateman, 2012; Taylor, 2012; Van Rooyen et al., 2012; Ghalib, 2013).

Research into the negative impacts of microfinance schemes may be particularly challenging, not least because of the potential for selection bias of various forms. Very few of the relevant studies identified employed the most robust methodological designs. More high-quality studies are needed that employ appropriate designs that can tackle the complexity of multifaceted schemes, and the complexity and potential confounding in the settings in which microfinance schemes

operate. Few, if any, of the evaluations included in the review were able to disentangle the effects of the main microfinance scheme from those of additional health-promotion and health-care components. Within the microfinance component alone it is hard to disentangle the role of empowerment approaches from poverty-reduction components. Measurement of differential impacts by socioeconomic status was also rare, but studies in Bangladesh provided an indication of how this can be done and revealed its potential value.

Further policy and intervention points in relation to the logic model (Figure 3), potential interventions, and areas of future related research will be considered in the Discussion chapter (Chapter 8).

7.6. Conclusions

Collective empowerment-based microfinance schemes represent the largest experiment in the empowerment of disadvantaged women in the world to date. Given the scale and coverage of these schemes, and their potential impacts on poverty and health inequalities, they deserve close scrutiny. In terms of improvements to evaluated health outcomes, the evidence from the larger, long-established schemes was encouraging. Questions remain, however, including on the potential for microfinance schemes to do unintended harm. These questions need to be addressed by appropriately designed evaluations that incorporate community-wide assessments of all potential impacts disaggregated by groups including by sex, ethnicity, and socioeconomic status.

Chapter 8 – Discussion

8.1 Introduction

At the start of this thesis, I described the relevant findings of a critical review which provided much of the theoretical basis for this research (Whitehead et al., 2016). The critical review of theories produced a logic model that posited two interconnected pathways between discrimination and poorer health outcomes for girls and women, compared to boys and men, in son preference countries (pathway 1 – women's lower control over resources, and pathway 2 – son preference). The first three studies investigated the empirical support for the pathways and mechanisms in the logic model (Figure 3). Study 1 focussed on evidence on postnatal health and survival outcomes for women and girls in relation to pathway 1. Studies 2 and 3 focussed on evidence on conception, prenatal and postnatal survival outcomes for females in relation to pathway 2. Together studies 1 to 3 consider evidence on health and survival outcomes across the whole lifecourse - from conception to adulthood. Study 4 investigated the effectiveness of collective, empowerment-based interventions to raise the social and material status of women and improve their health and survival chances and those of their children. These interventions have the potential to not only reduce (downstream) adverse health and survival outcomes for women and girls, but to also influence the (upstream) culture of son preference and the practices (mechanisms) of discrimination that lead to them.

This chapter will:

- Provide an overview of the findings from the four doctoral studies (in Chapters 4-7) and show how the research has addressed the main objectives of the thesis (Section 8.2).
- Synthesise the evidence across the doctoral studies (8.3).
- Discuss the strengths and limitations of the evidence base (8.4).
- Highlight methodological advances made in the thesis (8.5).
- Identify important, priority areas for future research (8.6).
- Identify important implications for policy (8.7).

8.2 Overview of findings of the studies in relation to the objectives

These doctoral studies set out to investigate the pathways from profound discrimination against women and poorer health outcomes, at the *macro/societal level.* The societal context for all the selected measures and concepts is therefore all important, not least the choice of son preference countries as societal contexts exhibiting the most profound gender discrimination.

The key findings from the studies in relation to the research objectives are summarise below.

Objective 1 - To conduct a systematic review and synthesis of observational evidence on the health impacts of women's low control/autonomy in societies with profound gender discrimination and gender bias. This objective was achieved by the conduct of Study 1.

This study was the first theory-based systematic review of observational evidence of the health impacts of women's low control in their living environment in societies with profound gender discrimination and gender bias. It made an important contribution with virtually all the studies showing that lower control for women in their living environment was significantly associated with poorer health outcomes for women and for their children. A critical inclusion criteria for this societal level study was that the study had to measure the 'actual control' over their daily lives that the participants had in the society in which they lived. Studies that only measured 'perceived control' or control beliefs were excluded.

The study found some high quality epidemiological evidence that higher control for women was associated with reduced risk of mortality for infants and children, and better mental health of women. Lower control was associated with poorer infant survival. Lower quality epidemiological evidence indicated that lower control for women was associated with higher rates of low birth weight, malnutrition (for infants, children, and women), poorer infant and child growth, disadvantage for girls in nutritional status compared to boys, diarrhea and acute respiratory tract infections in children aged under 2, anemia for women, and infant, child and maternal mortality. Lower control was also associated with poorer self-reported health status for women. There was evidence that women's empowerment may play a partial mediating role between women's educational status and infant mortality, and that levels of household socioeconomic status (measured using a Wealth Index) acted as an effect modifier. This study provides empirical support for the (upper) low control pathway of the logic model (Figure 3).

Objective 2 - To conduct a systematic review and synthesis of the empirical evidence on the impacts of profound gender discrimination on the survival of girls and women in son-preference countries, including estimates of the numbers of 'Missing Women' over time. This objective was achieved by the conduct of study 2.

The study found that there was consistent evidence from demographic studies of a survival disadvantage for girls and women in son-preference countries. There was firm evidence for the operation of both a prenatal and postnatal pathway, with girls and women experiencing a survival disadvantage at every stage of life, compared to boys and men. Latest estimates, based on data for 2010, suggest there were around 126 million girls and women 'missing' from son preference countries and the world's population total. Estimates from studies conducted over four decades between 1980 and 2020 also suggested that the scale of the problem was growing in absolute and relative (to population growth) terms and will continue to increase to a peak of 150 million 'missing' girls and women in 2035, before levelling off and gradually reducing to 142 million in 2050. This study provides empirical support for the (lower) son preference pathway of the logic model (Figure 1).

Objective 3 - To elucidate whether the discriminatory practice of pre-natal sex selection 'migrates' with some diasporas from son preference countries to high-income destination countries without a pervasive culture of son preference. This objective was achieved by conduct of study 3.

This study was the first systematic review of evidence on the potential migration of sex-selection practices from son preference countries to high-income destination countries. There was evidence that the practice of sex-selective abortion appears to persist among certain immigrant population groups, particularly from India and China, after arrival in destination countries in Europe, North America, and Australasia. Most (demographic and epidemiological) studies found significantly male-skewed sex ratios at birth for babies of immigrants born in some son preference countries in parts of Asia. Findings varied by birth order, typically with higher male-skews to sex ratios at higher birth orders, and by origin country or the origin region of migrant mothers within destination countries. Two studies from the UK reported mixed results for babies of mothers born in India. For countries with only single studies, it was not possible to draw firm conclusions. This study also provides empirical support for the (lower) son preference pathway of the logic model in relation to migrant populations from son preference countries after arrival in high-income destination countries (Figure 3).

Objective 4 - To conduct one or more systematic reviews of policies and interventions to tackle discriminatory practices that threaten female health and survival in son-preference countries, starting with schemes based on collective empowerment of girls and women. This objective was achieved by conduct of study 4.

This study was the first systematic review of evaluations of the impact of collective empowerment-based microfinance interventions on health and wellbeing outcomes across all country settings. It was also the first review to focus on the role of empowerment in the pathways to health-related outcomes, and the first to highlight the differential distribution of impacts by gender, stage of life (infants, children, adults), and socioeconomic status. There was clear evidence of improvements to important maternal and child health outcomes associated with membership of larger, long-established empowerment-based microfinance schemes in low- and middle-income countries, including prominent schemes serving millions of women in Bangladesh. Membership of schemes was associated with reduced violence against women, improvements to women's and children's nutritional status, increases in healthcare use, improvements to women's sexual health and their wellbeing, and reductions in women's and children's morbidity, and child mortality. The evidence highlighted that there are also risks with such interventions and participation may initially lead to increases in interpersonal violence against women, as gender norms are challenged, but may lead to overall reductions in violence over time as gender norms change and women feel more empowered and confident to handle flash points that can lead to violence.

8.3 Evidence synthesis across the doctoral studies

By considering the findings across the four doctoral studies as a whole, deeper insights have been gleaned from the evidence.

8.3.1. Studying the extreme case at societal level

First is the value of studying the health impact of discrimination and low control at the macro/societal level. It is vital to consider people in their societal context (Östlin et al., 2001). It is in the societal context that discrimination against women plays out and the consequences of that discrimination, including health impact, become manifest (Gita Sen et al., 2007). At this level, we purposively chose to study contexts in which women had the most severe forms of restricted control over their daily lives: societies with profound gender discrimination and gender bias (e.g. as indicated by entrenched preference for sons). The rationale for this choice was that the potential health impacts would be at their greatest in such societies and therefore the chances of detecting any health effects should be increased. There is supporting empirical evidence within my doctoral studies for the two theoretical pathways leading from profound gender discrimination and ensuing low control to poor health outcomes for women. Many of the studies, particularly in thesis study 1, were of low methodological quality, and more robust study designs are needed to untangle the mechanisms.

Although we chose the extreme case of the most profound gender discrimination at societal level, it does not mean that the issue is small in scale: half the women on the planet live in son preference countries, with the ensuing severe restrictions on their daily lives. Effects in health of these restrictions are, therefore, of global health significance.

8.3.2. Capturing differential survival chances at societal level

For these doctoral studies, measures of health outcomes also needed to be at the societal level, but this requirement poses a unique challenge in this field. If reduced survival chances for women in son preference societies are suspected of being one of the major health impacts, then standard population measures of life expectancy, mortality rates, years of life lost and so on may fail to pick up one of the most severe potential impacts: not being born. This is where Amartya Sen and colleagues in the 1980s first came up with an ingenious method of capturing this aspect of survival manifested as a shortfall in the number of women alive in son preference countries at various stages of the lifecourse (Sen, 1986, 1989). They turned to the demographic evidence-base and devised methods to analyse the sex ratio at birth 'observed' in son preference countries and to make comparisons with the 'expected' sex ratio at birth in appropriate reference countries which do not exhibit son preference and other indicators of profound gender discrimination. Since then, the methods for selecting reference countries and calculating 'expected' sex ratios at birth have been refined considerably, culminating the most sophisticated methodologies of Klasen and Wink (2002, 2003), Guilmoto (2012a), and Bongaarts and Guilmoto (2015a).

Reinforcing the differential chances of being born, is the hypothesised mechanism of 'relative neglect' of girl children and women throughout the lifecourse in son preference societies (Sen, 1990; Drèze and Sen, 2002; Bongaarts and Guilmoto, 2015b), which further diminishes survival chances at every stage of the lifecourse. The calculations of 'missing women' take into consideration both the skewed

sex ratio at birth and the skewed all-age population sex ratio which incorporates loss of girls and women through 'relative neglect' at every stage of life.

The empirical studies reviewed in the thesis studies reveal evidence for the continued existence of both prenatal sex selection leading to a shortfall of newborn girls and postnatal discrimination against girls and women adding to the cumulative shortfall of females in the populations of son-preference countries.

8.3.3. Picking up opposing trends in women's survival

By synthesising the empirical evidence on trends over time in relation to 'missing women', together with the timing of technological advances, study 2 highlights the apparent operation of two opposing forces. On the one hand, there has been a near universal improvement in female mortality in low- and middle-income countries over recent decades, influenced by improvements in the social determinants of health: reduction in poverty and improvements in nutrition and access to effective healthcare, aided by progress in access to schooling for girls and greater employment/economic empowerment of women. This has improved the survival chances of women throughout the postnatal lifecourse. On the other hand, this progress in female mortality rates has been counterbalanced by the widespread adoption of technological innovations, such as ultrasound scans in pregnancy, which have led to the rise of a new phenomenon in son-preference societies - the human manipulation of sex ratios at birth by prenatal sex identification and sex-selective abortions. The mechanisms leading to poorer survival for females vis-à-vis males have changed over time, but the health inequality has persisted, even widened. This meets one of Phelan et al's (2010) four essential features of a fundamental social cause of health inequalities, that 'the association between a fundamental social cause and health is reproduced over time via the replacement of intervening mechanisms' (Link and Phelan, 1995; Phelan et al., 2010). The adverse trend affecting the sex ratio at birth is not picked up by tools such as the Gender Inequality Index, which continues to show favourable changes in social norms towards women in many son-preference countries (UNDP, 2015). Paradoxically, the influence of the ancient tradition of son preference has become stronger, not weaker, over recent decades as a result of the new technological tools we have at our disposal. These opposing forces need to be considered together to make sense of the population trends and to devise the best possible ways of preventing the tragedy of 'missing women'.

Although economic and related development (in employment, education etc) may have led to general reductions in female mortality in son preference countries, evidence of increases in sex-selective abortion since the mid-1980s in many countries suggests that women's status has continued to be eroded. Lofstedt et al. (2004) argued that '*assumptions that discrimination against girls would diminish with economic development and female education have proven simplistic*' (p86). Echavarri and Husillos (2016) argued that without wider cultural/societal change '*the alleviation of poverty alone might fail to automatically reduce sex-based discriminatory practices*' (p372).

As incomes rise through economic development, and sex-selection technologies become cheaper, sex-selection is likely to become more accessible and more widespread (Kulkarni, 2010). In addition, studies on sex-selective abortion that included (proxy) measures of women's socio-economic status within India (Bhalotra and Cochrane, 2010; Bhat and Zavier, 2007; Gellatly and Petrie, 2017; George and Dahiya, 1998; Guilmoto and Ren, 2011; Hu and Schlosser, 2015; Jha et al., 2006, 2011) and Viet Nam (Guilmoto, 2012b) indicate that increasing women's education and employment levels alone may actually increase levels of sex-selection, at least in the short-term. Better-educated households may have greater awareness of sex-selection technologies and be more able to afford and access them (Jha et al., 2006; Mukherjee, 2013). Longer-term studies may reveal more positive outcomes over time.

8.3.4. The emergence of unforeseen societal consequences

The doctoral studies all registered the widespread concern in the literature under review about the potential for wider health, social and economic impacts of profound discrimination against women at the societal level, but much of the evidence was anecdotal in nature. There was particular speculation in the literature about the long-term consequences of have a surplus of young men in male-skewed populations in son preference countries, amplified by government population control policies, such as the One-Child Policy in China (Banister, 2004; Bien et al., 2013; Bongaarts, 2013; Bulte, 2011; Chen et al., 2013; Ebenstein, 2011; Eklund, 2011; Guilmoto, 2010; Hesketh and Min, 2012; Hudson and Den Boer, 2004; Jiang et al., 2011 and 2012; Li, 2007; Mitra, 2014; South et al., 2014). A common concern was having millions of men without wives or children, China being particularly hard hit. There were reports of risky sexual behaviours, rape, abduction of women in rural areas for marriage, and criminal victimisation in China (see, for example, Bien et al, 2013; Hesketh et al, 2011; South et al, 2014). Other data, in India in particular, also show worrying adverse trends, with annual growth in per capita 'crimes against women' (rape, abduction, child trafficking, dowry murder, torture, sexual harassment, and assault) (NCRB, 2013; World Bank, 2015).

Few empirical studies of wider societal consequences have, however, been conducted to date. Gaps were identified in both the primary study-level and systematic review-level evidence base. Hesketh and Min (2012) contend that although 2010 Census figures for China showed the first drop in the sex ratio at birth in three decades, the number of excess young males would continue to increase for at least another two decades as the excess of newborn boys grow up. This is consistent with Bongaarts and Guilmoto's 2015 empirical projections (Bongaarts and Guilmoto, 2015b). Hesketh and Min argued that '*whilst it is not yet fully clear how a surplus of millions of men will affect these societies…, the problem* [was] *about to come to a crisis point, as a large surplus of men reach reproductive age*'. Projections suggest that the number of unmarried single men after 2030 might exceed the number of unmarried women by 50-60 per cent in China and India for several decades (Guilmoto, 2012a). Poor, rural and illiterate men are likely to be the losers in the competition for available brides (Banister, 2004, Guilmoto, 2012a). There is likely to be a geographical dimension to this socioeconomic inequality, with greater (intra- and inter-country) emigration leading to population depletion and

ageing, health, wellbeing, and other wider social and economic impacts on poorer rural areas than richer urban areas (Blair et al., 2022). There may be impacts on the wellbeing of unmarried men (including depression, anxiety, loneliness, and lower life satisfaction) risky behaviours (alcohol misuse, gambling, conflict with others, suicidal ideation), crime and violence, social order/disorder, migration, human trafficking and prostitution, bride trafficking, and bride-abduction (Bhalotra and Cochrane, 2010; Yang et al., 2020; Costello et al., 2022).

Hudson and den Boer (2004) argue that as women become increasingly scarce, they may become more precious 'commodities', and be more likely to be controlled by men (Hudson and den Boer, 2004). Women's reduced share of the population may also translate into weaker representation in public decision-making, with men gaining greater control of the public and political institutions that contribute to women's oppression (Guilmoto, 2012). Although there is some empirical evidence (Yang et al., 2020; Blair et al., 2022; Costello et al., 2022), studies currently appear to be limited in number, scope, geographical coverage, and methodological quality.

Another potential wider impact of large numbers of involuntary bachelors in China (also known as involuntary celibates, and colloquially as "bare branches") muted in the literature may be adoptions of abandoned girls, who, according to Chen et al. (2015), may be adopted by more affluent families to serve as a future daughter-in-law and household help. This is a gap in the current primary study- and systematic review-level evidence on the scale and health and wellbeing impacts of sex-selective abandonment and adoption. This is also another potential intervention entry point that has now been incorporated in the updated logic model Figure 12). Related interventions may include interventions for the health and wellbeing of 'hidden girls', abandoned and adopted girls, and for millions of involuntary celibate men without partners or wives across son preference countries. Evaluations of such interventions, if any interventions exist, are also a gap in the current primary- and systematic review-level evidence bases.

8.3.5. A further unforeseen consequence: the 'migration' of prenatal sex selection with diaspora from son-preference countries?

During the course of my doctoral studies, a new line of enquiry arose out of questions about a further unforeseen consequence of prenatal sex selection in son-preference countries. Is there any evidence of a continuation of the practice of sex-selective termination when diaspora from son-preference countries emigrate to high-income host countries without son preference? The original question arose from concerns in the UK, during an official enquiry into whether amendments should be made to the regulations overseen by the Human Fertilisation and Embryology Authority. At the time, there was a continued ban on sex selection of offspring for non-medical purposes in the UK and this was one of the regulations under scrutiny.

In 2018, we undertook a rapid scoping review to inform this UK policy debate, which concluded that there was scant evidence on this question, but that the only study of the UK situation that we

identified found substantially raised male: female sex ratios at birth for babies of mothers born in India, but not elsewhere (Whitehead and Pennington, 2018, unpublished report to Department of Health).

This scoping review was the stimulus for an extension to my doctoral studies to conduct a full-scale systematic review on the question. This systematic review (doctoral study 3) synthesised the current, albeit limited, body of evidence on sex ratios at birth, comparing the babies of mothers who had emigrated from specified son-preference countries with the babies of mothers born in the destination country without son-preference. The paucity of studies, particularly high methodological studies, was identified as an important gap in the primary study-level evidence base. There is also a gap, a paucity of evidence, on the persistence of sex-selection practices across generations of migrants. We did not identify any evaluations of related interventions, if they exist, in these settings. This is a gap in the primary-level evidence base. While doctoral study 2 identified that new prenatal sex identification and sex-selection technologies may pose new threats to female survival in son preference countries, these new technologies, and more expensive pre-conception and pre-implantation technologies, may be easier to access in richer countries and may therefore present more immediate risks to female survival. The gap in evidence on new sex-selection technologies is therefore also relevant to high-income countries receiving migrants from son preference countries.

8.3.6. Profound gender discrimination/son preference countries and regions within the studies included in the Thesis study reviews

41 profound gender discrimination/son preference countries and regions within the studies were included in the reviews in thesis studies 1, 2, and 4. They are shown in Table 13. It should be noted that this is not an exhaustive list of all potential countries/regions with profound societal level gender discrimination and/or son preference globally. Some countries were excluded from the published analyses due to technical reasons, including widely recognised issues with data quality in some low- and middle-income countries (Hesketh and Xing, 2006; Bongaarts and Guilmoto, 2015b; Chao et al., 2019).

Table 13 Profound gender discrimination/son preference countries and regions within the studies included in the reviews (Thesis studies 1,2, and 4)

1. Afghanistan	22. Malawi
2. Albania	23. Mali
3. Armenia	24. Montenegro
4. Azerbaijan	25. Nepal
5. Bangladesh	26. Nicaragua
6. Benin	27. Nigeria
7. Botswana	28. Pakistan
8. China	29. Peru
9. Colombia	30. Region of Sub-Saharan Africa[a]
10. Democratic Republic of the Congo	31. Region of West Africa[a]
11. Egypt	32. Singapore
12. Ethiopia	33. South Korea
13. Georgia	34. Taiwan
14. Ghana	35. Tanzania

15. Haiti 16. India 17. Indonesia 18. Iran 19. Kenya 20. Kosovo 21. Liberia	36. Tunisia 37. Uganda 38. Uzbekistan 39. Vietnam 40. Zambia 41. Zimbabwe
Notes a. The included regional studies (Sen, 1989; Coale, 1991; Klasen, 1994; Klasen and Wink, 2002, 2003; Khalert, 2014; Guilmoto, 2012; Bongaarts and Guilmoto, 2015) did not report individual countries.	

8.3.7. Identification of policy entry points

The findings from the four doctoral studies as a whole provide pointers for potential policy/intervention entry points along the pathways leading from profound gender discrimination and women's low control over their destiny to adverse health outcomes. Figure 12 is an updated logic model, adding the potential policy entry points that have emerged from the synthesis of findings in the doctoral studies, with illustrative examples of types of policy/intervention at each point.

Figure 12. Updated logic model – Theoretical pathways and mechanisms between gender discrimination and reduced survival and poorer health outcomes for women and girls, studies undertaken and future studies, and policy and intervention entry points and potential interventions.
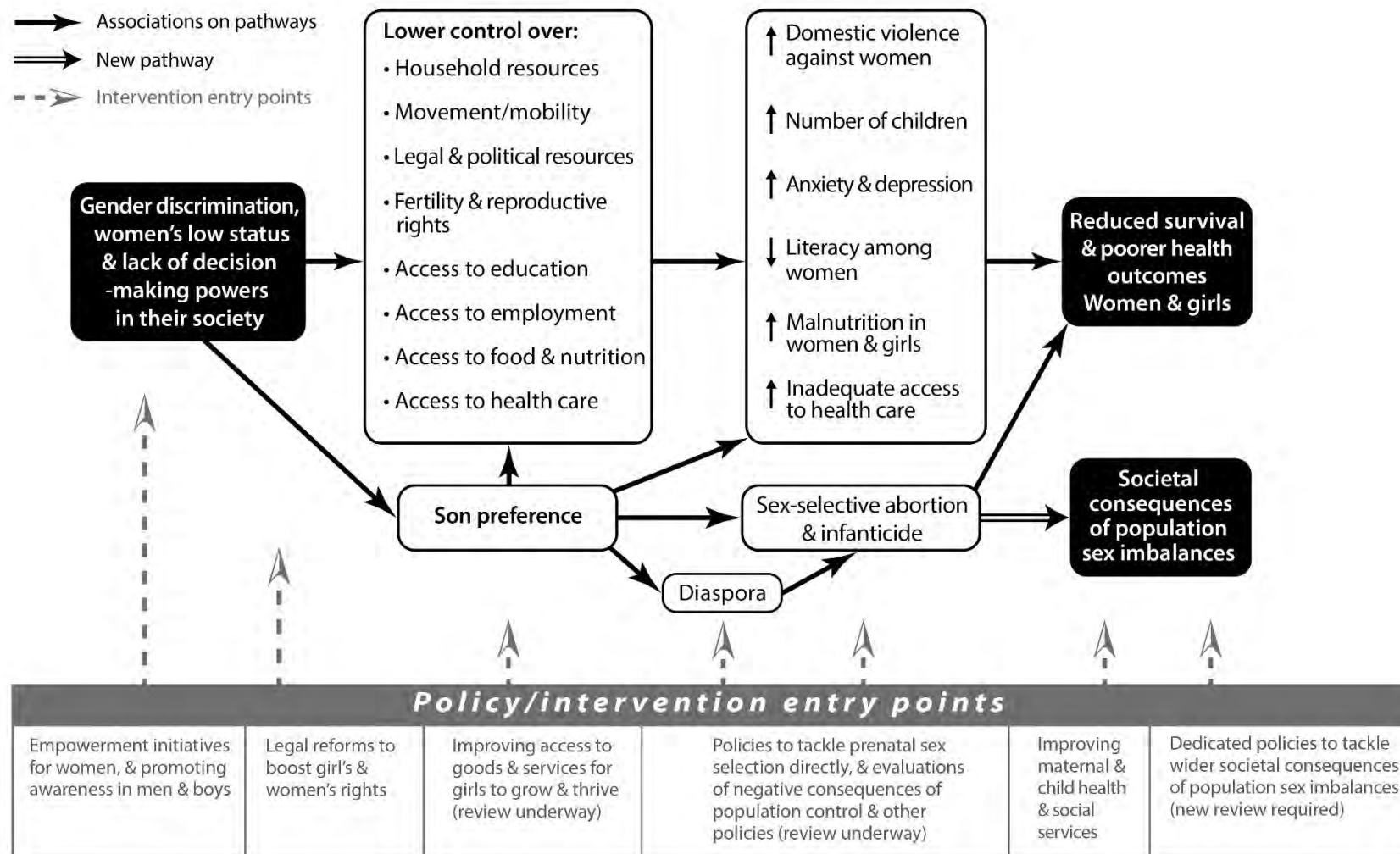
Working from left to right of the model, at the extreme left-hand side are possible actions to influence societal level discrimination against women and their resulting low status and control in their societies. To date, these actions fall into two main types, the first being women's empowerment initiatives in specific societies to boost women's social and economic power directly, at the same time as attempting to nudge cultural shifts across society about the value of daughters. The second is a human rights-based approach, aiming to enhance women's legal status, such as advocacy/enactment of legislative reforms to inheritance and property rights and the promotion of democratic rights. These two types of intervention have been the central focus of the efforts of national and international development agencies over the past several decades, and also work indirectly on the entrenched practice of son preference.

The next entry point is aimed at tackling directly the 'relative neglect' of girls and women which leads to reduced access to the essential goods and services that they need to grow and thrive. These interventions aim to improve access, and range from the direct provision of more school places for girls, to nutritional programmes and free/more affordable maternal and child health services. Again, there is an entry point to influence son preference by counter-balancing it with demonstrations of how daughters are valued by service providers. This also includes conditional or unconditional cash transfers to parents of girls. Such direct action is the mainstay of international aid agencies, as well as a succession of national gender equity initiatives.

Then there are entry points on the specific problems emerging in the wake of technological innovations, such as ultrasound scans enabling sex-selective abortion. Specific legal bans on sex selection of offspring for non-medical reasons, such as the Pre-Conception and Pre-Natal Diagnostic Techniques Act 1994 in India that prohibited the use of technology for sex selection for social reasons and advertising of such services. Bans in themselves are not likely to work if they are not effectively enforced and there are loopholes in regulations. They also only represent a sticking plaster if there are counter forces in society that are magnifying the tendency to son preference – a classic example being the One-Child population control policy in China – if parents are only allowed one child in a society where son preference is rife, then there will be added pressure to engage in prenatal sex selection. Falling fertility levels in other son preference countries are also thought to have had similar, albeit less dramatic, impacts on the pressure to have sons and on subsequent increases in sex selection practices (Pörtner, 2015, 2022; Jayachandran and Pande, 2017). It has to be noted that at each entry point, there are existing policies that have already been introduced by jurisdictions in specific countries that may have unintended negative as well as positive impacts, all of which need to be evaluated.

Finally, on the right-hand side, are new policy entry points to cope with the problems outlined in Section 8.3.4, of wide-ranging and unforeseen consequences of population sex imbalances. These imbalances, generated by a combination of technological innovations that enable prenatal sex selection and population control policies, have led to challenges to the fabric of society and require a dedicated set of policies to deal with them.

Study 4 carried out a systematic review of interventions at the first entry point: specifically on women's empowerment initiatives, results and conclusions from which are analysed in Chapter 7, and the evidence synthesis revealed further entry points where systematic reviews are needed, some of which are in the pipeline for post-doctoral studies, as indicated in Section 8.6 on further research.

One novel line of enquiry, springing from the findings of trends in sex ratios at birth in doctoral study 2, is the insight to be gleaned from in-depth case studies of outliers: previously son-preference countries that have bucked the trend and returned to biologically normal sex ratio at birth. South Korea is one notable example, worthy of a case study approach, employing a range of qualitative and quantitative methods to answer the questions of why and how the country has improved the situation. This is in line with a small but growing body of health equity studies setting out to learn from instances in which the health and welfare of less privileged groups and jurisdictions fare better than expected given their level of resources (they 'punch above their weight') (Caldwell, 1986; Drèze and Sen, 1989; Östlin et al, 2001; Baum et al, 2018).

8.4 Strengths and limitations across the evidence base

The results chapters 4 to 7 identify specific strengths and limitations within the evidence included in the systematic reviews, and of the review approaches. However, there are important common themes across the doctoral studies that have implications for evidence generation in this field and the synthesis of findings across the thesis.

8.4.1. Study design and sample

Firstly, across the systematic reviews there were few high-quality longitudinal studies. Particularly in study 1, the paucity of higher methodological quality longitudinal studies was a gap in the current primary study-level evidence base. In Study 3 the small number of studies, issues with sample sizes in some analyses, heterogeneity (settings, populations, measurement, and analyses), and lack of longitudinal studies were limitations. The review only identified 11 studies of sufficient methodological quality to meet the inclusion criteria. Small sample sizes of some minority immigrant groups in some high-income countries present a methodological challenge, particularly for higher (and therefore increasingly smaller) birth orders. Some studies have attempted to address sample size issues by aggregating migrant groups to larger regions (all of Asia, for example), and some have aggregated the same (country of origin) migrant population groups over long time periods. Both approaches are problematic. Aggregation to larger geographical regions may include migrant groups from countries with contrasting cultures and practices. Aggregation of data over long time periods may conceal the impacts of changes over time, such as the impacts of new sex-selection technologies, and changes to culture and practices (such as rapid increases over time in SRBs in Vietnam, and reductions in South Korea, for example). Most of the intervention studies included in study 4 were of

lower methodological quality, with only three higher methodological quality, longitudinal studies. There were also a lack of studies evaluating adverse outcomes as well as potential beneficial ones, and no studies investigated impacts on wider communities.

These methodological issues prevent a full, comprehensive understanding of the impacts of profound gender discrimination and related interventions, and limit understanding of the pathways and mechanisms through which inequalities are generated and interventions work (or don't).

8.4.2. Limited assessment of mediation and modification pathways.

Related to the issue raised in Section 8.4.1 is the lack of a structured investigation of mediating and modifying pathways in many studies. Most studies in study 1, for example, controlled for socioeconomic status, although more robust controls for socioeconomic status should be developed, but generally they did not have a specific model of the causal pathways that were being investigated and the role of confounders mediators and modifiers in the pathways. For example, an important mediator is access to health services and healthcare seeking behaviour, however few studies explored this.

8.4.3. Limited measurement of women's level of control/autonomy

The conceptualisation and measurement of control was challenging. Most of the studies included in Study 1 and Study 4, however, developed proxies for women's control or autonomy that succeeded to a degree in capturing actual or 'real' control, as opposed to subjective perceptions of control or control beliefs. We excluded studies that used crude, indirect, proxies for women's control in their communities (noting the studies also failed to measure health outcomes). A paucity of studies with direct measures of women's control/empowerment was identified as a gap in the current primary study-level evidence base. Developing appropriate measures of actual control in the living environment is a key area for future research which should attempt to match the robust measures that have been developed in the work environment in high-income countries (e.g., Karasek and Theorell, 1990).

8.4.4. Limited analysis of mechanisms at different spatial levels

One challenge in primary studies and synthesizing evidence across studies is to understand how mechanisms generating gender inequalities work and are generated across different levels. The reviews in this thesis have either focused on the household level (Studies 1 and 4), or the national level (Study 2) (plus a few regional level studies within the includes in Study3). Clearly pathways to inequalities work across households, neighbourhoods, communities, regions (particularly in very large countries such as India and China), and nations. Synthesising evidence across those levels is however challenging. As part of the process of ensuring the Study 2 systematic review only included studies of reasonable methodological quality, in the absence of a suitable tool for 'scoring' demographic

evidence (no international standard existing), the review only included representative studies at the national level. While this was a pragmatic approach and a strength in methodological quality terms, it was also a limitation that meant the review did not include subnational studies which indicate potentially large geographical and socioeconomic variations in SRBs within son preference countries. Looking within countries, provincial and district level analyses conducted in China and India reveal large variations in SRB across regions and between urban and rural areas that changed over time (relating to population urbanisation, and an apparent spread of son preference in what Kuzhiparambil and Rajani described as a 'contagion effect') that were masked in aggregate national level data (Jiang et al., 2017; Poston et al., 1997; Jha et al., 2011; Kuzhiparambil and Rajani, 2012; Guilmoto, 2012a). Subnational studies in India also suggest that mothers from more affluent socio-economic positions were more likely to have (and/or record) male births than mothers from lower social positions (Bhalotra and Cochrane, 2010; Bhat and Zavier, 2007; Gellatly and Petrie, 2017; George and Dahiya, 1998; Hu and Schlosser, 2015; Jha et al., 2006, 2011). The subnational evidence suggests that more empowered, affluent, and better-educated women in India were more likely to use abortion to achieve family size and sex compositions perceived as 'ideal' in their society. The subnational evidence on geographic, ethnic, religion, and socioeconomic distribution of sex-selection practices within countries may provide additional important insights into the phenomenon, and potential interventions, if limitations to methodological quality (and assessment of quality) can be overcome.

8.4.5 The issue of circularity

There is also a potential limitation related to the issue of circularity. In thesis studies 2 and 3, some of the primary studies included in the systematic reviews selected countries for analysis based on the existence of male skewed sex ratios, which were taken as an indicator of son preference. But the researchers in the primary studies were also treating skewed sex ratios as an indicator of the extent of female survival disadvantage in these countries – that is, the outcome of interest in the primary studies that I reviewed on the impact of son preference on female survival. On the one hand, this is a circularity limitation (Kriegeskorte 2010). On the other hand, the approach of investigating male skewed sex ratios to reveal the extent of 'missing women' is a conceptual and methodological innovation that has advanced knowledge on important questions. This is not a limitation of the primary studies. Furthermore, all the countries included in the primary studies that I reviewed (see table x in Appendix) could be shown in sociological/political economy literature to exhibit entrenched son preference, so it seemed valid to include these primary studies in my review to answer the review question.

8.5. Methodological advances

In the course of addressing the thesis objectives, the doctoral studies in this thesis made additional methodological advances.

First, the studies carried forward and extended the theory-based approach into the systematic reviews of empirical studies and the incorporation of theory-based logic models in this doctoral thesis. The particular challenges of conducting systematic reviews of theory have been well set out by Campbell and colleagues (2014) and refined in a number of worked examples (Pound and Campbell 2015a and 2015b) and theory reviews tailored to public health questions (e.g. Lorenc et al, 2012; Bonell et al, 2013). We were guided by and adapted these methods when further developing our mapping review of theories of how control over destiny could lead to socioeconomic inequalities in health, findings of which went on to underpin the whole of this thesis (Whitehead, Pennington et al., 2016).

The logic model of macro/societal level theories of pathways between profound discrimination against women and adverse health outcomes guided many of our key decisions on which linkages in the model to study, the searching and identification of the relevant literature, and the appraisal and interpretation of evidence in the light of the theories. Drawing on the interrogation of the evidence from the four doctoral studies, we were able to update the logic model to reflect additional theory emerging from unforeseen consequences of national policies and technological innovations (Figure 12). The additional insights, gained through the theory and logic model-based approach, led to an iterative, evidence-based evolution of the underpinning logic model, which now includes important refinements and additions which aid understanding of the pathways, mechanisms, outcomes, intervention points, and priority areas for future research. Future research can be guided by this synthesis and understanding of what the current knowledge base tells us, and what remains to be investigated.

Second, the doctoral studies provide a worked example of what is involved in taking societal context and complexity into account in systematic reviews and evidence synthesis. A growing number of commentators call for complexity to be taken into account in the real world circumstances in which inequalities in health play out (Shiell et al., 2008; Hawe et al., 2009; Hawe, 2015; Petticrew et al., 2019), adverse effects of well-intentioned policies and interventions occur (Oliver, 2020; Lorenc and Oliver, 2013; Baum et al., 2019) and the operation of structural determinants of health are paramount but under-researched (O'Campo, 2012), who argues:

"*current research on inequities tends to focus on documenting disparities among individuals or subpopulations with little focus on identifying the macro-social causes of adverse population health. Moreover, the research base falls far short of a focus on the solutions to the complex multilevel drivers of disparities*" (O'Campo, 2012).

At every stage of the systematic review process, the doctoral studies wrestled with, and solved, the many methodological issues involved in making assessments at the macro/societal level, as detailed in section 8.3. These macro-level challenges ranged from the theories underpinning the logic models to the selection of appropriate measures of actual control at the societal level, to the health outcome

measures and the theory of change in the intervention studies. The context of life for women in son preference countries needed to be understood in all its complexity.

Third, during the course of studies 2 and 3, we made advances in quality appraisal for the demographic studies on observed and expected population sex ratios. No international standard has been developed for 'scoring' the types of demographic evidence in these reviews. Demographic studies present a layer of complexity for such scoring even beyond the tricky issues raised by more common types of observational study. Although the ROBINS-E tool (Risk of Bias in Non-randomised Studies of Exposures) was developed for use with observational studies of exposures, it built upon tools for risk of bias assessment in randomised trials, diagnostic test accuracy studies, and observational studies of *interventions*. It has been shown to be inappropriate for the task of evaluating observational studies of exposures for questions of *harm relevant to public and environmental health* (Bero et al, 2018). In the absence of a suitable validated tool for 'scoring' demographic evidence, the approach we developed for quality-assuring the evidence entailed:

- Including only studies employing good quality national data sources (vital statistics, Census, high quality population surveys).
- Excluding single-centre studies and those with non-representative population samples.
- Excluding those in which the samples were too small for the sub-group analyses that the studies had undertaken (a particular problem for some analyses of sex ratios at birth for higher birth orders of some immigrant groups in destination countries).
- Excluding studies which pooled data inappropriately across too many years or across critical time periods when significant technological innovations had come into common use.
- Examining the theoretical basis for the choice of reference population and excluding those studies that had used an inappropriate reference against which to make comparisons (this was an issue particularly for immigrant groups from son preference countries to non-son-preference destination countries).

The approach could be improved still further. Appropriate risk-of-bias and methodological (and reporting) quality assessment and scoring tools need to be developed to assess the complexities of such observational demographic studies in the future. This gap in methodological quality assessment tools for demographic studies is itself another insight from this research.

8.6. Priority areas for future research

Gaps in the evidence base were identified and some priorities for further research incorporated into the updated logic model in Figure 12. There are four main lines of enquiry:

8.6.1. Further elucidation of the pathways to adverse health impacts

There are several mechanisms in the pathways to adverse health impacts depicted in the logic model in Figure 12 that need further elucidation to better inform future policy. An immediate question for a systematic review is:

> What is the evidence on the health and survival impacts of discrimination and neglect in access to health care and nutrition to girls and women, relative to boys and men, in son-preference countries?

I have already started this systematic review, as indicated on the logic model.

One of the key insights from study 2 was the existence of the 'paradox of opposing forces affecting female survival' in son preference countries - general improvements in postnatal female mortality, contrasting with rising levels of prenatal sex selection. The identified limitation of the Gender Inequality Index (GII) in not capturing female-to-male survival in son preference countries needs to be investigated, and potential modifications to such indices considered. The opposing forces need to be untangled further. To aid this untangling, there is a need for further evidence on prenatal influences on sex ratios at birth in son-preference countries. Studies on the impacts of birth stopping and sex-selective contraception use on sex ratios at birth need systematic review and contributions to numbers of 'missing' girls and women assessed. New primary-level studies on the impacts of new technologies for prenatal sex selection on sex ratios are urgently required, followed by systematic review when appropriate. One important review question is:

> What is the evidence on the impacts of new technologies for pre-implantation sex-selection, foetal sex identification, and sex-selective abortion on sex ratios at birth in son preference countries?

8.6.2. Evidence synthesis of wider societal consequences of profound discrimination against women

A new theoretic pathway was revealed during the process of undertaking doctoral study 2: the societal imbalances in sex ratios at birth created in recent decades in a country producing unforeseen adverse impacts on the social fabric of that society as the surplus of young men reach adulthood. This has been added as a new pathway in the revised logic model in Figure 12, leading to adverse societal outcomes for the whole of the population, not only for women living in that society. Reports of the development of these wider adverse consequences are, however, scattered and sometimes anecdotal. There is a need for systematic reviews on the empirical evidence concerning this new pathway.

8.6.3. The migration of prenatal sex selection

The question of whether practices such as sex selective abortion persist when people from son preference countries emigrate to non-son-preference countries is an important one for the host countries which prohibit discrimination of this nature. Doctoral study 3 revealed the relative paucity of studies on this question, particularly high methodological studies. There is also a gap in the evidence base on the persistence of sex-selection practices across generations of migrants. Further and higher methodological studies are needed of sex ratios at births of children born to migrant populations from son preference countries in high-income countries including the UK, Norway, New Zealand, Greece, Italy, Spain, and Canada, in particular. Studies of migrant populations from countries with more recently emerging skewed sex ratios, such as Vietnam, are also needed. The systematic review in Study 3 should be updated when sufficient further evidence is available.

8.6.4. Systematic reviews of policy and intervention studies

Doctoral study 4 reviewed interventions at one policy/intervention entry point depicted in the logic model in Figure 12: women's empowerment initiatives. It is apparent that further reviews of the evidence related to the other important policy entry points depicted in the model are needed. Examples of potentially relevant policies and interventions are given in the model for each intervention entry point. Together, these represent a vast research agenda, which will need to be broken down into component parts.

I have chosen to undertake a systematic scoping review of studies at one of the most immediate policy entry points, a decision stemming from the findings of my doctoral studies. This scoping review will cover the influence of population control policies on prenatal sex selection practices in son preference countries and legal/regulatory measures introduced to control or prohibit the practices.

In addition, as highlighted in section 8.3, the intensive study of positive outliers could yield valuable insights for future policy development. From doctoral study 2, South Korea is a case in point. It bucked the trend and returned to biologically normal sex ratio at birth. Why and how did this come about? That is an important question for an in-depth case study employing a range of qualitative and quantitative methods.

8.7. Implications for policy

8.7.1 The magnitude and urgency of the problem

There have been concerted efforts by international organisations such as the UN and the WHO to highlight some of the overt and insidious effects of profound gender discrimination on health and

survival in son preference countries. There is however a danger that the full scale and ramifications of the problem have been under recognised as a public health disaster in some quarters.

This research has highlighted that the injustice of profound gender discrimination has led to a great many more than 100 million girls and women being denied the chance of life or the opportunity to flourish, and that the problems of 'missing women' and its wider effects have grown, not diminished, in recent years, despite improvements in some countries. Recent empirical predictions suggest significant growth beyond Southern and Central Asia and the Caucuses, into parts of North and sub-Saharan Africa in coming years. Chao et al. predicted that sub-Saharan Africa may become the third locus of 'missing girls' later this Century, as the region grows to become the most populous on earth (Chao et al., 2021, UN, 2023). Wider impacts on the demographic, economic and social 'threads' of the fabric of societies, including increasing millions of 'excess' men being denied hope of partners, wives, and children, need to be recognised and addressed. The potential for new waves of sex selective abortion through new, affordable, and discreet technologies also highlighted by this research are yet to receive proper attention, and that is urgently required.

Previous policy efforts have failed to match the scale and pace of the problem in most countries, and some policies (including mandatory population control policies) appear to have exacerbated it. The scale, severity and persistence of the problem over time, the paradox of opposing forces affecting female survival, and the evolution of mechanisms of discrimination highlighted by this research need to be recognised and addressed. We should not be lulled into complacency by reductions in sex selection at birth in some countries. This is a global public health catastrophe affecting girl's and women's survival in societies covering over half the population on earth as well as some other countries receiving migrants. It should receive global attention from governments, policy makers, academics, journalists, civil society organisations, and the public commensurate to its magnitude.

This research points to the need for: i. better evidence to inform better policies; ii. the use of lessons from national comparisons, on policy levels, and on the importance of women's control/autonomy; iii. targeting of policies to intervention points, pathways, and the use of 'upstream' policies; iv. prevention of a new technologically driven wave of sex selection; v. action to understand and address migration related concerns; and vi. tackling of the wider and longer-term consequences of skewed sex ratios.

(i) Better evidence to inform better policies

Policies should be informed by the best available evidence (Blessing et al., 2017), but the major gaps and limitations in the evidence base highlighted by this research need to be addressed. This includes gaps in the evidence on some mechanisms, the wider impacts of 'missing women' and 'excess males', and the pressing need for more robust evaluations of the effectiveness of policies and interventions. Beyond the identification of the effectiveness of interventions, policy makers also need to be armed with an understanding of the 'ingredients' of why, how, and for whom interventions will and will not work, and this will require further, different forms of investigation (O'Campo, 2012; Pawson, 2006).

(ii) National level comparisons, policy levels, and the importance of women's control

By systematically reviewing the evidence across multiple studies, this research highlighted international comparative evidence that indicates the potential for national policy change. Study 2 shows that South Korea completely reversed the increasing trend in excess male-to-female sex ratios at birth in the 1990s. By 2007 sex ratios at birth had returned to natural, biologically normal levels. This coincided with the establishment of civilian democratic government and reversal of authoritarian policies and laws that reinforced a patriarchal culture/family system that was originally socially engineered in the early-mid Choson dynasty (1392-1910) to create a strong authoritarian state. That system replaced an earlier, more bilateral and equitable family system (Chung and Das Gupta, 2007). One-Child policy in China may be an example of national policy unintentionally exacerbating the problem, but South Korea provides an example that son preference culture can be deliberately reduced through national-level action. Chung and Das Gupta (2007) found that almost three-quarters of the decline in son preference was attributed to normative cultural change (including from changes to family laws), and the remaining to increases in educated and urban populations, which all reduced the patriarchal, patrilineal, and patrilocal organisation of families and society at large over time. The changes in South Korea point to the need for multifaceted, multi-level intervention, and the essential role of national social and economic policies in shaping the organisation of society.

This thesis research identified a range of potential national policies including changes to inheritance and property rights, social protection in old age, women's legal and political representation, education and employment opportunities for girls and women, mandatory and voluntary population control policies, support to the parents of girls, and legislation banning use and advertising of sex selection technologies (Figure 12). It is not possible or appropriate to single out any one policy, partly because of the identified need for robust evaluative research, partly because of the scale and extent of this societal-level problem, and partly because the example of South Korea and the findings from across the thesis studies, and the underlying theory, all point to the need for multifaceted, multi-level combinations of policies to tackle the pervasive culture of discrimination. Systemic problems require systematic solutions. The evidence also points to the importance of women's control/autonomy and empowerment in the pathways, and in the solutions. There is also an opportunity to empower women to improve their living conditions through their meaningful involvement in the design and delivery of the necessary policies. Gender Impact Assessment, Health Equity Impact Assessment and related methodologies provide established approaches to meaningful involvement of stakeholders in the decisions that affect their lives, to 'gender proofing' policies, and to reducing inequalities (for example, Abrahams et al., 2004; Pennington et al., 2021).

The thesis studies, particularly studies 1 and 4, provide insights into the mechanisms and effectiveness of collective empowerment-based interventions. These studies indicate that actual control, such as control over resources, can have profound effects on both women's health and that of their children. This highlights the need for intervention to include concrete measures that increase women's direct control over decision-making and access to/control over resources. Study 1 also indicated that for the

poorest women, empowerment alone was unable to effect change, so interventions must raise them from extreme poverty first. Control/empowerment is a potential 'flexible resource' for women that, according to Link and Phelan (1995) may be deployed to avoid risks and adopt protective strategies by individuals or collectives when social conditions and risks factors change over time. Evidence in Study 4 (Kim et al., 2007) showed that newly empowered and more confident women adapted their behaviour to avoid risks of intimate partner violence during cultural transition/upheaval. Increased ability to adapt to changing circumstances may bring additional, longer-term benefits beyond the immediate improvements to material living conditions brought about by microfinance. As with national-level policies, women can also be empowered by meaningful involvement in the design and delivery of interventions in their communities, and in the evaluation of impacts and in subsequent development of refinements.

Evidence from study 1 indicated the mediating role that the degree of control has in the relationship between education and health outcomes and the modifying effects of wealth. This indicates that policies aiming to improve the education of women, also need to pay attention to the pathways through which this leads to greater control and on to better health, aiming to enhance those pathways. This could, for example, include supporting girls in transitions from education to employment to help them manage competing demands and stressors/risks in their living and working environments.

The evidence from Study 4 indicates that attention should also be paid to potential unintentional adverse impacts of policies and interventions, such as potential stress from debt in microfinance schemes, and to ensuring that women have control over the incomes they receive. Link and Phelan (1995) argue that to reduce inequalities and not exacerbate them, interventions should minimise demands on individuals' resources, so benefits are not limited to those who can access/afford them. The collective funding arrangements and wider scheme support of microfinance schemes in Study 4 provide an example of this.

Chung and Das Gupta (2007) also point out that there is an often missed and important distinction between the intensity of son preference, and how it is manifested in sex ratios. They argue that in South Korea between 1985 and 1995 data indicate that the intensity of son preference fell (a result of normative change, education and urbanisation), but male-skewed sex ratios at birth still increased (as can be seen in Study 2 Figure 9) because newly introduced technologies made sex selection easier, and better educated women were more able to access and afford it (noting that a positive association between socioeconomic position and levels of sex selection at birth was also shown in the subnational studies in India described in Section 8.4.4.). This is important in other country contexts were economic development and rising incomes may increase access. It is also of pressing importance to the context of the new wave of relatively cheap, discrete, and easy to access technologies for prenatal sex selection, particularly in countries with a paucity of measures to combat a culture of son preference (a potential 'perfect storm' for sex selection).

(iii) Intervention points, pathways, and the importance of 'upstream' policies

The revised logic model in Figure 12 includes seven policy intervention points on the pathways between profound gender discrimination and health, survival, and wider outcomes identified during this research. While policies are now required to address issues at each of these points, the pathways to adverse outcomes may be 'broken' (prevented), or impacts ameliorated most effectively, by upstream interventions (left hand-side of the logic model) to reduce gender discrimination (intervention point 1) and increase women's control over resources (intervention point 2). The underlying theory, the evidence from Studies 1 and 4, and the wider literature on interventions (e.g. Kumar and Sinha, 2019) supports this.

(iv) Preventing a new technologically driven wave of sex selection

One of the starkest insights from this research is that a new wave of technology driven sex-selection may almost be upon us. New technologies for prenatal sex-selection, and home fetal sex identification and abortion have already been developed. It is too early to tell what impacts these technologies will have on sex ratios in son preference countries, but they are becoming cheaper, easier to distribute, less invasive, and easier to conceal. The nature of affordable home use technologies and modern methods of distribution may make proliferation far faster than for previous costly, cumbersome, and complicated technologies that brought about the last waves of sex-selection, as shown in study 2. A range of new policies is needed to address this. New regulations and measures for monitoring, governance, accountability, and for controlling the uptake of new technologies, and for mitigating impacts, may be needed. Kumar and Sinha (2019) suggest direct legal measures alone may be insufficient. Indirect measures across the intervention points in Figure 12 should also be considered. A pragmatic, 'best available evidence' approach to intervention may be necessary because the proliferation of the technologies may come before the generation of more robust evidence on effectiveness. Policies across the intervention points involve approaches to raise the material and social standing of women, including supportive measures for girls and women, and advocacy, communication, and community mobilisation (which were all important in South Korea). Again, the findings of this thesis suggest that multifaceted, multi-level interventions, which recognise the importance of women's status, control and empowerment, may be most effective. Demographic studies can reveal the toll on sex ratios, so sex ratios at birth should be carefully monitored so that growth hotspots can be understood, and timely interventions targeted. Problems with data quality in low- and middle-income countries are, however, widely recognised (Hesketh and Xing, 2006; Bongaarts and Guilmoto, 2015b; Chao et al., 2019). An interagency statement by WHO, ONCHR, UNFPA, UNICEF, and UN Women on the prevention of gender-based sex selection in 2011 advocated investment in data systems (national censuses, population surveys, and vital registration systems) for accurate and timely tracking of changes in SRBs at micro, subnational, and national levels to provide a sound basis for intervention (WHO, 2011). The need and urgency for these investments is growing with the rapid development of new technologies.

(v) Migration related concerns

Evidence on the migration of sex selection practices was limited in Study 3 by the small number of studies of sufficiently high methodological quality available. Policymakers should note that this is not an indication that there is not a problem, and most of the available, albeit limited, evidence points to the persistence of sex selection among some migrant population groups. The questions from Study 3, Chapter 6, need to be addressed to inform future policies: are abortion laws being broken by health professionals? Is there evidence that expectant parents travel overseas for sex-selective abortions? Are other birth control mechanisms, such as birth stopping, coming into play? To what extent do more recent sex selection technologies now play a role?

If the results from the studies in New Zealand and Italy that found no evidence of sex selection at birth can be replicated, further investigations into the context, policies and processes that may have contributed to weakening the link to past son preference may provide important policy insights for other countries.

Policy makers in host countries should act to ensure the rights of women in migrant communities are actively supported, and that the value of girls is promoted. The potential persistence of discrimination across generations after arrival in host countries could be tackled in universal education, and by civil society organisations working within communities.

High income countries such as the UK have some of the best vital registration systems in the world. It is therefore surprising that studies of sex ratios at birth in the UK were unable to access appropriate ONS data for mothers born in China because of data aggregation issues. As sex ratios at birth for babies of mothers born in China were identified as skewed in other high-income host countries, this issue should be investigated and resolved to enable further study.

(vi) Wider and longer-term consequences

The unforeseen wider impacts on the population, economic, and social threads of society in countries with high numbers of 'missing women' and 'excess men' need to be understood, along with subsequent health impacts. Related policies need to be developed and applied (and later evaluated) for the new pathway identified in the revised logic model (furthest right policy intervention points in Figure 12).

The most effective way of averting these wider societal consequences is of course prevention – reducing the numbers of 'missing' girls and women in the first place through intervention points on the left-hand-side of the logic model. As we saw in Study 2, however, there are already very large numbers of 'missing women' and 'excess men' in some countries, particularly in China and India, and policies need to be developed to tackle related impacts. This thesis research has identified potential impacts on the wellbeing of 'excess' ('involuntary celibate') men as well as women and on their wider communities. These include depression, anxiety, loneliness, and lower life satisfaction, risky

behaviours (sexual, alcohol misuse, gambling, conflict with others, suicidal ideation), crime and violence, social order/disorder, population depletion and ageing of the population in poorer and more rural areas, human trafficking and prostitution, bride trafficking, and bride-abduction. All of these need to be identified, understood, and addressed by far reaching policies and interventions. Other worrying impacts may be the adoption or trade in abandoned girls within countries (to serve as household help and future wives), or to other countries, with all the implications to the safety and wellbeing of such girls that brings. Abduction and trafficking of girls and women requires national and international cooperation in law enforcement and other areas. The potential for millions of 'hidden girls' in China, identified in Study 2, also need to be brought to the attention of policy makers. If these girls are 'hidden' from officialdom during the early years of life they may have limited or no access to key resources for health and wellbeing including healthcare, vaccinations, and education. Policies need to be developed to identify and support these girls. The geographical distribution of these unforeseen outcomes needs to be understood, with likely concentrations in areas with higher levels of son preference (higher numbers of 'missing women') and in poorer and more rural areas (higher numbers of 'excess men'), to inform the targeting of proportionate interventions.

Chapter 9 – Reflections on contribution to knowledge and my own research journey

In this concluding chapter I identify key advances in knowledge made as a result of this doctoral thesis, reflect on my own personal research journey during my studies and outline how I am taking forward some further studies from the research agenda that the thesis has generated.

9.1. Overall contribution to the knowledge base

This thesis research has made important original contributions to the knowledge base on the health and survival impacts of profound gender discrimination in son preference countries and on interventions to address them. Overall, this included advances in the understanding of:

- The empirical evidence relating to the upper (low control for women) pathway and the lower (son preference) pathway, and mechanisms in my thesis logic model.
- The magnitude, urgency, and distribution of the problem of 'missing women', wider societal issues, and the shifting nature of threats to female survival over time, including the paradox of opposing forces, and the imminent threat from new sex selection technology.
- The role and importance of women's control/empowerment in the pathways between profound gender discrimination and health and survival outcomes.
- The nature and importance of 'upstream' approaches to addressing the problem, and how they relate via the pathways to 'downstream' mechanisms, and how policies should be targeted across the multiple identified intervention entry points.
- The importance of considering impacts on both intended beneficial and unintended and unforeseen adverse outcomes.
- Important gaps and limitations in the evidence base, and priority areas for future research.

A crucial original overall contribution to the knowledge base is the evidence-based development/evolution of the underpinning logic model during the process of this research. This included the addition of intervention entry points that are key to addressing this issue, the addition of a new pathway to newly identified wider societal impacts, and the addition of potential policies and interventions to tackle the problem.

9.2. Personal reflections on my research journey

Conducting a part-time PhD while working as a busy public health researcher was not without difficulties, particularly in light of some considerable challenges particularly during the early years of the COVID-19 pandemic. My scientific peregrination through the knowledge base on the impacts of profound gender discrimination has however, been enlightening, fruitful, and often enjoyable, but

also shocking and deeply saddening on occasions when I discovered the scale of the health damage caused to so many women in the world today. This journey will continue with further dissemination of the important findings of the research, and through further investigation, some of which is already underway.

9.2.1 Development as a researcher and what I've learnt

I've made important progress in my development as a researcher during the 6 years of conducting this research. It has helped me discover my niche, the area of research that I am most suited to, most enjoy, and can have the greatest impact through. This is in the identification and synthesis of complex, often hard to find, theories and evidence on the social determinants of health inequalities, and actions to address them. It is broad, interconnected, and multidisciplinary in nature. The knowledge generated has wide implications for the organisation of societies and for the public's health. And fortunately, it's a pretty big niche, so it'll keep me busy!

I've learnt a great deal during the past 6 years, but some highlights include the following.

The use of theory through carefully synthesised, structured logic models is crucial to investigating and understanding evidence on the complex pathways, mechanisms, and contexts that create health inequalities in the real world. The process of synthesising theory allows us to 'step back', see the bigger picture, and understand 'upstream' and 'downstream' pathways, complex interrelationships, and mechanisms that may change over time.

Culture is important, and probably the most influential overarching, 'upstream' determinant of health inequality, as it shapes all levels of society. It has received too little attention in previous research as its ubiquitous effects are hard to conceptualise and difficult to measure.

'Your review is only as good as your search', In addition to carefully, iteratively designed database searches, supplementary approaches are essential for these types of evidence reviews. Sometimes 'less is more', as overcomplicated search syntaxes can limit, not improve, results, and add unnecessary screening workload. Human minds are still unequalled by software in the identification of relevant literature and in the interrogation and understanding of complex, disparate evidence; at least for the time being! Hybrid approaches involving people and 'machines' are most efficient and effective.

Exceptions or outliers are important, providing they are not simply the result of data errors, noise, bias, or chance. William Bateson (1908) put it best: *'Treasure your exceptions! ...Keep them always uncovered and in sight. Exceptions are like the rough brickwork of a growing building which tells that*

there is more to come and shows where the next construction is to be.' (Beatrice Bateson, 2009). South Korea is an important exception in Asia.

Multidisciplinary research is challenging and time consuming, but it yields results beyond what single disciplines can provide. Theory-based multidisciplinary systematic reviews across bodies of evidence provide greater insights into social phenomenon.

The peer review for publication in high quality academic journals can be challenging and time consuming, but it can really help strengthen papers, so it's worth the pain!

I've developed useful competencies and skills in the synthesis of theory, location of hard-to-find evidence (including 'needles in haystacks'), synthesis of complex evidence, creation of logic models, and lots of technical research and design skills that aid the efficient conduct of research and the dissemination of findings through multiple formats.

These developments have fed into and strengthened my wider work as a researcher specialising in knowledge synthesis across multiple projects and publications, as the Health Inequalities Policy Research Unit knowledge synthesis lead in the Department of Public Health, Policy and Systems at the University of Liverpool, in my previous work with Rhiannon Corcoran and colleagues in the Community Wellbeing Evidence and Communities of Place programmes on community empowerment and other evidence reviews, and the Community Wellbeing Tree and Wellbeing Inequality Assessment Toolkit (Pennington et al, 2021), and more recently on the WHO Collaborating Centre project on the health equity impacts of the pandemic, other crises, and recovery measures with Ben Barr and colleagues. What I have learnt from working for many years with Margaret Whitehead is that the task of a researcher is not complete if their thesis sits on a university shelf gathering dust. It is my duty as a PhD student to disseminate the findings of my research to where they can best be acted upon to bring about change for the better. I have learnt that lesson well with my supervisor's guidance.

9.3. Taking the research agenda from this thesis forward

Substantial further reviews of evidence are required, as indicated in Figure 12

In terms of the observational evidence on intervening mechanisms, I have started a further systematic review of evidence on the health and survival impacts of discrimination and neglect in access to health care and nutrition to girls and women, relative to boys and men, in son-preference countries. I am

also planning to conduct a systematic scoping review of evidence on the wider impacts of 'missing women' and 'excess men'.

In terms of the evidence on intervention points and policies, I have chosen to undertake a systematic scoping review examining the influence of population control policies on prenatal sex selection practices in son preference countries and legal/regulatory measures introduced to control or prohibit the practices. This is a clear, important gap in the systematic review-level evidence. Further systematic reviews are, however, required of other intervention points and policies.

Primary study-level evidence has not yet emerged on the impacts of new sex selection technologies on sex ratios at birth, particularly home use sex determination and abortion technologies. Given the potential for these technologies to have substantial and rapid effects on sex ratios at birth, I will be running periodic searches to identify the evidence as it emerges. I will also be running periodic searches for new studies on migrant sex ratios at birth so that that review (Study 3) can be updated in a timely fashion once sufficient additional evidence is available.

This research has to date resulted in three publications in high impact academic journals. A fourth paper on 'the migration of discrimination' is in the latter stages of development, before submission for publication. I'm planning, when I have more time available after completion of my part-time PhD, to disseminate the findings of this research further and to a wider audience in the academic community (importantly including students), and to stakeholders, policy makers, and civil society organisations, through a variety of in person and virtual platforms. One example of an addition to the academic publications is the production of an infographic on 'missing women' that I am currently developing for the NIHR Public Health Policy Research Unit, which funded the work that led to the Whitehead, Pennington et al. 2016 paper that stimulated this thesis, completing the circle.

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Whitehead M, Pennington A, Orton L, Nayak S, Petticrew M, Sowden A, et al. (2016) How could differences in 'control over destiny' lead to socio-economic inequalities in health? A synthesis of theories and pathways in the living environment. Health Place. 14(39):51-61.

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Appendices

Appendices for Chapter 4 – Study 1

Appendix 1

Example of search syntax – MEDLINE

MEDLINE and MEDLINE In-Process & Other Non-Indexed Citations
Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) <1946 to Present>
Searched via OVID 24/02/17. Restricted to English language only, 1980 to 2016.

Strategy:

1   (Gender or Women? or Woman or Girl? or female? or Mother? or Wife or Wives or Daughter?).ti,ab.

2   (autonomy or decision?mak* or self-determination or dis?empower* or empower* or powerless* or decision?latitude or decision?authority).ti,ab

3   (household? or home? or residence?).ti,ab.

4   1 and 2 and 3

5   Limit 5 to (English language and humans and yr="1980-2016")

Appendix 2

Critical appraisal and typology of observational studies

Studies that met our initial inclusion and exclusion criteria were first subjected to quality appraisal and second to categorisation based on study design, as follows.

1. Quality appraisal

The quality assessment tool contains four questions:

    i.   Selection bias

    ii.   Confounders

   iii.   Data collection

   iv. Withdrawals and dropouts

Each question can receive an A (good), B (fair), or C (poor) quality rating. The guidelines for the specific questions are as follows.

1. Selection bias

Selected study sample very likely to represent population from target area AND 80 to 100% response at baseline	A
Selected study sample very likely to represent population from target area AND 60 to 79% response at baseline; OR Selected study sample somewhat likely to represent population from target area AND 80 to 100% response at baseline	B
<60% baseline response; OR Somewhat likely to represent population AND <80% response; OR Not likely to represent population OR representativeness NR/unclear; OR Response rate at baseline NR/unclear	C

2. Confounding

They adjusted for key variables (SES, age, ethnicity) in the analysis and provided supporting data	A
Stated that they adjusted for key variables (SES, age, ethnicity) in the analysis but failed to provide supporting data	B
No adjustment for key variables reported	C

3. Data collection

Piloting or pre-testing of tool; OR checks on validity of data (e.g. verification of a percentage of responses); OR tool shown to be reliable in relevant population	A

Data collection tool based on previous research, but no piloting or checking, and reliability not demonstrated	B
Data collection unclear; OR tools not piloted, checked or based on previous research	C

4. Withdrawals and dropouts

Attrition <20%	A
Attrition 21%-40%	B
Attrition >40%; OR attrition NR; OR cross-sectional data only	C
Note: Attrition is measured as the percentage of the baseline sample lost at final follow-up	

Those that scored "C" on any of the criteria were excluded on quality grounds. Those that scored "A" or "B" were included in the final review, and categorized into "higher quality" or "lower quality" based on their study design, as the following typology illustrates.

2. Typology of quantitative observational study designs

i. Longitudinal studies using individual-level data	Higher quality studies
ii. Repeat cross-sectional studies using individual-level data	
iii. Ecological comparative studies (repeat cross-sectional)	
iv. Ecological comparative studies (single-point cross-sectional)	Lower quality studies
v. Case-control studies	
vi. Single-point cross-sectional studies	

Appendices for Chapter 5 – Study 2

Appendix 3

Example, MEDLINE search strategy for systematic review of evidence on relative survival outcomes for of girls and women in son-preference countries

MEDLINE, and MEDLINE In-Process & other Non-Indexed Citations <1980 to 2020>
Searched via OVID 17/11/20. Restricted to English language and human.
Syntax:
1   Son preference.ti,ab.
2   Gender preference.ti,ab.
3   Sex select*.ti,ab.
4   Sex-select*.ti,ab.
5   Gender select*.ti,ab.
6   Gender-select*.ti,ab.
7   Missing women.ti,ab.
8   Lost girls.ti,ab.
9   OR 1 to 8
10   Limit 9 to Humans, English language and 1980 to 2020

Appendix 4

Studies excluded during full text screening, and reasons for exclusion in systematic review of evidence on relative survival outcomes for of girls and women in son-preference countries

Article	Reasons for exclusion (Number of articles)
Agrawal S (2012) The sociocultural context of family size preference, ideal sex composition, and induced abortion in India: Findings from India's National Family Health Surveys. Health Care Women Int. 33:986-1019. Altindag O (2016) Son preference, fertility decline, and the nonmissing girls of Turkey. Demography. 53:541-566. Ambel A (2008) Essays on intrahousehold allocation and the family: Fertility, child education, and nutrition. Doctoral dissertation, Harvard University. Amin R, Mariam A (1987) Son preference in Bangladesh - an emerging barrier to fertility regulation. J Biosoc Sci, 19:221-228. Arulampalam W, Bhalotra S (2008) The linked survival prospects of siblings: Evidence for the Indian states. Popul Stud (Camb). 62:171-190. Bharadwaj P, Lakdawala L (2013) Discrimination begins in the womb Evidence of sex-selective prenatal investments. J Hum Resour. 48:71-113. Bhaskar V (2011) Sex selection and gender balance. Am Econ J Microecon. 3:252-253. Bose S (2012) A contextual analysis of gender disparity in education in India: The relative effects of son preference, women's status, and community. Sociol Perspect. 55:67-91. Bose S, Trent K (2006) Socio-demographic determinants of abortion in India: A north-south comparison. J Biosoc Sci. 38:261-282. Chamarbagwala R (2011) Sibling composition and selective gender-based survival bias. J Popul Econ. 24:935-955. Chamarbagwala R, Ranger M (2010) A multinomial model of fertility choice and offspring sex ratios in India. J Dev Stud. 46:417-438. Chaturvedi S, Chhabra P, Bharadwaj S, Smanla S, Kannan A T, Students Study Group (2007) Fetal sex-determination in Delhi: a population-based investigation. Trop Doct. 37:98-100.	Outcome - Not survival / 'missing girls or women' (as population ratios) (n=77)

Chen Y (2008) The significance of cross-border marriage in a low fertility society: Evidence from Taiwan. J Comp Fam Stud. 39:331.

Chen Y, Li H, Meng L (2013) Prenatal sex selection and missing girls in China: Evidence from the diffusion of diagnostic ultrasound. J Hum Resour. 48:36-70.

Chun H, Das Gupta M (2009) Gender discrimination in sex selective abortions and its transition in South Korea. Womens Stud Int Forum. 32:89-97.

Chung W, Das Gupta M (2011) Factors influencing 'missing girls' in South Korea. Appl Econ. 43:3365-3378.

Clark S (2000) Son preference and sex composition of children: Evidence from India. Demography. 37:95-108.

Cronk L (1991) Intention versus behaviour in parental sex preferences among the Mukogodo of Kenya. J Biosoc Sci. 23:229-40.

Dama M (2011) Sex ratio at birth and mortality rates are negatively related in humans. Plos One. 6(8):e23792.

Das Gupta M (2005) Explaining Asia's "missing women": A new look at the data. Popul Dev Rev. 31:529.

den Boer A, Hudson V (2017) Patrilineality, son preference, and sex selection in South Korea and Vietnam. Popul Dev Rev. 43:119-147.

Detray D (1980) Son preference in Pakistan - an analysis of intentions versus behavior. Popul Index. 46:382-382.

Dharmalingam A, Rajan S, Morgan S (2014) The determinants of low fertility in India. Demography. 51:1451-1475.

Dinh T, Borjesson L, Nga N, Johansson A, Malqvist M (2012) Sex of newborns associated with place and mode of delivery: A population-based study in Northern Vietnam. Gend Med. 9:418-423.

Dreze J, Murthi M (2001) Fertility, education, and development: Evidence from India. Popul Dev Rev. 27:33.

Ebenstein A (2011) Estimating a dynamic model of sex selection in China. Demography. 48:783-811.

Echavarri R A, Ezcurra R (2010) Education and gender bias in the sex ratio at birth: evidence from India. Demography. 47:249-268.

Edlund L (1999) Son preference, sex ratios, and marriage patterns. J Polit Econ. 107:1275-1304.

Edmeades J, Rohini P, MacQuarrie K, Falle T, Malhotra A (2012) Two sons and a daughter: Sex composition and women's reproductive behaviour in Madhya Pradesh, India. J Biosoc Sci. 44:749-764.

Eliason S, Baiden F, Tuoyire D, Awusabo-Asare K (2018) Sex composition of living children in a matrilineal inheritance system and its association with pregnancy intendedness and postpartum family planning intentions in rural Ghana. Reprod. 15(1)187.

Erfani A, McQuillan K (2014) The changing timing of births in Iran: An explanation of the rise and fall in fertility after the 1979 Islamic Revolution. Biodemogr. Soc. Biol. 60:67-86.

Gangadharan L, Maitra P (2003) Testing for son preference in South Africa. J Afr Econ. 12:371-416.

Guilmoto C (2017) Gender bias in reproductive behaviour in Georgia, Indonesia, and Vietnam: An application of the own-children method. Popul Stud (Camb). 71:265-279.

Hamoudi A (2010) Exploring the causal machinery behind sex ratios at birth: Does hepatitis B play a role? Econ Dev Cult Change. 59(1):1-21.

Haque I, Patel P (2016) Assessing Hindu-Muslim fertility differentials in West Bengal: Insights from the National Family Health Survey-3 Data. J Fam Hist. 41:192-224.

Hatlebakk M (2017) Son preference, number of children, education and occupational choice in rural Nepal. Rev Dev Econ. 21:1-20.

Hesketh T, Lu L, Xing Z (2011) The consequences of son preference and sex-selective abortion in China and other Asian countries. CMAJ. 183:1374-1377.

Hossain M, Phillips J, Legrand T (2007) The impact of childhood mortality on fertility in six rural thanas of Bangladesh. Demography. 44:771-784.

Hu L, Schlosser A (2012) Trends in prenatal sex selection and girls' nutritional status in India. CESifo Econ Stud. 58:348-372.

Jayaraj D, Subramanian S (2004) Women's wellbeing and the sex ratio at birth: Some suggestive evidence from India. J Dev Stud. 40:91-119.

Jha P, Kumar R, Vasa P, Dhingra N, Thiruchelvam D, Moineddin R (2006) Low male-to-female sex ratio of children born in India: National survey of 1.1 million households. Lancet. 367:211-218.

Jiang Q, Li S, Feldman M (2011) Demographic consequences of gender discrimination in China: Simulation analysis of policy options. Popul Res Policy Rev. 30:619-638.

Jiang Q, Li Y, Sanchez-Barricarte J (2016) Fertility intention, son preference, and second childbirth: Survey findings from Shaanxi Province of China. Soc Indic Res. 125:935-953.

Kabeer N, Huq L, Mahmud S (2014) Diverging stories of "Missing women" in South Asia: Is son preference weakening in Bangladesh? Fem Econ. 20:138-163.

Karki Y (1988) Sex preference and the value of sons and daughters in Nepal. Stud Fam Plann. 19:169-178.

Kastor A, Chatterjee S (2018) Impact of sex composition of living children and couples' agreement on subsequent fertility in India. J Biosoc Sci. 50:666-682.

Kaul T (2018) Intra-household allocation of educational expenses: Gender discrimination and investing in the future. World Dev. 104:336-343.

Knight J, Shi L, Deng Q (2010) Son preference and household income in rural China. J Dev Stud. 46:1786-1805.

Kureishi W, Wakabayashi M (2011) Son preference in Japan. J Popul Econ. 24:873-893.

Leung S (1994) Will sex selection reduce fertility. J Popul Econ. 7:379-392.

Lhila A, Simon K (2008) Prenatal health investment decisions: Does the child's sex matter? Demography. 45:885-905.

Li J, Cooney R (1993) Son preference and the one child policy in China - 1979-1988. Popul Res Policy Rev. 12:277-296.

Li J, Lavely W (2003) Village context, women's status, and son preference among rural Chinese women. Rural Sociol. 68:87-106.

Lipatov M, Li S, Feldman M (2008) Economics, cultural transmission, and the dynamics of the sex ratio at birth in China. Proc Natl Acad Sci USA. 105:19171-19176.

Mishra S, Ram B, Singh A, Yadav A (2018) Birth order, stage of infancy and infant mortality in India. J Biosoc Sci. 50:604-625.

Mwageni E, Ankomah A, Powell R (2001) Sex preference and contraceptive behaviour among men in Mbeya region, Tanzania. J Fam Plann Reprod Health Care. 27:85-89.

Nie L (2009) Essays on son preference in China during modernization. Doctoral thesis, University of California, Berkeley.

Nosaka A (2000) Effects of child gender preference on contraceptive use in rural Bangladesh. J Comp Fam Stud. 31:485.

Park C (1983) Preference for sons, family size, sex ratio: An empirical study in Korea. Demography. 20:333-352.

Park C, Cho N (1995) Consequences of son preference in a low-fertility society - imbalance of the sex-ratio at birth in Korea. Popul Dev Rev. 21:59-84.

Pham B, Hall W, Hill P, Rao C (2008) Analysis of socio-political and health practices influencing sex ratio at birth in Viet Nam. Reprod Health Matters. 16:176-184.

Pulver A, Ramraj C, Ray J, O'Campo P, Urquia M (2016) A scoping review of female disadvantage in health care use among very young children of immigrant families. Soc Sci Med. 152:50-60.

Puri S, Adams V, Ivey S, Nachtigall R (2011) "There is such a thing as too many daughters, but not too many sons": A qualitative study of son preference and fetal sex selection among Indian immigrants in the United States. Soc Sci Med. 72:1169-1176.

Ren X (1995) Sex differences in infant and child mortality in three provinces in China. Soc Sci Med (1982). 40:1259-69.

Ren Y (1995) Sex-differences in infant and child-mortality in 3 provinces in China. Soc Sci Med. 40:1259-1269.

Schwekendiek D (2010) Why has son-preference disappeared in North Korea? North Korean Rev. 6:65-73.

Short S, Zhai F, Xu S, Yang M (2001) China's one-child policy and the care of children: An analysis of qualitative and quantitative data. Soc Forces. 79:913-943.

Srinivasan S, Bedi A (2007) Domestic violence and dowry: Evidence from a south Indian village. World Dev. 35:857-880.

Tang Z, Sharp P (2011) Interactions of socioeconomic determinants, offspring sex preference, and fertility behaviour. Can Stud Popul. 38:99-113.

Tucker C, Van Hook J (2013) Surplus Chinese men: Demographic determinants of the sex ratio at marriageable ages in China. Popul Dev Rev. 39:209-229.

Weeks J, Rumbaut R, Brindis C, Korenbrot C, Minkler D (1989) High fertility among Indochinese refugees. Public Health Rep. 104:143-150.

Wong G, Leung W, Chin R (2010) Recent dramatic increase in the male-to-female sex ratio of babies born in Hong Kong. J Perinat Med. 38:209-213.

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Yount K, Langsten R, Hill K (2000) The effect of gender preference on contraceptive use and fertility in rural Egypt. Stud Fam Plann. 31:290-300.

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Almond D, Edlund L, Milligan K (2013) Son preference and the persistence of culture: Evidence from South and East Asian immigrants to Canada. Popul Dev Rev. 39(1):75. Almond D, Sun Y X (2017) Son-biased sex ratios in 2010 US Census and 2011-2013 US natality data. Soc Sci Med. 176:21-24. Blau F, Kahn L, Brummund P, Cook J, Larson-Koester M (2020) Is there still son preference in the United States? J Popul Econ. 33(3):709-750. Carol S, Hank K (2020) Natives' and immigrants' gender preferences for children in Germany. Eur J Popul. 36(2):235-246. Colls P, Silver L, Olivera G, Weier J, Escudero T, Goodall N, Tomkin G, Munne S (2009) Preimplantation genetic diagnosis for gender selection in the USA. Reprod Biomed Online. 19(S2):16-22. Dhillon N, MacArthur C (2010) Antenatal depression and male gender preference in Asian women in the UK. Midwifery. 26:286-293. Edvardsson K, Axmon A, Powell R, Davey M (2018) Male-biased sex ratios in Australian migrant populations: A population-based study of 1 191 250 births 1999-2015. Int J Epidemiol. 47(6):2025-2037. Filho A, Kawachi I (2013) Are sex-selective abortions a characteristic of every poor region? Evidence from Brazil. Int J Public Health. 58:395-400. Gonzalez L (2018) Sex selection and health at birth among Indian immigrants. Econ Hum Biol. 29:64-75. Grech V (2017) Further evidence of male offspring preference for certain subgroups in the United States (2007-2015) Early Hum Dev. 110:9-12. Grech V (2017) Evidence of socio-economic stress and female foeticide in racial disparities in the gender ratio at birth in the United States (1995-2014) Early Hum Dev. 106:63-65. Grech Victor (2017) Further evidence of male offspring preference for certain subgroups in the United States (2007–2015) Early Hum Dev. 110:9-12. Howell E Zhang H, Poston D (2018) Son preference of immigrants to the United States: Data from US birth certificates, 2004-2013. J Immigr Minor Health. 20(3):711-716. Joseph K, Lee L, Williams K (2016) Sex ratios among births in British Columbia, 2000-2013. J Obstet Gynaecol Can. 38(10):919. Liu P, Rose G (1995) Social aspects of > 800 couples coming forward for gender selection of their children. Hum Reprod. 10:968-71.	Country – not son-preference (n=20)

Park C, Braun K, Horiuchi B, Tottori C, Onaka A (2009) Longevity disparities in multiethnic Hawaii: An analysis of 2000 life tables. Public Health Rep. 124:579-584. Singh N, Pripp A, Brekke T, Stray-Pedersen B (2010) Different sex ratios of children born to Indian and Pakistani immigrants in Norway. BMC Pregnancy Childbirth. 10:5. Takaku R (2018) First daughter effects in Japan. J Jpn Int Econ. 50:48-59. Tang Z (2013) Sex preference for children and Chinese fertility in America. In: Chan Kwok-bun, ed., International handbook of Chinese families. New York: Springer Science & Business Media: 263-275. Tonnessen M, Aalandslid V, Skjerpen T (2013) Changing trend? Sex ratios of children born to Indian immigrants in Norway revisited. BMC Pregnancy Childbirth. 13:6.	
Agrawal A (2018) Women's human rights and migration: sex selective abortion laws in the United States and India. Int Fem J Polit. 20:284-285. Belanger D (2015) Son preference, science, and modernity. Asian Popul Stud. 11:211-213. Mackenzie D (2019) 23 million girls are 'missing' worldwide. New Sci. 242:10. Vogel Lauren (2012) Sex selection migrates to Canada. CMAJ. 184:E163-4.	Not empirical (n=4)
Bhattacharjya H, Baidya S (2017) Determinants of child sex ratio in West and South Districts of Tripura, India. Indian J Public Health. 61:112-117. Brooks R (2012) "Asia's missing women" as a problem in applied evolutionary psychology? Evol Psychol. 10:910-925. Chun H, Doyal L, Payne S, Il-Cho S, Kim I (2006) Understanding women, health, social change: the case of South Korea. Int J Health Serv. 36:575-592. Das Gupta M (2006) Cultural versus biological factors in explaining Asia's "missing women": Response to Oster. Popul Dev Rev, 32:328-332. Das Gupta M, Jiang Z, Li B, Xie Z, Chung W, Hwa-Ok B (2003) Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. J Dev Stud. 40:153-187. Das Gupta M, Bhat P (1997) Fertility decline and increased manifestation of sex bias in India. Popul Stud (Camb). 51(3)307-315. Dyson T (2012) Causes and consequences of skewed sex ratios. Annu Rev Sociol. 38:443-461. Guo Z, Das Gupta M, Li S (2016) 'Missing girls' in China and India: Trends and policy challenges. Asian Popul Stud. 12:135-155. Hesketh T, Xing Z (2006) Abnormal sex ratios in human populations: Causes and consequences. Proc Natl Acad Sci U S A. 103:13271-13275. Loh C, Remick E (2015) China's skewed sex ratio and the One-Child Policy. China Q. 222:295-319.	Not a primary-level study (review level) (n=13)

Murphy R (2014) Sex ratio imbalances and China's Care for Girls Programme: A case study of a social problem. China Q. 219:781-807.

Oldenburg P (1992) Sex-ratio, son preference and violence in India - a research note. Econ Polit Wkly. 27:2657-2662.

Sen A (1992) Missing women. BMJ. 304:587-588.

Basten S, Verropoulou G (2013) 'Maternity migration' and the increased sex ratio at birth in Hong Kong SAR. POP STUD-J DEMOG. 67(3):323-334. Belanger D, Oanh K (2009) Second-trimester abortions and sex-selection of children in Hanoi, Vietnam. Popul Stud (Camb). 63:163-171. Chhetri U D, Ansari I, Bandary S, Adhikari N (2011) Sex preferences among mothers delivering at Patan Hospital. Kathmandu Univ Med J. 9:229-32. Chu J (2001) Prenatal sex determination and sex-selective abortion in rural central China. Popul Dev Rev. 27:259. Graham M J, Larsen U, Xu X (1998) Son preference in Anhui Province, China. Int Fam Plan Perspect. 24:72-77. Guha A, Rai A, Gupta D, Mondal R (2019) Abandoned babies at Tertiary Care Rural Medical College Hospital: The Indian scenarios. Indian J Pediatr. 86:335-339. Kant S, Srivastava R, Rai S, Misra P, Charlette L, Pandav C (2015) Induced abortion in villages of Ballabgarh HDSS: rates, trends, causes and determinants. Reprod. 12:51. Le V, Duong D, Nguyen A, Nguyen C, Bui H, Pham C, Le T, Tran B (2017) Sex ratio at birth in Vietnam: Results from data in CHILILAB HDSS, 2004 to 2013. Asia Pac J Public Health. 29:25S-34S. Lee I, Lai Y, Kuo P, Chang C (2012) Human sex ratio at amniocentesis and at birth in Taiwan. Taiwan J Obstet Gynecol. 1:572-575. Mohanty S, Rajbhar M (2014) Fertility transition and adverse child sex ratio in districts of India. J Biosoc Sci 46(6):753-771. Qian Z (1997) Progression to second birth in China: A study of four rural counties. POP STUD-J DEMOG. 51:221-228.. Rai P, Paudel I, Ghimire A, Pokharel P, Rijal R, Niraula S (2014) Effect of gender preference on fertility: Crosssectional study among women of Tharu community from rural area of eastern region of Nepal. Reprod. 11:1-11.	Not population-level, or not national level (n=17)

Sahni M, Verma N, Narula D, Varghese R, Sreenivas V, Puliyel J (2008) Missing Girls in India: Infanticide, Feticide and Made-to-Order Pregnancies? Insights from Hospital-Based Sex-Ratio-at-Birth over the Last Century. Plos One. 3(5):e2224. Sharma M, Kumar S, Vats K (2018) Disappearing of Daughters or Failure to Perforate the Chakravyuha of Favoritism from Womb to Tomb. Med Legal Update. 18(2):211-218. Srinivasan S, Bedi A (2008) Daughter elimination in Tamil Nadu, India: A tale of two ratios. J Dev Stud. 44(7):961-990. Tse W, Leung K, Hung B (2013) Trend of sex ratio at birth in a public hospital in Hong Kong from 2001 to 2010. Hong Kong Med J. 19:305-310. Varghese J, Aruldas V, Jeemon P (2008) Beyond the numbers: Factors distorting sex ratio at birth. Indian J Gend Stud. 15:115-125.	
Seth S (2007) Sex selective foeticide in India. J Assist Reprod Genet. 24:153-154.	Not a full published study (n=1)
Almond D, Li H, Zhang S (2019) Land reform and sex selection in China. J Polit Econ. 127:560-585. Bhalotra S, Chakravarty A, Mookherjee D, Pino F (2019) Property rights and gender bias: Evidence from land reform in West Bengal. Am Econ J Appl Econ. 11:205-237. Bhattacharjya D, Sudarshan A, Tuljapurkar S, Shachter R, Feldman M (2008) How can economic schemes curtail the increasing sex ratio at birth in China? Demogr Res. 19:1831-1850. Chakraborty T (2015) Trade Liberalization in a traditional society: Implications for relative female survival. World Dev. 74:158-170. Chakravarty A (2010) Supply shocks and gender bias in child health investments: Evidence from the ICDS Programme in India. B E J Econ Anal Policy. 10(1):88. Frost M, Puri M, Hinde P (2013) Falling sex ratios and emerging evidence of sex-selective abortion in Nepal: Evidence from nationally representative survey data. BMJ Open. 3:e002612. Kalsi P (2017) Seeing is believing- can increasing the number of female leaders reduce sex selection in rural India? J Dev Econ. 126:1-18. Li H, Zheng H (2009) Ultrasonography and sex ratios in China. Asian Econ Policy Rev. 4:121-137.	Interventional study (for other review) (n=12)

Li J (1995) China One-Child Policy - How and how well has it worked - a case-study of Hebei-Province, 1979-88. Popul Dev Rev. 21(3):563-585. Lin M, Liu J, Qian N (2014) More missing women, fewer dying girls: the impact of sex-selective abortion on sex at birth and relative female mortality in Taiwan. J Eur Econ Assoc. 12:899-926. Nandi A, Deolalikar A (2013) Does a legal ban on sex-selective abortions improve child sex ratios? Evidence from a policy change in India. J Dev Econ. 103:216-228. Sharma B, Gupta N, Relhan N (2007) Misuse of prenatal diagnostic technology for sex-selected abortions and its consequences in India. Public Health. 121:854-860.	
Total excluded at full text screening	N=144

Appendix 5

List of included studies for systematic review of evidence on relative survival outcomes for of girls and women in son-preference countries

1. Banister J (2004) Shortage of girls in China today. J Popul Res. 21(1):19-45.
2. Bhat P, Zavier A (2007) Factors influencing the use of prenatal diagnostic techniques and the sex ratio at birth in India. Econ Polit Wkly. 42(24):2292-2303.
3. Bongaarts J, Guilmoto C (2015a) How many more missing women? Excess female mortality and prenatal sex selection, 1970-2050. Popul Dev Rev. 41:241-269.
4. Bongaarts J (2013) The implementation of preferences for male offspring. Popul Dev Rev. 39(2):185-208.
5. Cai Y, Lavely W (2003) China's missing girls: Numerical estimates and effects on population growth. China Rev. 3:13-29.
6. Cai Y (2017) Missing Girls or Hidden Girls? A Comment on Shi and Kennedy's "Delayed Registration and Identifying the "Missing girls' in China". China Q. 231:797-803.
7. Chao F, Gerland P, Cook A, Alkema L (2019) Systematic assessment of the sex ratio at birth for all countries and estimation of national imbalances and regional reference levels. Corrected June 26, 2019. PNAS. 116(19):9303-9311.
8. Chun H, Das Gupta M (2009) Gender discrimination in sex selective abortions and its transition in South Korea. Womens Stud Int Forum. 32(2):89-97.
9. Coale A (1991), Excess female mortality and the balance of the sexes in the population: An estimate of the number of 'missing females'. Popul Dev Rev. 17(3):517-523.
10. Condorelli A (2015) An emergentist vs a linear approach to social change processes: A gender look in contemporary India between modernity and Hindu tradition. SpringerPlus. 4:156.
11. Den Boer A, Hudson V (2017) Patrilineality, son preference, and sex Selection in South Korea and Vietnam. Popul Dev Rev. 43(1):119-147.
12. Duthe G, Mesle F, Vallin J, Badurashvili I, Kuyumjyan K (2012) High sex ratios at birth in the Caucasus: Modern technology to satisfy old desires. Popul Dev Rev. 38(3):487-501.
13. Goodkind D (2011) Child underreporting, fertility, and sex ratio imbalance in China. Demography. 48(1):291-316.
14. Grech V (2015) Evidence of economic deprivation and female foeticide in a United Nations global births by gender data set. Early Hum Dev, 91(12):855-8.
15. Guilmoto C, Hoang X, Van T (2009) Recent increase in sex ratio at birth in Viet Nam. PLoS ONE. 4(2): e4624.

16. Guilmoto C (2012) Sex imbalances at birth. Current trends, consequences and policy implications. Bangkok: UNFPA (United Nations Population Fund) Asia and the Pacific Regional Office).

17. Guilmoto C (2012b) Son preference, sex selection, and kinship in Vietnam. Popul Dev Rev. 38(1):31-54.

18. Huang Y, Tang W, Mu Y, Li X, Liu Z, Wang Y, et al. (2016) The sex ratio at birth for 5,338,853 deliveries in China from 2012 to 2015: A facility-based study. PLoS ONE 11(12): e0167575.

19. Jiang Q, Li S, Faldman M (2012) China's missing girls in the three decades from 1980 to 2010. Asian Women. 28(3)53-73.

20. Jiang Q, Yu Q, Yang S, Sanchez-Barricarte J (2017) Changes in sex ratio at birth in China: a decomposition by birth order. J Biosoc Sci. 49:826-841.

21. Kahlert M (2014) Trends in missing women in the 2000s. MA dissertation. Göttingen University.

22. Klasen S (1994) "Missing women" reconsidered. World Dev. 22(7):1061-1071.

23. Klasen S, Wink C (2002) A turning point in gender bias in mortality? An update on the number of missing women. Popul Dev Rev. 28(2):285-312.

24. Klasen S, Wink C (2003) "Missing women": Revisiting the debate. Fem Econ. 9(2-3):263-299.

25. Michael M, King L, Guo L, McKee M, Richardson E, Stuckler D (2013) The mystery of missing female children in the Caucasus: an analysis of sex ratios by birth-order. Int Perspect Sex Reprod Health. 39(2):97-102.

26. Organisation for Economic Cooperation and Development (OECD) (2014) SIGI (Social Institutions and Gender Index) Methodological Background Paper. Paris: OECD. http://genderindex.org/sites/default/files/Backgroundpaper.pdf

27. Rahm L (2020) Gender-biased sex selection in South Korea, India and Vietnam - Assessing the influence of public policy. Switzerland: Springer Nature.

28. Sen A (1986) Africa and India: What do we have to learn from each other? Proceedings of the Eighth World Congress of the International Economic Association New Delhi (December, 1986). London: Macmillan.

29. Sen A (1989) Women's survival as a development problem. Am Acad Arts Sci Bull. 43(2):14-29.

30. Shi Y, Kennedy J (2016) Delayed registration and identifying the "missing girls" in China. China Q. 228:1018-1038.

31. Shi Y, Kennedy J (2017) Missing girls, indirect measures and critical assumptions: A response to Yong Cai's comments. China Q. 231:804-810.

32. Tufuro S, Guilmoto C (2020) Skewed sex ratios at birth: A review of global trends. Early Hum Dev. 141:104868.

33. Yoo S, Hayford S, Agadjanian V (2017) Old habits die hard? Lingering son preference in an era of normalizing sex ratios at birth in South Korea. Popul Res Policy Rev. 36(1):25-54.

34. Zeng Y, Tu P, Gu B, Xu Y, Li B, Li Y (1993) Causes and implications of the recent increase in the reported sex-ratio at birth in China. Popul Dev Rev. 19(2):283-302.

Appendix 6

Data time points, sources, and data time gaps between Klasen & Wink (2003) and Kahlert (2014) studies of 'missing women'

	Klasen & Wink 2003	Kahlert 2014*	Data sources (Kahlert, 2014)	Data time gap
China	2000	2010	National Census data	10 years
Taiwan	1999	2012	Statistical Yearbook of the Republic of China 2012	13 years
South Korea	1995	2010	National Census data	15 years
India	2001	2011	National Census data	10 years
Pakistan	1998	2011	United Nations (UN) Population Division	13 years
Bangladesh	2001	2011	National Census data	10 years
Nepal	2001	2011	National Census data	10 years
Sri Lanka	1991	2012	National Census data	21 years
West Asia	2000	2012	Demographic Yearbook 2012	12 years
Egypt	1996	2006	National Census data	10 years
Algeria	1998	2008	National Census data	10 years
Tunisia	1994	2004	National Census data	10 years
Sub-Saharan Africa	2000	2012	Demographic Yearbook 2012	12 years
Note: *Kahlert's 2014 study was supervised by Stephan Klasen. It used similar methods which allow for comparison between the studies over time. The 2014 study data were graciously provided by Mirjam Kahlert.				

Appendices for Chapter 6 – Study 3

Appendix 7

Example, MEDLINE search strategy for systematic review of sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia

MEDLINE, and MEDLINE In-Process & other Non-Indexed Citations
Searched via OVID 02/03/22. Restricted to English language and human.
Syntax:
1   Son preference.ti,ab.
2   Gender preference.ti,ab.
3   Sex select*.ti,ab.
4   Sex-select*.ti,ab.
5   Gender select*.ti,ab.
6   Gender-select*.ti,ab.
7   Missing women.ti,ab.
8   Lost girls.ti,ab.
9   OR 1 to 8
10   Limit 9 to Humans, English language and 1980 to 2021

Appendix 8

Studies excluded during full text screening, and reasons for exclusion in systematic review of sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia

Article	Reasons for exclusion (Number of articles)
Egan J, Campbell W, Chapman A, Shamshirsaz A, Gurram P, Benn P(2011) Distortions of sex ratios at birth in the United States evidence for prenatal gender selection. Prenat Diagn. 31(6):560–5. Grech V (2017) Evidence of socio-economic stress and female foeticide in racial disparities in the gender ratio at birth in the United States (1995-2014). Early Hum Dev. 106:63-65. Tang Z (2013) Sex preference for children and Chinese fertility in America. In: Chan Kwok-bun, ed., International handbook of Chinese families. New York, NY: Springer Science & Business Media. pp.263-275. Tapia F, Raftakis (2021) Sex ratios and gender discrimination in Modern Greece. Popul Stud (Camb). 76(2):329-346.	Population – not immigrants (n=4)
Blau F, Kahn L, Brummund P, Cook J, Larson-Koester M (2020) Is there still son preference in the United States? J Popul Econ. 33(3):709-750. Carol S, Hank K (2020) Natives' and immigrants' gender preferences for children in Germany. Eur J Popul. 36(2):235-246. Colls P, Silver L, Olivera G, Weier J, Escudero T, Goodall N, Tomkin G, Munne S (2009) Preimplantation genetic diagnosis for gender selection in the USA. Reprod Biomed Online. 19(S2):16-22. Dhillon N, MacArthur C (2010) Antenatal depression and male gender preference in Asian women in the UK. Midwifery. 26:286-293. Ezdi S, and Pastorelli S. (2021). Is There Evidence of Gender Preference for Offspring in France? Examining the Predilections of Native Women and Immigrant Women from Asia and Africa. Comparative Population Studies, 46:303-329. Gonzalez L (2018) Sex selection and health at birth among Indian immigrants. Econ Hum Biol. 29:64-75. Grech V (2017) Further evidence of male offspring preference for certain subgroups in the United States (2007-2015) Early Hum Dev. 110:9-12. Joseph K, Lee L, Williams K (2016) Sex ratios among births in British Columbia, 2000-2013. J Obstet Gynaecol Can. 38(10):919. Liu P, Rose G (1995) Social aspects of > 800 couples coming forward for gender selection of their children. Hum Reprod. 10:968-71.	Outcome – Not population sex ratios (n=11)

Park C, Braun K, Horiuchi B, Tottori C, Onaka A (2009) Longevity disparities in multiethnic Hawaii: An analysis of 2000 life tables. Public Health Rep. 124:579-584. Pulver A, Ramraj C, Ray J G, O'Campo P, and Urquia M L. (2016). A scoping review of female disadvantage in health care use among very young children of immigrant families. Social Science & Medicine, 152:50-60.	
Agrawal S (2012) The sociocultural context of family size preference, ideal sex composition, and induced abortion in India: Findings from India's National Family Health Surveys. Health Care Women Int. 33:986-1019. Almond D, Li H, Zhang S (2019) Land reform and sex selection in China. J Polit Econ. 127:560-585. Altindag O (2016) Son preference, fertility decline, and the nonmissing girls of Turkey. Demography. 53:541-566. Ambel A (2008) Essays on intrahousehold allocation and the family: Fertility, child education, and nutrition. Doctoral dissertation, Harvard University. Amin R, Mariam A (1987) Son preference in Bangladesh - an emerging barrier to fertility regulation. J Biosoc Sci, 19:221-228. Arulampalam W, Bhalotra S (2008) The linked survival prospects of siblings: Evidence for the Indian states. Popul Stud (Camb). 62:171-190. Banister J (2004) Shortage of girls in China today. J Popul Res. 21(1):19-45. Belanger D, Oanh K (2009) Second-trimester abortions and sex-selection of children in Hanoi, Vietnam. Popul Stud (Camb). 63:163-171. Bhalotra S, Chakravarty A, Mookherjee D, Pino F (2019) Property rights and gender bias: Evidence from land reform in West Bengal. Am Econ J Appl Econ. 11:205-237. Bharadwaj P, Lakdawala L (2013) Discrimination begins in the womb Evidence of sex-selective prenatal investments. J Hum Resour. 48:71-113. Bhaskar V (2011) Sex selection and gender balance. Am Econ J Microecon. 3:252-253. Bhat P, Zavier F (2007) Factors influencing the use of prenatal diagnostic techniques and the sex ratio at birth in India. Econ Polit Wkly. 42(24):2292-2303. Bhattacharjya D, Sudarshan A, Tuljapurkar S, Shachter R, Feldman M (2008) How can economic schemes curtail the increasing sex ratio at birth in China? Demogr Res. 19:1831-1850.	Country – not in Europe, North America, and Australasia (n=147)

Bhattacharjya H, Baidya S (2017) Determinants of child sex ratio in West and South Districts of Tripura, India. Indian J Public Health. 61:112-117.

Bongaarts J (2013) The implementation of preferences for male offspring. Popul Dev Rev. 39(2):185-208.

Bongaarts J, Guilmoto C (2015) How many more missing women? Excess female mortality and prenatal sex selection, 1970-2050. Popul Dev Rev. 41:241-269.

Bose S, Trent K (2006) Socio-demographic determinants of abortion in India: A north-south comparison. J Biosoc Sci. 38:261-282.

Bose S (2012) A contextual analysis of gender disparity in education in India: The relative effects of son preference, women's status, and community. Sociol Perspect. 55:67-91.

Brooks R (2012) "Asia's missing women" as a problem in applied evolutionary psychology? Evol Psychol. 10:910-925.

Cai Y (2017) Missing Girls or Hidden Girls? A Comment on Shi and Kennedy's "Delayed Registration and Identifying the "Missing girls' in China". China Q. 231:797-803.

Cai Y, Lavely W (2003) China's missing girls: Numerical estimates and effects on population growth. China Rev. 3:13-29.

Chakraborty T (2015) Trade Liberalization in a traditional society: Implications for relative female survival. World Dev. 74:158-170.

Chakravarty A (2010) Supply shocks and gender bias in child health investments: Evidence from the ICDS Programme in India. B E J Econ Anal Policy. 10(1):88.

Chamarbagwala R, Ranger M (2010) A multinomial model of fertility choice and offspring sex ratios in India. J Dev Stud. 46:417-438.

Chamarbagwala R (2011) Sibling composition and selective gender-based survival bias. J Popul Econ. 24:935-955.

Chao F, Gerland P, Cook A, Alkema L (2019) Systematic assessment of the sex ratio at birth for all countries and estimation of national imbalances and regional reference levels. Corrected June 26, 2019. PNAS. 116(19):9303-9311.

Chaturvedi S, Chhabra P, Bharadwaj S, Smanla S, Kannan A T, Students Study Group (2007) Fetal sex-determination in Delhi: a population-based investigation. Trop Doct. 37:98-100.

Chen Y (2008) The significance of cross-border marriage in a low fertility society: Evidence from Taiwan. J Comp Fam Stud. 39:331.

Chen Y, Li H, Meng L (2013) Prenatal sex selection and missing girls in China: Evidence from the diffusion of diagnostic ultrasound. J Hum Resour. 48:36-70.

Chhetri U D, Ansari I, Bandary S, Adhikari N (2011) Sex preferences among mothers delivering at Patan Hospital. Kathmandu Univ Med J. 9:229-32.

Chu J (2001) Prenatal sex determination and sex-selective abortion in rural central China. Popul Dev Rev. 27:259.

Chun H, Doyal L, Payne S, Il-Cho S, Kim I (2006) Understanding women, health, social change: the case of South Korea. Int J Health Serv. 36:575-592.

Chun H, Das Gupta M (2009) Gender discrimination in sex selective abortions and its transition in South Korea. Womens Stud Int Forum. 32(2):89-97.

Chung W, Das Gupta M (2011) Factors influencing 'missing girls' in South Korea. Appl Econ. 43:3365-3378.

Clark S (2000) Son preference and sex composition of children: Evidence from India. Demography. 37:95-108.

Coale A (1991), Excess female mortality and the balance of the sexes in the population: An estimate of the number of 'missing females'. Popul Dev Rev. 17(3):517-523.

Condorelli A (2015) An emergentist vs a linear approach to social change processes: A gender look in contemporary India between modernity and Hindu tradition. SpringerPlus. 4:156.

Cronk L (1991) Intention versus behaviour in parental sex preferences among the Mukogodo of Kenya. J Biosoc Sci. 23:229-40.

Dama M (2011) Sex ratio at birth and mortality rates are negatively related in humans. Plos One. 6(8):e23792.

Das Gupta M, Bhat P (1997) Fertility decline and increased manifestation of sex bias in India. Popul Stud (Camb). 51(3)307-315.

Das Gupta M, Jiang Z, Li B, Xie Z, Chung W, Hwa-Ok B (2003) Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. J Dev Stud. 40:153-187.

Das Gupta M (2005) Explaining Asia's "missing women": A new look at the data. Popul Dev Rev. 31:529.

Das Gupta M (2006) Cultural versus biological factors in explaining Asia's "missing women": Response to Oster. Popul Dev Rev, 32:328-332.

den Boer A, Hudson V (2017) Patrilineality, son preference, and sex selection in South Korea and Vietnam. Popul Dev Rev. 43:119-147.

Detray D (1980) Son preference in Pakistan - an analysis of intentions versus behavior. Popul Index. 46:382-382.

Dharmalingam A, Rajan S, Morgan S (2014) The determinants of low fertility in India. Demography. 51:1451-1475.

Dinh T, Borjesson L, Nga N, Johansson A, Malqvist M (2012) Sex of newborns associated with place and mode of delivery: A population-based study in Northern Vietnam. Gend Med. 9:418-423.

Dreze J, Murthi M (2001) Fertility, education, and development: Evidence from India. Popul Dev Rev. 27:33.

Duthe G, Mesle F, Vallin J, Badurashvili I, Kuyumjyan K (2012) High sex ratios at birth in the Caucasus: Modern technology to satisfy old desires. Popul Dev Rev. 38(3):487-501.

Dyson T (2012) Causes and consequences of skewed sex ratios. Annu Rev Sociol. 38:443-461.

Ebenstein A (2011) Estimating a dynamic model of sex selection in China. Demography. 48:783-811.

Echavarri R A, Ezcurra R (2010) Education and gender bias in the sex ratio at birth: evidence from India. Demography. 47:249-268.

Edlund L (1999) Son preference, sex ratios, and marriage patterns. J Polit Econ. 107:1275-1304.

Edmeades J, Rohini P, MacQuarrie K, Falle T, Malhotra A (2012) Two sons and a daughter: Sex composition and women's reproductive behaviour in Madhya Pradesh, India. J Biosoc Sci. 44:749-764.

Eliason S, Baiden F, Tuoyire D, Awusabo-Asare K (2018) Sex composition of living children in a matrilineal inheritance system and its association with pregnancy intendedness and postpartum family planning intentions in rural Ghana. Reprod. 15(1)187.

Erfani A, McQuillan K (2014) The changing timing of births in Iran: An explanation of the rise and fall in fertility after the 1979 Islamic Revolution. Biodemogr. Soc. Biol. 60:67-86.

Filho A, Kawachi I (2013) Are sex-selective abortions a characteristic of every poor region? Evidence from Brazil. Int J Public Health. 58:395-400.

Frost M, Puri M, Hinde P (2013) Falling sex ratios and emerging evidence of sex-selective abortion in Nepal: Evidence from nationally representative survey data. BMJ Open. 3:e002612.

Gangadharan L, Maitra P (2003) Testing for son preference in South Africa. J Afr Econ. 12:371-416.

Goodkind D (2011) Child underreporting, fertility, and sex ratio imbalance in China. Demography. 48(1):291-316.

Graham M J, Larsen U, Xu X (1998) Son preference in Anhui Province, China. Int Fam Plan Perspect. 24:72-77.

Grech V (2015) Evidence of economic deprivation and female foeticide in a United Nations global births by gender data set. Early Hum Dev, 91, pp.855-8.

Guha A, Rai A, Gupta D, Mondal R (2019) Abandoned babies at Tertiary Care Rural Medical College Hospital: The Indian scenarios. Indian J Pediatr. 86:335-339.

Guilmoto C (2012) Sex imbalances at birth. Current trends, consequences and policy implications. Bangkok: UNFPA.

Guilmoto C (2012A) Son preference, sex selection, and kinship in Vietnam. Popul Dev Rev. 38(1):31-54.

Guilmoto C (2017) Gender bias in reproductive behaviour in Georgia, Indonesia, and Vietnam: An application of the own-children method. Popul Stud (Camb). 71:265-279.

Guilmoto C, Hoang X, Van T (2009) Recent increase in sex ratio at birth in Viet Nam. PLoS ONE. 4(2): e4624.

Guo Z, Das Gupta M, Li S (2016) 'Missing girls' in China and India: Trends and policy challenges. Asian Popul Stud. 12:135-155.

Hamoudi A (2010) Exploring the causal machinery behind sex ratios at birth: Does hepatitis B play a role? Econ Dev Cult Change. 59(1):1-21.

Haque I, Patel P (2016) Assessing Hindu-Muslim fertility differentials in West Bengal: Insights from the National Family Health Survey-3 Data. J Fam Hist. 41:192-224.

Hatlebakk M (2017) Son preference, number of children, education and occupational choice in rural Nepal. Rev Dev Econ. 21:1-20.

Hesketh T, Xing Z (2006) Abnormal sex ratios in human populations: Causes and consequences. Proc Natl Acad Sci U S A. 103:13271-13275.

Hesketh T, Lu L, Xing Z (2011) The consequences of son preference and sex-selective abortion in China and other Asian countries. CMAJ. 183:1374-1377.

Hossain M, Phillips J, Legrand T (2007) The impact of childhood mortality on fertility in six rural thanas of Bangladesh. Demography. 44:771-784.

Hu L, Schlosser A (2012) Trends in prenatal sex selection and girls' nutritional status in India. CESifo Econ Stud. 58:348-372.

Huang Y, Tang W, Mu Y, Li X, Liu Z, Wang Y, et al. (2016) The sex ratio at birth for 5,338,853 deliveries in China from 2012 to 2015: A facility-based study. PLoS ONE 11(12): e0167575.

Jayaraj D, Subramanian S (2004) Women's wellbeing and the sex ratio at birth: Some suggestive evidence from India. J Dev Stud. 40:91-119.

Jha P, Kumar R, Vasa P, Dhingra N, Thiruchelvam D, Moineddin R (2006) Low male-to-female sex ratio of children born in India: National survey of 1.1 million households. Lancet. 367:211-218.

Jiang Q, Li S, Faldman M (2012) China's missing girls in the three decades from 1980 to 2010. Asian Women. 28(3)53-73.

Jiang Q, Li S, Feldman M (2011) Demographic consequences of gender discrimination in China: Simulation analysis of policy options. Popul Res Policy Rev. 30:619-638.

Jiang Q, Li Y, Sanchez-Barricarte J (2016) Fertility intention, son preference, and second childbirth: Survey findings from Shaanxi Province of China. Soc Indic Res. 125:935-953.

Jiang Q, Yu Q, Yang S, Sanchez-Barricarte J (2017) Changes in sex ratio at birth in China: a decomposition by birth order. J Biosoc Sci. 49:826-841.

Kabeer N, Huq L, Mahmud S (2014) Diverging stories of "Missing women" in South Asia: Is son preference weakening in Bangladesh? Fem Econ. 20:138-163.

Kahlert M (2014) Trends in missing women in the 2000s. MA dissertation. Göttingen University.

Kalsi P (2017) Seeing is believing- can increasing the number of female leaders reduce sex selection in rural India? J Dev Econ. 126:1-18.

Kant S, Srivastava R, Rai S, Misra P, Charlette L, Pandav C (2015) Induced abortion in villages of Ballabgarh HDSS: rates, trends, causes and determinants. Reprod. 12:51.

Karki Y (1988) Sex preference and the value of sons and daughters in Nepal. Stud Fam Plann. 19:169-178.

Kastor A, Chatterjee S (2018) Impact of sex composition of living children and couples' agreement on subsequent fertility in India. J Biosoc Sci. 50:666-682.

Kaul T (2018) Intra-household allocation of educational expenses: Gender discrimination and investing in the future. World Dev. 104:336-343.

Klasen S (1994) "Missing women" reconsidered. World Dev. 22(7):1061-71.

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Adsera A, Ferrer A (2020) Speeding up for a Son: Sex Ratio Imbalances by Birth Interval Among South Asian Migrants to Canada. Canadian Studies in Population. 47:133-149	Methodological quality (n=7)

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Department of Health (2013) Birth Ratios in the United Kingdom. A report on gender ratios at birth in the UK. London: Department of Health (May 2013). Department of Health (2014) Birth Ratios in England and Wales A report on gender ratios at birth in England and Wales. London: Department of Health (May 2014). Department of Health and Social Care (2022) Sex ratios at birth in the United Kingdom, 2016 to 2020. London: Department of Health and Social Care (November 2022).	Not peer reviewed (n=3)
Total excluded at full text screening	N=176

Appendix 9

List of included studies for systematic review of sex ratios for babies of migrants from son preference countries living in Europe, North America, and Australasia

1. Castelló A, Urquia M, Rodríguez-Arenas M, Bolúmar F (2019) Missing girls among deliveries from Indian and Chinese mothers in Spain 2007–2015. European Journal of Epidemiology (2019) 34:699–709.

2. Dubuc S, Coleman D (2007) An Increase in the Sex Ratio of Births to India-born Mothers in England and Wales: Evidence for Sex-Selective Abortion. Population and Development Review. 33(2):383-400.

3. Edvardsson K, Axmon A, Powell R, Davey M (2018) Male-biased sex ratios in Australian migrant populations: A population-based study of 1 191 250 births 1999-2015. Int J Epidemiol. 47(6):2025-2037.

4. Edvardsson K, Davey M-A, Powell R, Axmon A (2021) Sex ratios at birth in Australia according to mother's country of birth: A national study of all 5 614 847 reported live births 1997–2016. PLoS ONE 16(6): e0251588.

5. Festini F, Taccetti G, Repetto T, Cioni M, de Martino M (2003) Sex ratio at birth among Chinese babies born in Italy is lower than in China. J Epidemiol Community Health. 57:967-968.

6. Lhila A, Simon K (2008) Prenatal health investment decisions: Does the child's sex matter? Demography. 45:885-905.

7. Ray J, Henry D, Urquia M (2012) Sex ratios among Canadian liveborn infants of mothers from different countries. CMAJ. 184(9):E492-496.

8. Simon-Kumar R, Paynter J, Chiang A, Chabba N (2021) Sex ratios and 'missing women' among Asian minority and migrant populations in Aotearoa/New Zealand: a retrospective cohort analysis. BMJ Open. 11:e052343.

9. Smith C, Fogarty A (2014) Is the mothers' country of birth associated with the sex of their offspring in England and Wales from 2007 to 2011? BMC Pregnancy and Childbirth. 14:332.

10. Urquia M, Moineddin R, Jha P, O'Campo P, McKenzie K, Glazier R, et al. (2016) Sex ratios at birth after induced abortion. CMAJ. 188(9):E181-E190.

11. Wanigaratne S, Uppal P, Bhangoo M, Januwalla A, Singal D, Urquia M (2018) Sex ratios at birth among second-generation mothers of South Asian ethnicity in Ontario, Canada: a retrospective population-based cohort study. J Epidemiol Community Health. 72:1044–1051.

Appendices for Chapter 7 – Study 4

Appendix 10

Example Medline search strategy

Medline <1980 to 2014 Week 41>

Searched via OVID 20/10/14. Restricted to English language and humans.

1   Micro-credit$.ti,ab. (29)

2   Microcredit$.ti,ab. (61)

3   "Micro credit$".ti,ab. (29)

4   Micro-finance$.ti,ab. (13)

5   Microfinance$.ti,ab. (83)

6   "Micro finance$".ti,ab. (13)

7   Microsaving$.ti,ab. (0)

8   Micro-saving$.ti,ab. (0)

9   "Micro saving$".ti,ab. (0)

10   (Bangladesh and BRAC).ti,ab. (70)

11   (IMAGE adj2 (scheme or intervention or initiative)).ti,ab. (255)

12   PRAGATI.ti,ab. (2)

13   "Bangladesh Rural Advancement Committee".ti,ab. (44)

14   "Grameen Bank".ti,ab. (19)

15   "Credit union".ti,ab. (18)

16   or/1-16 (535)

17   limit 16 to (human and english language) (381)

Appendix 11

Quality assessment for the systematic reviews of effectiveness (Modified from Lorenc et al., 2013)

The quality assessment tool contains six questions:

1. Selection bias

2. Study design

3. Confounders

4. Blinding

5. Data collection

6. Withdrawals and dropouts.

Each question can get an A (high), B (medium) or C (low) (or D (lowest) for study design) quality rating, as per the tool below.

The guidelines for the specific questions are as follows.

5. Selection bias

Selected study sample very likely to represent population from target area AND 80 to 100% response at baseline	A
Selected study sample very likely to represent population from target area AND 60 to 79% response at baseline; OR Selected study sample somewhat likely to represent population from target area AND 80 to 100% response at baseline	B
<60% baseline response; OR Somewhat likely to represent population AND <80% response; OR Not likely to represent population OR representativeness NR/unclear; OR Response rate at baseline NR/unclear	C

6. Study design

Control group and pre and post longitudinal data OR random allocation	A
No control group and pre and post longitudinal data; OR Control group and pre and post cross-sectional data AND no indication of major change in population	B
No control group and pre and post cross-sectional data; OR Control group and pre and post cross-sectional data AND possibility of major change in population	C
Control group, post intervention only data	D

Note: 'longitudinal' = same individuals pre and post; 'cross-sectional' = different individuals.

Where studies use mixed designs (e.g. presenting both cross-sectional and longitudinal data),

give the highest grade applicable to the analyses actually reported. Where studies collect longitudinal data and report attrition rates, grade as longitudinal even if only cross-sectional analyses are reported.

7. Confounders

Control group matched on key variables (at least two of: SES or relevant proxies (area or individual level), gender, age, ethnicity (individual level)) AND supporting data presented; OR Outcomes adjusted for key variables (at least two of: gender, age, ethnicity, SES) using appropriate methods	A
Stated that control group matched or 'similar', but supporting data not presented	B
No matching or adjustment reported AND likely to be substantial differences between groups; OR no information on differences between intervention and control group; OR no control group	C

Note: RCTs will be rated 'B' if no information on between-group differences is presented

8. Blinding

Both outcome assessors AND participants blind to allocation	A
Either outcome assessors OR participants blind to allocation	B
Blinding NR; OR no control group	C

9. Data collection

Piloting or pre-testing of tool; OR checks on validity of data (e.g. verification of a percentage of responses); OR tool shown to be reliable in relevant population	A
Data collection tool based on previous research, but no piloting or checking, and reliability not demonstrated	B
Data collection unclear; OR tools not piloted, checked or based on previous research	C

10. Withdrawals and dropouts

Attrition <20%	A
Attrition 21%-40%	B
Attrition >40%; OR attrition NR; OR cross-sectional data only	C

Note: Attrition is measured as the percentage of the baseline sample lost at final follow-up.

Appendix of published papers

Appendix 12

The health impacts of women's low control in their living environment: A theory-based systematic review of observational studies in societies with profound gender discrimination

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ARTICLE INFO

ABSTRACT

We conducted a systematic review of observational evidence on the health impacts of women's low control/ autonomy in the living environment in societies with profound gender discrimination and gender bias. Thirty observational studies of varying methodological quality were included. Overall, the evidence suggests that women's lower control or autonomy (for example lack of freedom of movement outside the home, lack of authority to access healthcare for sick children) was associated with poorer mental and physical health for women and higher morbidity and mortality for their children, after adjusting for their socioeconomic circumstances. Further studies are needed to disentangle and understand the pathways between low control and health outcomes in contexts of profound gender discrimination. This systematic review has highlighted the general low quality of the evidence base on this research question. It identifies the pressing need for high quality, longitudinal studies in the future.

1. Introduction

The proposition that the control that people have over their own lives is important for the health of individuals and societies is becoming more widespread in the public health and development literature (Whitehead et al., 2016). The Nobel Laureate, Amartya Sen, concludes:

"*the success of an economy and of a society cannot be separated from the lives that members of the society are able to lead. Since we not only value living well and satisfactorily, but also appreciate having control over our own lives.*" (Sen, 2003).

Both Sen and Marmot argue that control over your own life is a crucial determinant of health, well-being, and longevity (Sen, 1999a; Marmot, 2004). Furthermore, the global Commission on Social Determinants of Health (CSDH) concluded that inequalities in level of control and participation play a big part in generating social inequalities in health (CSDH, 2008).

There is a reasoned set of theories about how low control could lead to poorer health and contribute to inequalities in health (Whitehead et al., 2016), but what about the empirical evidence? There is a relatively strong body of observational evidence relating to the work environment, where robust measures of 'job demand' (the pressures of the workload) and 'job control' (degree of autonomy/latitude in managing that workload) have been developed in high income country contexts (Karasek and Theorell, 1990; Demerouti et al., 2001). These measures try to quantify 'actual' level of control that the employees experience in their jobs, rather than merely their perceptions or beliefs about how much control they feel they have. These studies generally show that high job demands coupled with low job control constitute health-damaging stressors that may lead to mental or physical ailments such as CVD (Van der Doef and Maes, 1999; Kuper and Marmot, 2003; Kuper et al., 2005; Bosma et al., 2005; Theorell et al., 2015). There is evidence that this combination of high demand but low control is more

common in lower skilled jobs, thereby providing a mechanism for generating inequalities in health between different occupational groups (Marmot et al., 1997).

The literature on the health effect of control in the living environment is less well developed and disparate, compared with the formal work environment. By 'living environment' we mean the households, communities and societies in which people live and go about their daily lives outside paid work. It is much more difficult to devise the equivalent measures of 'actual' control relating to the relatively unstructured setting of the living environment and to disentangle impact of control on health from all the other influences.

One approach has been to study the most severe forms of restricted control in the living environment: the limitations placed on women in societies with profound gender discrimination and gender bias (i.e. preference for sons). For millions of women in some low and middle-income countries with this profound gender discrimination, women's lives are highly restricted. They need a male relative's permission for all kinds of everyday caring activities, such as seeking healthcare for themselves and their children and going outside the family compound for any reason, even visiting other family members. They need to be accompanied by a male relative on such excursions outside their home. Women's access to schooling, to paid employment in the formal labour market, to food and nutrition may be severely limited.

Population health theories suggest that such lack of control and narrowly circumscribed autonomy in the living environment may have adverse effects on women's health and the survival of their children (Sen, 1999a, 1999b). One pathway between women's low control/limited autonomy and health is through reduced access to key determinants of health – including limited control over access to preventive and curative health services, education and paid employment opportunities, food and nutrition, fertility and reproductive rights. In turn, this reduced access to determinants of health may lead to poorer health including higher levels of anxiety and depression, malnutrition, health risks from greater numbers of pregnancies and childbirth, and domestic violence against women. Survival of the women's children may be adversely effected by not being allowed to take a sick child to hospital or for immunisations and other preventive procedures. In addition, in societies with marked son preference, lower female survival rates may also occur through mechanisms such as neglect or infanticide of girl babies and, in recent decades, as sex determination and selection technologies have become widely available, the practice of sex-selective abortion (Banister, 2004). Although women's autonomy in the living environment is generally constrained in cultures with profound gender discrimination, there is still variation across households and communities in the degree to which a woman is free to make decisions concerning key determinants of health. This variation provides opportunities for research to make comparisons between women with relatively low and high levels of control.

We set out to conduct a systematic review of empirical evidence of the impact of women's low control in the living environment on health outcomes, based on the hypothesised pathways between control and health in societies exhibiting profound gender discrimination.

2. Methods

2.1. Logic model and search strategy

The search strategy and interrogation of the evidence was guided by the logic model in Fig. 1. This shows the hypothesised pathways between the low status and constrained autonomy of women in their living environment in societies exhibiting profound gender discrimination/bias (column 1) and poorer health outcomes (column 4). Lower control/reduced power to use available resources that influence health (column 2) is hypothesised to act as a mediating factor, leading to adverse health-related effects (column 3), which result in poorer health outcomes for women and for their children (column 4). Son preference

is shown in a separate pathway as having both direct and indirect effects on child survival.

We searched the electronic databases MEDLINE and MEDLINE In-Process, PsycINFO, Social Science Citation Index, and Conference Proceedings Citation Index - Social Sciences and Humanities for articles published between January 1980 and December 2016 on the association between women's levels of control in their living environment and health-related outcomes. We also drew on relevant results of an earlier search from a broader review of associations between control/empowerment and inequalities in health. Reference lists of included studies were scanned for relevant articles. We also requested data from researchers who had published previously on control and health-related outcomes. The Medline search strategy is available in Web Supplement/Appendix 1.

2.2. Inclusion and exclusion criteria

A study was only included if it reported empirical data from quantitative observational studies in low and middle-income countries (LMIC) with strong gender discrimination, that included all three of the following components:

a) ***Measured women's level of control in their living environment***. The measures had to indicate the degree of 'actual' control that the woman could exercise in her day-to-day life in the society in which she lived. For example, how much freedom of movement she had outside her home; whether she had autonomy to take a sick child for medical treatment. Many studies developed autonomy indices, combining several measures of what women reported they were able to do or not do in daily decision-making. Studies were excluded if they only measured perceived control or control beliefs, e.g. a general (non-specific) question about how much control a woman perceives that she has in her household. This exclusion also covered studies from the psychological literature that examined perceived 'locus of control' of individuals as a personality trait, without reference to the living environment or women's status in society. Studies which measured degree of control in the work environment were also excluded because they did not relate to the living environment. A substantial body of literature was located relating to the effects of son preference on survival, but these studies were excluded because they did not measure level of control.

b) ***Measured a health outcome***. Studies that measured women's physical or mental health or that of their children were included. Studies were excluded that only went as far as measuring intermediate health-related outcomes depicted in column 3 of Fig. 1(e.g. access to health care), but did not go on to measure the health outcome. Application of this criterion led to exclusion of a large body of studies that examined level of control and health-seeking behaviour, but failed to measure health outcomes.

c) ***Made some adjustment for socioeconomic factors/circumstances (SES) that may operate in the pathways to influence women's health.*** SES is a powerful determinant of population health in its own right, with the poverty and material disadvantaged suffered by poor rural women in low and middle-income countries causing higher morbidity and mortality directly. In addition, SES may act as a moderator in the pathway between control and health, or control may act as a mediator in the pathway between SES and health, as depicted in the logic model in Fig. 1. To be included, studies had to make some attempt to take SES circumstances and pathways into account.

2.3. Screening and review

Titles and abstracts of all records were independently screened by two reviewers to identify potentially eligible studies based on the initial
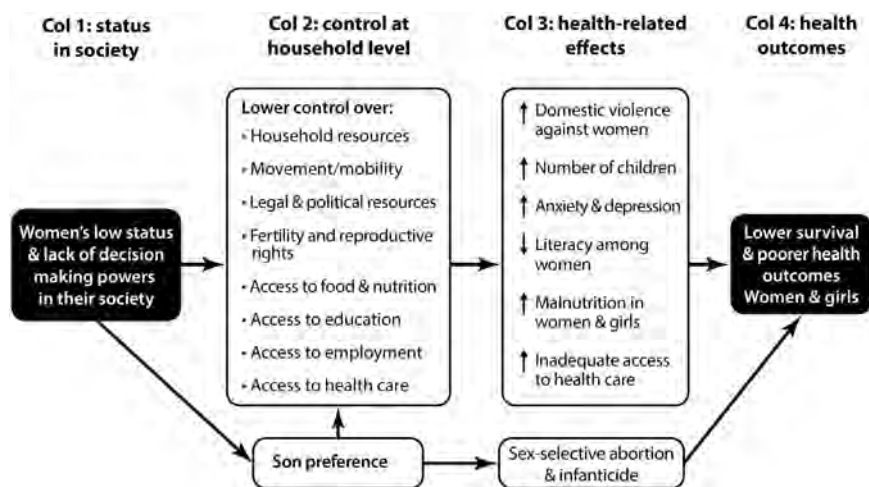
Fig. 1. Logic model of theoretical pathways from women's low control in their living environment to poorer health outcomes. Source: Adapted from (Whitehead et al., 2016).

inclusion and exclusion criteria above. All articles deemed potentially eligible were retrieved in full text. Two reviewers independently screened full text articles using a pre-designed and piloted eligibility assessment form and the software package Eppi-reviewer 4. Reasons for exclusion were recorded. Disagreements were resolved by consensus or by recourse to a third reviewer.

Studies that met the initial inclusion criteria were then critically appraised using a modified version of a tool tested for use in the appraisal of observational studies (Barker et al., 2000). Critical appraisals were conducted independently by two reviewers, with any disagreements resolved by consensus or by recourse to a third reviewer. Only those studies that met a set of pre-defined minimum quality criteria - in terms of selection bias, confounding, data collection and withdrawals/dropouts - were eventually included in the review (see Web Supplement/Appendix 2).

Reviewers extracted data from the included studies into pre-designed and piloted forms. Data extractions were checked for accuracy and completeness by a second reviewer. Extracted data included: study aims, study design, setting (country), measures of control/autonomy, adjustment for SES, health outcomes and main findings. The review team identified a typology of appropriate quantitative observational study designs (following the approach outlined by Petticrew and Roberts, 2003) to help organise the evidence (Web Supplement/Appendix 2), with evidence from higher quality studies being reported first and in more detail. Studies were assessed to determine whether they provided any empirical evidence on the relationship between women's level of control/autonomy in the living environment and health outcomes. Results were synthesised narratively.

3. Results

From an initial 2443 records, thirty studies on women's low control in the living environment and health outcomes in LMICs with strong gender discrimination were included. Fig. 2 shows the progression of studies through the review process.

All thirty studies measured the degree of control that women could exercise in the living environment in the societies in which they lived, including measures of their autonomy in making decisions about household resources, sexual and reproductive decision-making, freedom of movement and control over decisions to seek healthcare. Box 1 contains examples of the measures of women's control/autonomy used in the studies.

The observational designs employed in the studies ranged from a higher quality longitudinal study using individual level data, to lower quality single time-point cross-sectional designs. A range of health outcomes was measured for women and for their children (Tables 1, 2).

All the included studies adjusted for socioeconomic characteristics of the study participants to varying extent.

3.1. Findings of higher quality studies

Three of the 30 studies in the review employed higher quality longitudinal study designs (Table 1) and are described in greater detail here.

Hossain et al. (2007) studied the effect of women's status on infant and child mortality in four rural areas of Bangladesh. Bangladesh is a society in which women's autonomy and status is severely constrained, coupled with strong son preference over the period of data collection. Observing that Bangladeshi women are the key household decision-makers for child health care and nutrition, the study tested the hypothesis that women's constrained authority and autonomy adversely affects the survival of their children, partly through reduced access and ability to use preventive and curative child health services. Data on individual women from a 1988 cross-sectional 'women's status' survey were used to construct indices of women's autonomy and authority and linked to data on the subsequent mortality of the surveyed women's children. Demographic and socioeconomic characteristics of the mother and household from previous surveys were also linked with the child data and used as statistical controls. Enhanced autonomy for women (an index including measures of freedom of movement to visit friends/family, and access to healthcare for sick children) was significantly associated with lower post-neonatal mortality of their children (RR = 0.88, p < 0.05). Enhanced household authority for women (an index of measures on household decisions on, for example, access to healthcare and education) was also associated with significantly lower mortality of their children aged 1–5 (RR = 0.84, p < 0.05). These relationships do not differ significantly by gender of child – suggesting, according to the authors, that the pronounced effect of selective gender bias on the survival of girls in Bangladesh is unrelated to the household autonomy and authority of their mothers. While lower autonomy was generally associated with women from poorer households, the exception was for the custom of purdah, the most extreme form of restriction on women in this society. Purdah was associated with richer, higher status, households. It was the higher status women who experienced the most extreme lack of autonomy over their lives to such an extent that purdah was treated as a marker for household wealth in this analysis. The custom was weakly associated with decreased neonatal mortality, but not postneonatal of under-5 survival of children.

Alemayehu et al. (2015) conducted a study in Ethiopia to examine the association between women's SES (measured by maternal education level) and infant death, and the possible mediation or moderation
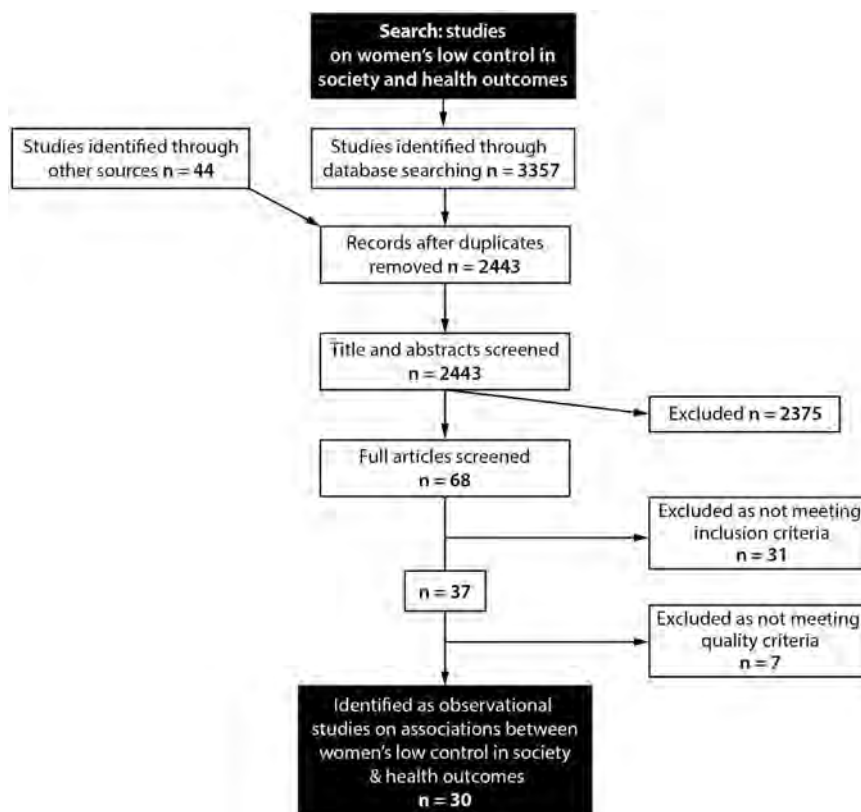
Fig. 2. PRISMA flow chart of the progression of studies through the review.

roles of women's empowerment and household wealth. Ethiopia is a highly male-dominated society, where women in general have a limited say in household-level decisions. A secondary repeat cross-sectional analysis was conducted on data from three rounds of the Ethiopian Demographic and Health Survey in 2000, 2005 and 2011, from which woman's and husband's educational status were separately analysed, and a woman's empowerment index and a household wealth index were constructed. Controlling for three confounders of age, type of residential area and husband's educational status, a woman's educational status was significantly associated with experience of infant death: the higher the maternal educational status the lower the risk of infant death. A mother who completed high school had 31% lower risk of experiencing infant death compared to a mother with no education. Woman's empowerment was associated with woman's educational level, after controlling for the three confounders above, with greater empowerment associated with higher educational level. Mediation analysis, controlling for the three potential confounders and the direct effect of woman's educational level, showed that empowerment partially mediated the education-infant death association: there was a 13% reduction in the initial association which was statistically significant (p < 0.001). In contrast, household SES, measured by the Wealth Index, played no part in mediating the education-infant death association. In a stratified analysis by wealth index, however, degree of wealth acted as an effect modifier: the effect of woman's education and of woman's empowerment on infant death was strongest among mothers from

richer households and weakest among those from poorer households.

The third higher quality study was carried out in Egypt, representing an Arab Middle Eastern setting, in which senior male kin disproportionately control many resources and women's agency is severely restricted. This individual level longitudinal study analysed data from the 2005 Egypt Demographic and Health Survey and followed up a sample from that survey of 608 ever-married women in 2012. It examined the association between women's empowerment and their subsequent mental health, measured by generalised anxiety (Yount et al., 2014). It tested the hypotheses that 1) women's acquisition of pre-marital enabling resources will be negatively associated with their generalised anxiety at interview, and 2) that women's post-marital agency (exclusive ability to make important household decisions) will be positively associated with women's premarital enabling resources and will partially mediate the resources-anxiety relationship. The results confirmed the first hypothesis: women's higher schooling attainment, premarital paid work, later age at first marriage, and greater proximity to birth family were significantly associated with lower generalised anxiety. The second hypothesis concerning post-marital agency was only partially supported. Making exclusive decisions about visits to family was associated with lower generalised anxiety, whereas making exclusive decisions about personal healthcare and major household purchases were associated with higher generalised anxiety. The mediation analysis indicated that women's post-marital agency may partly mediate the relationship

Box 1.Examples of measures of women's control in the living environment in societies exhibiting strong gender discrimination.

1. **Household decision-making measures**: whether a woman had the final say in decisions on - large household purchases, day-to-day household purchases, health care for herself, and visits to family and friends (Desai and Johnson, 2005).
2. **Women's autonomy index**: whether a woman's husband allows wife to work outside home, go out with friends, work in a male environment (prior to marriage) (Qadir, 2011).
3. **Women's autonomy indices**: household decision making autonomy, child-related decision-making autonomy, financial autonomy, mobility autonomy (Shroff, 2011).

Table 1
Higher quality studies of women's control in their living environment and health outcomes.

Study (author, year)	Country	Measures of women's control	Health outcome measures	Summary of results (statistically significant associations, p ≤ 0.05)	Design and study quality
Hossain et al. (2007)	Bangladesh	Household autonomy index; Household authority index	Neonatal, post-neonatal & childhood mortality (1 – 5 years)	Lower autonomy for women associated with poorer health and survival for children	Longitudinal, individual-level, linked data; higher quality
Alemayehu et al. (2015)	Ethiopia	Household decision-making index	Infant Mortality	Lower empowerment for women was associated with poorer infant survival	Repeat cross-sectional, individual-level data, retrospective recall of infant death; higher quality
Yount et al. (2014)	Egypt	Women's household autonomy measures	Generalised anxiety (women)	Mixed: Lower mobility autonomy associated with higher anxiety; Lower healthcare and major household purchasing autonomy associated with lower anxiety. No association between daily household purchase autonomy and anxiety.	Longitudinal, individual-level linked data; higher quality

between some of the measures of women's premarital enabling resources and their subsequent generalised anxiety. This study is unique in our review in incorporating a parallel qualitative study, which helped interpret the multivariate findings. The nuanced findings identified the importance of: pre-marital economic activity, particularly market work, for enhancing post-marriage agency and mental health; the women's birth family as a key extra-marital social resource, and the potential adverse costs of having decision-making power in terms of family reaction (Yount et al., 2014).

3.2. Findings from lower quality studies

Twenty-seven studies - one case-control study and 26 single time-point cross-sectional studies - provide lower quality, but largely consistent, evidence of associations between lower levels of control for women in their living environment and higher risks of adverse health outcomes (Table 2). These studies spanned a range of Asian, African and South American settings, exhibiting strong gender discrimination to a greater or lesser extent, and some, in addition, exhibiting son preference. Box 2 summarises the range of adverse health outcomes for women or their children associated with women's lower control/constrained autonomy in the studies in Table 2.

Twenty-one of the 27 lower quality studies found lower control was associated with poorer health outcomes, after adjustment for socio-economic status/circumstances. Three found mixed results, including beneficial and adverse associations across different measures of control and different health outcomes (Nankinga et al., 2016; Hadley et al., 2010; Dancer and Rammahan, 2009). Three studies found no significant associations (Ramaprasad et al., 2016; Sudha et al., 2007; Qadir, 2011). The overall conclusion is that these 27 lower quality studies provide weak evidence on their own, but taken together they point in the same general direction as the three higher quality studies: lower control for women associated with significantly higher risk of adverse health outcomes. More robust study designs are needed to draw firmer conclusions.

4. Discussion

Our systematic review identified thirty observational studies that met our strict inclusion criteria and examined the associations between women's control in the living environment and health outcomes in societies exhibiting profound gender discrimination, coupled in some countries with marked son preference. All the studies were conducted in low and middle-income countries. A consistent finding of nearly all the studies was that women's low control in their living environment was significantly associated with worse health outcomes for the women themselves or for their children, after adjusting for socioeconomic circumstances. Only three studies, however, were of higher quality to provide more robust evidence. These demonstrated a temporal relationship, with enhanced autonomy/empowerment of women associated with a subsequent reduced risk of infant and child mortality in Bangladesh (Hossain et al., 2007) and better mental health of the women in Egypt (Yount et al., 2014). Evidence of a mediation role for women's empowerment was also found: women's empowerment partially mediated the association between women's educational status and infant death in Ethiopia, while degree of household wealth acted as an effect modifier (Alemayehu et al., 2015). A partial mediating role for women's post-marital agency between premarital enabling resources and subsequent mental health was also found in Egypt (Yount et al., 2014).

4.1. Limitations of the reviewed studies

There were several limitations of the studies included in the review. Most of the studies were lower quality, single point cross sectional design that could not establish a temporal relationship: women's

Table 2
Lower quality Studies of women's control in their living environment and health outcomes.

Study (author, year)	Country	Measures of women's control	Health outcome measures	Summary of results (statistically significant associations, p ≤ 0.05)	Design and study quality
Fantahun et al. (2007)	Ethiopia	Household decision-making index	Childhood mortality	Lower decision-making for women associated with poorer survival for children	Prospective case-control; lower quality
Desai and Johnson (2005)	Benin, Malawi, Mali, Uganda, Zimbabwe, Egypt, India, Nepal, Haiti, Colombia, Nicaragua, Peru	Women's household decision-making authority measures	Child nutritional status (height-for-age); Childhood mortality (between 13 and 60 months)	Lower decision-making authority for women was associated with lower nutritional status in India and Malawi, and with higher mortality in Egypt, India, Mali and Nepal. No significant associations in other countries.	Cross-national ecological comparative (single point cross-sectional); lower quality
Hindin (2006)	Zimbabwe, Zambia, Malawi	Women's household decision-making measures	Women's anthropometric status (chronic energy deficiency/low BMI)	In Malawi, lower decision-making for women was associated with poorer health for women. In Zambia, lower decision-making for women was associated with poorer health for women in urban (but not rural) areas. No association in Zimbabwe	Cross-national ecological comparative (single point cross-sectional); lower quality
Agustina et al. (2015)	Indonesia	Maternal agency measures	Diarrhea and acute respiratory tract infections in children < 2 yrs of age	Low maternal agency associated with poorer child health (both outcomes)	Cross-sectional (two time-points); lower quality
Sudha et al. (2007)	India	Women's autonomy index; Economic autonomy index	Reproductive Tract Infections	No associations	Single time-point cross-sectional
Nankinga et al. (2016)	Uganda	Measure of women's involvement in decision-making about her own health care; Sexual empowerment index;	Women's sexually transmitted infections	Mixed: Lower decision-making for women about own health care was associated with higher STI rates. Lower sexual empowerment for women was associated with lower STI rates	Single time-point cross-sectional
Hadley et al. (2010)	Uzbekistan	Women's autonomy measures (ownership autonomy; purchasing autonomy; travel autonomy; body-sex autonomy; final decision autonomy)	Depressive symptoms; systolic & diastolic blood pressure (women)	Mixed: Greater travel autonomy associated with lower odds of depressive symptoms, greater decision autonomy associated with higher odds of depression. No autonomy-depression association with ownership autonomy or control over purchases.	Single time-point cross-sectional
Qadir et al. (2011)	Pakistan	Women's autonomy index	Women's psychological morbidity	No association.	Single time-point cross-sectional
Barchi (2012)	Botswana	Women's autonomy measures (freedom of movement, economic independence, control of household resources, household-related decision-making,	Women's self-reported health status (SRHS), depression, suicidal ideation	Lower autonomy for women (economic independence; control of household resources) was associated with lower women's SRHS. No associations between autonomy measures & depression or suicidal ideation	Single time-point cross-sectional
Mabsout (2011)	Ethiopia	Women's decision-making index	Women's low BMI; anaemia scores	Lower decision-making for women associated with poorer health for women	Single time-point cross-sectional
Hindin (2000)	Zimbabwe	Women's household decision-making measures	Women's anthropometric status (chronic energy deficiency/low BMI)	No say in decision-making for women associated with poorer health for women	Single time-point cross-sectional
Singh et al. (2015)	Democratic Republic of the Congo, Egypt, Ghana, Liberia, Mali, Nigeria, Uganda, Zambia	Women's household decision-making index	Women's low BMI	Low decision-making for women was associated with having low BMI	Single time-point cross-sectional (pooled data)
Sethuraman et al. (2006)	India	Women's empowerment measures (household decision-making, mobility)	Maternal malnutrition and anaemia; Child nutritional status (malnutrition),	Lower empowerment for women (both measures) was associated with poorer health for children (aged 6–24 months)	Single time-point cross-sectional
Mashal et al. (2008)	Afghanistan	Maternal autonomy measures (autonomy in seeking healthcare for herself and children)	Major child illness (acute diarrhea, acute respiratory infection); Child nutritional status	A lack of maternal autonomy was associated with poorer child health (growth retardation, acute respiratory infection)	Single time-point cross-sectional

Table 2 *(continued)*

Study (author, year)	Country	Measures of women's control	Health outcome measures	Summary of results (statistically significant associations, p ≤ 0.05)	Design and study quality
Rahman et al. (2015)	Bangladesh	Mother's decision-making autonomy measures	Child nutritional status (growth stunting, wasting, underweight)	No say in decision-making for women was associated with poorer child health	Single time-point cross-sectional
Chakraborty and Anderson (2011)	India	Maternal autonomy index	Low Birth Weight	Low maternal autonomy associated with poorer health for new-borns	Single time-point cross-sectional
Roushdy (2004)	Egypt	Women's investment in children's human capital decision-making measures (schooling and nutrition)	Child nutritional status (growth stunting)	No association between women's autonomy and child health	Single time-point cross-sectional
Shroff et al. (2009))	India	Women's financial and physical autonomy indices	Child nutritional status (growth stunting)	Lower autonomy for women associated with poorer health for children	Single time-point cross-sectional
Shroff et al. (2011)	India	Women's autonomy indices	Infant nutritional status (malnutrition, wasting)	Lower autonomy for women associated with poorer health for children	Single time-point cross-sectional
Ramaprasad et al. (2016)	India	Mother's decision-making autonomy measures	Child nutritional status (growth stunting, wasting, underweight)	No associations	Single time-point cross-sectional
Bose (2011)	India	Women's autonomy index (household decision-making; movement)	Child nutritional status (malnutrition); gender disadvantage in nutritional status (likelihood of girls being malnourished compared to boys)	Lower autonomy for women associated poorer child health (higher malnutrition in all children), and with higher probability of girls being malnourished, compared to boys.	Single time-point cross-sectional
Brunson et al. (2009)	Kenya	Women's autonomy index	Child nutritional status (malnutrition)	Low autonomy for women was associated with poorer health for children aged 3–10 yrs. No association between women's autonomy and younger children's (aged 0–35 months) health.	Single time-point cross-sectional
Dancer and Rammohan (2009)	Nepal	Maternal autonomy measures (household decision-making; healthcare decision-making)	Child nutritional status (wasting; growth stunting)	Lower maternal autonomy associated with poorer health outcomes, particularly for girls.	Single time-point cross-sectional
Ross-Suits (2010)	Tanzania	Maternal autonomy measures (healthcare decision, financial autonomy)	Child nutritional status (malnutrition; growth stunting)	Low healthcare decision autonomy for women was associated with poorer child health outcomes (growth stunting). No associations between other variables.	Single time-point cross-sectional
Roy (2013)	India (state level)	Household decision-making measures	Neo-natal and Post neo-natal mortality	Lower decision-making for women associated with poorer health for infants	Single time-point cross-sectional
Hossain (2015)	Bangladesh	Measures of women's participation in household decisions; movement autonomy measures	Infant mortality	Lower decision-making for women was associated with higher infant mortality	Single time-point cross-sectional
David (1999)	Egypt	Personal autonomy measures	Childhood mortality	Lower autonomy for women associated with higher child mortality	Single time-point cross-sectional

Studies are ordered by health outcomes where possible (fourth column).

7

Box 2. Associations between low control for women and adverse health outcomes identified in single-point cross-sectional studies in Table 2.

Higher rates of:

- Infant, child and maternal mortality
- Malnutrition (for infants, children and women)
- Infant and child growth
- Gender disadvantage in childhood nutritional status/malnutrition (for girls)
- Low birth weight
- Anaemia (for women)
- Diarrhea and acute respiratory tract infections in children < 2 yrs of age

Lower levels of:

- Self-reported health status for women

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control and health outcomes were measured at the same point in time. Conclusions that could be drawn from these studies were therefore limited to whether statistically significant associations were present, and the general direction of those associations, after adjusting for socioeconomic circumstances. We gave more weight in our review to the findings of the two individual level longitudinal studies and the one ecological longitudinal study, which attempted to establish temporal ordering and/or explore intervening mechanisms. More longitudinal studies of this nature are needed in future research.

Adjustment for confounders, mediators and effect modifiers was relatively crude in most studies. It is particularly important to adjust for differences in socioeconomic circumstances in the living environment as these are important determinants of population health in their own right (CSDH, 2008). All the included studies did attempt to adjust for socioeconomic circumstances or pathways (those that did not were excluded from the review), but the scope for unmeasured effects was still considerable.

In all studies, the conceptualisation and measurement of control was challenging. Most, however, developed proxies for women's control or autonomy that were clearly based on theory and succeeded to a degree in capturing actual or 'real' control, as opposed to general perceptions of control or control beliefs. Developing appropriate measures of actual control in the living environment is a key area for future research in this field to match the robust measures that have been developed in the work environment in high-income countries (e.g. Karasek and Theorell, 1990).

4.2. Limitations of this systematic review

Our systematic review had certain limitations, predominantly related to the strict inclusion and exclusion criteria, which restricted the number and nature of studies eventually included in the review.

First, the review did not cover the many studies on son preference and health, which relate to the pathway in the lower part of the logic model in Fig. 1. This is mainly because the studies did not measure women's level of control in their living environment and so did not meet essential criterion 'a' as specified in our Methods section. We did, however, locate over 100 studies on the impact of son preference on relative survival of female infants and children into adulthood, which are currently the subject of a separate systematic review.

Second, there is a large body of evidence linking low control to intermediate health-related outcomes, such as healthcare seeking behaviour, domestic violence, and use of contraceptive services. These reveal important information about potential mechanisms linking low control in the living environment to poorer health, but as the studies did not go on to measure health outcomes, they did not address our review question fully and were excluded.

Third, all the studies in the review measure women's control in the living environment within their households, but women also face

constraints on their autonomy imposed by their communities or neighbourhoods in societies with profound gender discrimination. Our search (and helpful reviewers) identified some studies that, on the surface, analysed how community-level control affects women's health, but on assessment all were excluded for two main reasons. Most, if not all failed to measure control at the community level directly, but used measures of socioeconomic status, such as rates of women's educational attainment, wealth, or employment. These SES indicators are conceptually distinct from the notion of 'control' and, indeed, are known to be determinants of health in their own right, for which 'control' may act as a mediator in the pathway between SES and health outcomes. In addition, all the community-level studies that we located failed to measure health outcomes, but rather assessed intermediate outcomes, such as use of healthcare services. They were therefore excluded as not meeting the review's criteria and addressing the review question. This finding from the review highlights the gaps in the observational evidence on community-level control in relation to women's autonomy and health, and identifies the need for the development of robust measures of control at the community level for future studies.

4.3. Putting women's low control in context

Key mechanisms indicated in the higher quality studies in this review need further teasing out in the light of specific societal contexts. First is the finding that in the Ethiopian context that women's empowerment partially mediates the maternal education-infant death relationship, but still leaves the largest part of the mechanism unexplained (Alemayehu et al., 2015). The wealth of the household played no part in the mediation, but did act as an effect modifier in a very intriguing way: both empowerment and education had the strongest inverse association with infant deaths among women from the richest households and weakest among those from poorest households. One possible explanation is that poverty and material deprivation experienced by the women in the poorest households has such an overwhelming effect on their access to the pre-requisites for health that empowerment can do relatively little to counter the effects of this deprivation. For women in the richest households, however, where poverty is not blocking access to healthcare, education, employment and so on, then differences in women's power may play a greater role in influencing the observed health outcomes between women with different degrees of control in their daily lives. Other studies have postulated the reverse: that women's higher levels of autonomy will have a greater effect on children's health in poorer households where resources are severely constrained (Brunson et al., 2009). The nature of these differing mechanisms need unpicking further, and certainly point to the need for stratified analysis by SES in all such studies, as well as high quality qualitative studies to illuminate why the associations have developed.

Second, is the tricky issue of how to treat 'purdah' in these analyses and how to interpret the results. In the Bangladeshi context, Hossain et al. (2007) contend that, while *purdah* can be seen as the most extreme manifestation of the subjugation of women, in practice the custom has been eroded in recent years. It has become increasingly associated with richer households, because the costs of *purdah* (additional clothing, transport, not being able to work outside the home) have become unsustainable for poorer households. In Hossain et al.'s analyses, the net effect of *purdah* is therefore taken to portray the effect of household economic status rather than women's level of control within the household. The finding that the index of purdah was weakly associated with lower neonatal mortality was speculated to be due to women in *purdah* acquiring access to antenatal and postnatal care that more deprived households could not afford. The effect wears off by the postneonatal and early childhood periods. Further studies, both quantitative and qualitative, are needed to disentangle the net effect of *purdah* from economic status.

Third, is the issue of whether women's greater autonomy can mitigate the effects of gender bias – son preference – and the selective deprivation of girls. In the Bangladeshi study, the hypothesis that the effects of gender bias on the autonomy and authority of mothers will be more harmful for the survival of girls than for boys was not supported (Hossain et al., 2007). The effect was similar for girls and boys. It may be that individual women's autonomy may be insufficient to affect the underlying dynamic that drives son preference in such a gender-biased society. On the policy front, this flags up the potential importance of societal level efforts to reduce or eliminate gender discrimination, which may then go on to influence the drivers of son preference. The health impacts of such societal level efforts need to be evaluated and, indeed, efforts in Bangladesh over the last two decades have shown marked success in improving the survival of girls, particularly poor girls who had the worst chances of survival, relative to rich girls and poor and rich boys (Bhuiya et al., 2001; Orton et al., 2016).

Finally, questions arise about the difficulties of conducting research of this nature and interpreting the results in the overarching societal context in which the reviewed studies took place. All the studies attempted to exploit the variation in levels of women's control or autonomy found in their study countries to assess associations with health outcomes. But it is likely that the degree of variation in women's autonomy is still relatively small in the societies with profound gender discrimination and gender bias. The variation may, therefore, be insufficient to detect an effect on health, even if such an effect is present. Given this constraint, it is surprising that so many studies were able to detect an association, even if modest. One suggestion for further studies to address this issue is to compare meaningful jurisdictions within a society, such as comparisons of the experience of women in Indian states, known to differ significantly in terms of women's rights and status.

5. Conclusion

The impetus for conducting research on women's low control in society and impact on health stems from knowledge of the very restricted lives in which many women live in some societies. This is due, for example, to extreme gender discrimination and ingrained cultural practices that limit women's freedom to go about their daily lives in their living environment (Sen, 1999a and 199b). The notion that low status and lack of control over decisions may have adverse effects on population health has been raised in the development literature as a key public health concern by Amartya Sen and others for many years (Sen, 1989, 2001; Wickrama and Lorenz, 2002).

The studies identified by this systematic review demonstrate serious efforts on the part of researchers to devise empirical measures that capture women's experiences of lack of control over their daily lives in the context of specific cultures and societies in which the women live. These measures represent methodological advances, but there is still a

need for further refinement of such measures. These would feed into empirical studies that seek to understand the extent and nature of any health impact, as an aid to working out what can be done to prevent or ameliorate adverse health effects, as well as to empower women more directly. This systematic review is timely in identifying and synthesising the available empirical evidence, which does, indeed, show some disturbing health impacts, but also provides insights into the methods and measures that could be further developed to investigate this important issue.

This is the first theory-based systematic review of observational evidence of the health impact of low control of women in the living environment in societies with profound gender discrimination and gender bias. The evidence suggests that women's low control is associated with adverse health outcomes measured at the population level. Further studies, including in-depth qualitative investigations, are needed to disentangle and understand these pathways in greater depth.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.healthplace.2018.02.001.

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The impacts of profound gender discrimination on the survival of girls and women in son-preference countries - A systematic review

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A B S T R A C T

Amartya Sen first used the phrase 'missing women' to describe a survival disadvantage for women exposed to extreme gender discrimination in son-preference countries. In 1989 he estimated that, despite a biological survival advantage for females, there were 100 million fewer women in Asia and north Africa than expected. He blamed corrosive gender discrimination restricting the resources needed for survival. This systematic review examined demographic evidence on the impacts of profound gender discrimination on the survival of girls and women in son-preference countries. Thirty-four included studies provided consistent evidence of lower-than-expected female survival in 15 societies. Male-to-female sex ratios rose particularly in China and India between the 1980s and 2010s, despite general improvements in female mortality. High sex ratios in South Korea, however, returned to biologically normal levels. The number of 'missing women' rose steadily from 61 million in 1970 to 126 million in 2010 and was predicted to continue to rise until 2035. The number of 'missing women' in the world increased in relative and absolute terms between 1980 and 2020. Profound discrimination reduces female survival at every stage of life. Future research is needed to understand the complete pathways and mechanisms leading to poorer survival and the major policy drivers of these trends to devise the best possible ways of preventing the tragedy of 'missing women'.

1. Introduction

In 1986, the Nobel Laureate in Economics, Amartya Sen, first drew attention to the phenomenon that he termed 'missing women' (Sen, 1986). As he explained in 1990:

> "In West Asia and North Africa a great many more than a hundred million women are simply not there … they are 'missing' … because women are neglected compared with men … These numbers tell us, quietly, a terrible story of inequality and neglect leading to the excess mortality of women" (Sen, 1990).

Sen's concern was sparked by suspiciously skewed population sex ratios (PSRs) in countries with profound gender discrimination. Population sex ratio refers to the total number of males for every 100 females in the population, which is compared in countries with and without extreme forms of gender discrimination. From these comparisons, an estimate can be made of the 'number of females who would be alive, in the absence of profound gender discrimination', referred to as the number of 'missing women'.

Sen and many others after him have maintained that profound gender discrimination threatens women's very survival and fundamental right to live (Sen, 1989, 1999; Coale, 1991; Klasen and Wink, 2002, 2003; Banister, 2004; Guilmoto, 2012a). Theory postulates two main, inter-connected pathways from such discrimination to poorer survival chances for women worldwide (depicted in Fig. 1, Whitehead et al., 2016). The first is the impact of corrosive gender discrimination affecting women from when they are born and right throughout their lives. In particular societies, the gender discrimination that accompanies women's low status and lack of decision-making powers in their society lead to reduced autonomy for women, and a form of relative neglect, with poorer access than their male counterparts to: household resources, food and nutrition, health services, schooling and employment/economic opportunities, as well as legal resources such as property, fertility, and reproductive rights. This relative neglect leads on to excess mortality and reduced survival of women and girls and is a longstanding, historical pathway, explaining much of the reduced survival reflected in the 'missing women' numbers until recent decades (Bongaarts and Guilmoto, 2015b).

The second pathway is through particular consequences of son preference (depicted at the lower part of Fig. 1). Son preference refers to the entrenched cultural preference for sons over daughters, which is a pervasive social norm in some societies and which leads on to discriminatory practices and behaviours. It leads not only to the excess mortality of women and girls through the first pathway described above, but

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also, more directly, to a shortfall of newborn girls, through prenatal sex selection and female infanticide. Although there have been reports of female infanticide over the centuries, this practice has not been on a scale that changed the sex ratio at birth (SRB). For most of human history, right up until 1980, the SRB has been fairly stable at 105 to 107 males for every 100 female newborns (median 105.9) in all populations, with the exception of a few known ethnic variations (Hesketh and Xing, 2006). This ratio is therefore taken to be the biologically natural level and the median of 105.9 is widely used as the norm for calculating deviations in the SRB. Slightly more boys than girls are born, which appears to be nature's way of compensating for women being hardier than men and surviving better at all ages – provided they are given similar care and attention (Zarulli et al., 2018). From the 1980s onwards, however, the SRB has risen in many son-preference countries as new technologies to detect the sex of a fetus were introduced and became more affordable, leading to the practice of sex-selective abortion on a wide scale. This second pathway, through prenatal sex selection leading to a shortfall of newborn girls, is estimated to have made an increasing contribution to the numbers of missing women and girls in son-preference countries in recent decades.

To contextualise these practices, there are several cultural reasons why sons are preferred over daughters, related to entrenched gender norms, particularly in agrarian economies. First, sons are considered to have a higher wage-earning capacity. Second, they continue the family line in patriarchal societies, which includes receiving any inheritance. Third, they are expected to have responsibility for their parents in illness and old age. In contrast, daughters are often seen as an economic burden rather than a resource, because their earning power is low, their parents would have to pay out a marriage dowry to the husband's family, and the daughter would then move to be part of her husband's family, ceasing to have responsibility for caring for her own parents (Hesketh and Xing, 2006). The thrust of many development and health strategies over the past 40 years has, therefore, been to challenge such gender norms through the empowerment of girls and women, by improving their access to education and employment opportunities, the theory being that such empowerment would in turn improve their economic independence and hence status in society (Sen, 1999).

It is becoming increasingly clear, though, that the new contemporary technological advances and their ensuing impact on the numbers of 'missing women' also need urgent attention if empowerment strategies are to work. A body of literature has accumulated on the phenomenon of 'missing women' since Sen first coined the phrase in the 1980s, but it has yet to be comprehensively synthesised. The aim of our systematic review is to synthesise the empirical evidence on the impacts of profound gender discrimination on the survival of girls and women in son-preference countries. This is the first systematic review of its kind, encompassing up-to-date empirical evidence on both the impact of prenatal sex selection and postnatal excess mortality in women and girls. It employs a logic model on the son-preference pathway, drawn from a critical review of theory published in Health & Place, which was itself the first of its kind (Whitehead et al., 2016).

2. Methods

2.1. Search strategy and identification of evidence

Six electronic databases (OVID Medline, OVID Medline In-Process and Other Non-Indexed Citations, American Psychological Association (APA) PsycINFO, Web of Science Social Science Citation Index, Web of Science Conference Proceedings Citation Index - Social Sciences and Humanities, and CINAHL Plus [via EbscoHOST]) were searched for articles published in English between 1980 and 2020 on son preference, sex selection, and 'missing women'.

A theory-based logic model (Fig. 1) informed development of the search strategy and interrogation of the evidence. Systematic review approaches followed the Centre for Reviews and Dissemination's guide to undertaking systematic reviews, and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (CRD, 2009; Moher et al., 2009; Page et al., 2021). Search terms were identified through relevant sample papers in results from three related, preceding reviews (Whitehead et al., 2016; Orton et al., 2016; Pennington et al., 2018). Pilots of the database searches identified that a single-tier search ('a broad net') using a range of highly relevant (specific) terms would provide the best balance of sensitivity and specificity. Search
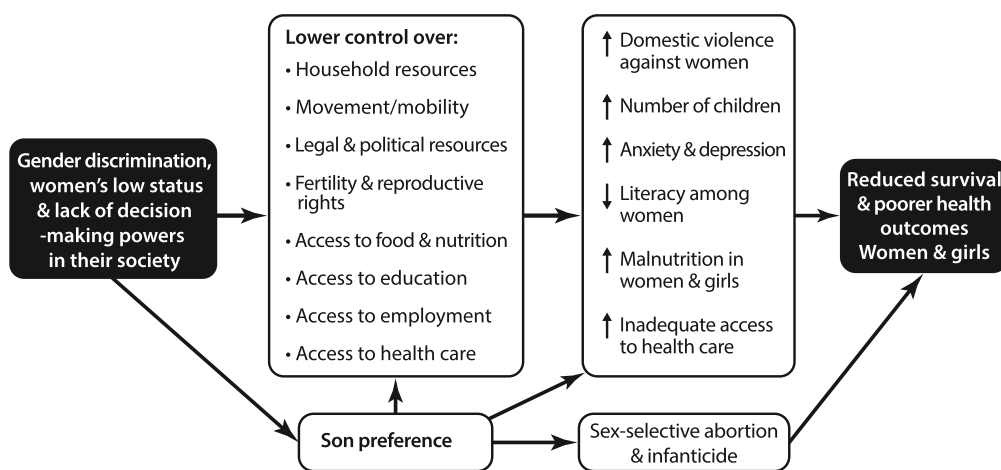
Fig. 1. Theoretical pathways and mechanisms between gender discrimination, women's low status and lack of decision-making powers in son-preference societies, and reduced survival and poorer health outcomes for women and girls.
Source: Adapted from Whitehead et al. (2016).

Table 1

Inclusion/exclusion criteria for systematic review of evidence on relative survival outcomes for girls and women in son-preference countries.

	Included	Excluded
Population & Setting	Populations in established son-preference countries. At national level.	Sub-national populations.
Studies and data of interest	Quantitative empirical representative population-level studies, including demographic studies of observed and expected sex ratios at birth and in adulthood.	Non-empirical studies (including evidence reviews). Qualitative studies. Studies on populations not representative of societal level. Opinion/discussion pieces not providing empirical data.
Outcomes	Sex-specific survival indicated by sex ratios at birth and other ages; estimates of shortfalls of women ('missing women') in the population of son-preference countries, derived from sex ratio data.	Studies not measuring survival outcomes.
Time coverage	1980–2020	–
Language	English-language studies.	–

syntaxes were tailored and ran on specific appropriate databases. Dates of searches, search terms and syntaxes, databases searched, number of hits, keywords, and other comments were recorded, so the searches were transparent, systematic, and replicable (an example of the MEDLINE search strategy is in Appendix 1).

The results of the searches were deduplicated in Endnote reference manager before export into EPPI Reviewer 4 systematic review management software. Reference lists of included studies were scanned for any additional relevant articles (backward citation searching or 'citation snowballing'). We also ran advanced (Boolean and date-limited) Google searches to identify any publications that may have been missed by the database searches (but no further papers were identified). Finally, we contacted authors (experts in the field) to request missing or unpublished data for key papers and any additional relevant publications (but no further papers were identified).

2.2. Study selection

2.2.1. Study inclusion and exclusion criteria

Study inclusion and exclusion criteria focused on sex ratios in son-preference countries (Table 1).

Demographic studies reporting empirical data from quantitative investigations in low- and middle-income countries (LMICs) with a culture of strong gender discrimination and son preference were included. Studies that measured survival outcomes for females at any stage of life compared with males were included. Studies were only included if they used data from representative national population-level samples.

2.2.2. Screening for inclusion/exclusion

Studies were selected for inclusion through two stages (title and abstract screening and full-text screening). Titles and abstracts of all records retrieved from the searches were independently screened by two reviewers to identify potentially eligible studies based on the inclusion/exclusion criteria (Table 1). All potentially eligible papers were retrieved in full text. Two reviewers then screened the full text of the articles in EPPI-reviewer 4 (Thomas et al., 2010). Reasons for exclusion were recorded (Appendix 2). Any queries or disagreements in the

Table 2

National level evidence on trends in male-to-female Sex Ratios at Birth (SRBs) in son-preference countries, 1982–2017.

Study	Data sources	Results	
Country, Author/s, year *(number of included studies)*		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
EAST AND SOUTHEAST ASIA			
China *(n=9)*		*1982–2017*	*Highest = 121.2 (2010)*
Zeng et al. (1993)	1982–87: Fertility and Contraception Survey; 1989: 10 Percent Sample 1990 Census	1982 1983 1984 1985 1986 1987 1989	107.2 107.7 108.3 111.2 112.1 110.8 113.8
Huang et al. (2016)	National Maternal Near Miss Surveillance System	2012 2013 2014 2015	111.0 110.2 108.8 109.5
Jiang et al. (2017)	Censuses; sample Censuses; survey data	1981 1986 1989 1993 2000 2005 2010	107.8 113.1 113.9 114.1 119.9 120.5 121.2
Jiang et al. (2012)	Censuses	2000 2010	119.9 121.2
Bongaarts (2013)	United Nations (2011) World Population Prospects: The 2010 Revision ("author's calculations")	2011	119
Guilmoto (2012a)	Annual estimate	2011	117.8
Rahm (2020, p23)	National statistics UNFPA (United Nations Population Fund)	2014–15	114.7
Tufuro & Guilmoto (2020)	2015 Inter-Census, National Statistical Office	2015	113.5
Chao et al. (2019)	Various sources (including Census, vital registration, population surveys), identified in Chao et al. (2019)	1981 1990 2000 2004 2010 2017	107.3 111.9 117.1 117.9 117.4 114.3
Taiwan *(n=1)*		*1982–2017*	*Highest = 110.0 (2004)*
Chao et al. (2019)	Vital Registration (Demographic Fact Book)	1982 1990 2000 2004 2010 2017	106.9 109.8 109.3 110.0 108.6 107.6
South Korea *(n=8)*		*1980–2017*	*Highest = 116.5 (1990)*
Chun & Das Gupta (2009)	Vital statistics: Korea Statistical Information System (KOSIS), Korea National Statistical Office	1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994	105.3 107.2 106.8 107.4 108.3 109.5 111.7 108.8 113.3 111.7 116.5 112.1 113.6 115.3 115.2

Table 2 (*continued*)

Study	Data sources	Results	
Country, Author/s, year (number of included studies)		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
		1995	113.2
		1996	111.6
		1997	108.2
		1998	110.1
		1999	109.6
		2000	110.2
		2001	109.0
		2002	110.0
		2003	110.7
		2004	108.2
		2005	107.7
Guilmoto (2012a)	Birth registration	2010	106.7
Yoo et al. (2017)	National Survey on Fertility, Family Health & Welfare (NFFHS)	1990	116.5
		2013	105.3
Jiang et al. (2017)	Vital statistics	1990	116.5
Den Boer & Hudson (2017)	Korea Statistical Information Service	1981	107.1
		1985	109.4
		1990	116.5
		2000	110.2
		2007	106.2
		2014	105.3
Rahm (2020, p23)	National statistics UNFPA	2015–16	105.1
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	1982	107.2
		1990	115.1
		2000	109.9
		2010	106.5
		2017	105.6
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2017	106.2
Singapore (*n=2*)		*1990–2017*	*Highest = 107.6 (2000)*
Guilmoto (2012a)	Birth registration	2009	107.5
Chao et al. (2019)	Vital registration (United Nations Demographic Yearbook)	1990	107.2
		2000	107.6
		2010	106.8
		2017	106.5
Vietnam (*n=6*)		*1989–2017*	*Highest = 112.6 (2012)*
Guilmoto et al. (2009)	Annual population survey	1989	107
		1999	105.5
		2000	109
		2001	107
		2002	104
		2003	108
		2004	106
		2005	108
		2006	111.6
Guilmoto (2012b)	Censuses; National Family Health Surveys (NFHS); annual population surveys (including state-level analysis)	2005	110.0
		2009	110.6
		2010	111.2
Guilmoto (2012a)	Annual demographic survey	2010	111.2
Rahm (2020, p23)	National statistics UNFPA	2013–14	112.2
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	1990	106.5
		2000	107.6
		2001	107.6
		2010	112.4
		2012	112.6
		2017	112.2
Tufuro & Guilmoto (2020)	Annual Population Survey	2016–17	112.1

Table 2 (*continued*)

Study	Data sources	Results	
Country, Author/s, year (number of included studies)		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
SOUTH ASIA			
India (*n=7*)		*1975–2017*	*Highest = 113.1 (1994-96)*
Bhat & Zavier (2007)	Census	2001	110.4
Guilmoto (2012a)	Sample registration	2008–10	110.5
Bongaarts (2013)	United Nations (2011) World Population Prospects: The 2010 Revision ("author's calculations")	2010	108
Condorelli (2015)	Sample registration system	1982–1984	109.8
		1984–1986	109.5
		1986–1988	109.6
		1988–1990	109.8
		1990–1992	111.1
		1992–1994	113.0
		1994–1996	113.1
		1996–1998	110.9
		1998–2000	111.1
		2000–2002	112.1
		2005–2007	109.4
		2006–2008	110.6
		2007–2009	110.4
		2008–2010	110.5
		2009–2011	110.4
		2010–2012	110.1
Rahm (2020, p23)	National statistics UNFPA	2013–14	110.0
Tufuro & Guilmoto (2020)	Sample registration system, National Statistical Office	2014–16	111.3
Chao et al. (2019)	Demographic and Health Survey (DHS) – Full Birth Histories	1975	106.1
		1990	109.6
		1995	111.3
		2000	111.3
		2010	109.8
		2017	109.8
Pakistan (*n=1*)		*2007*	*Highest = 109.9 (2007)*
Guilmoto (2012a)	Population and demographic survey	2007	109.9
Nepal (*n=1*)		*2012–2016*	*Highest = 110.6 (2012-16)*
Tufuro & Guilmoto (2020)	DHS sample	2012–16	110.6
WEST ASIA			
Azerbaijan (*n=6*)		*1990–2017*	*Highest = 119 (2001-06)*
Duthé et al. (2012)	Censuses; demographic surveys	1999	112
		2001–06	119
		2011	117
Michael et al. (2013)	DHSs; vital statistics	2005–09	116
Guilmoto (2012a)	Birth registration	2011	116.5
Rahm (2020, p23)	National statistics UNFPA	2014–15	114.6
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	1990	106.6
		1991	106.8
		2000	115.5
		2003	117.1
		2010	116.6
		2017	113.4
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2017	113.5

Table 2 (*continued*)

Study	Data sources	Results	
Country, Author/s, year *(number of included studies)*		Year/s	Sex Ratio at Birth (number of males born per 100 females born)
Armenia (*n=6*)		*2000–2017*	*Highest = 126 (2000-05)*
Duthé et al. (2012)	Census	2001	116
	Demographic surveys	2000–05	126
Michael et al. (2013)	DHSs; vital statistics	2005–09	117
Guilmoto (2012a)	Birth registration	2010	114.9
Rahm (2020, p23)	National statistics UNFPA	2014–15	113.3
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	1990	106.6
		1992	105.9
		2000	117.6
		2010	116.6
		2017	111.7
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2017	109.8
Georgia (*n=6*)		*1990–2017*	*Highest = 122 (2000-05)*
Duthé et al. (2012)	Census	2002	110
	Demographic surveys	2000–05	122
Michael et al. (2013)	DHSs; vital statistics	2005–09	121
Guilmoto (2012a)	Birth registration (provisional)	2009–11	113.6
Rahm (2020, p23)	National statistics UNFPA	2010–16	108.0
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	1990	106.2
		1992	106.3
		2000	111.4
		2003	111.5
		2010	108.1
		2017	106.5
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2017	107.9
SOUTHEAST EUROPE			
Albania (*n=4*)		*2008–2017*	*Highest = 111.7 (2008-10)*
Guilmoto (2012a)	Birth registration (provisional)	2008–10	111.7
Rahm (2020, p23)	National statistics UNFPA	2012–13	109.0
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	2017	108.3
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2017	110.6
Montenegro (*n=4*)		*1980–2017*	*Highest = 109-9 (1997 & 2012-14)*
Guilmoto (2012a)	Birth registration	2009–11	109.8
Rahm (2020, p23)	National statistics UNFPA	2012–14	109.9
Chao et al. (2019)	Vital Registration (United Nations Demographic Yearbook)	1980	105.6
		1990	109.0
		1997	109.9
		2000	109.8
		2010	109.0
		2017	107.2
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2015–17	107.4
Kosovo (*n=2*)		*2014–2017*	*Highest = 111.2 (2017)*
Rahm (2020, p23)	National statistics UNFPA	2014–16	110.9
Tufuro & Guilmoto (2020)	Birth registration, National Statistical Office	2017	111.2

Notes: n = in column 1 shows the number of included studies with data for that country. The range of years with available data is shown in column 3. SRB results in columns 3 and 4 are rounded to one decimal place where possible. "Highest" in column 4 refers to the highest observed/recorded SRB, for the most recent year/s recorded.

screening process were resolved by discussion or recourse to a third reviewer.

In practice, the ($n = 20$) studies excluded as not being conducted in son-preference countries but otherwise meeting the remaining inclusion criteria were studies of diasporas from son-preference countries (India, China, etc.) that had migrated to high-income countries such as the USA and UK; these studies were set aside for a subsequent review.

2.3. Data extraction, harmonisation, and synthesis

Reviewers extracted data from studies into pre-designed and piloted forms. Extractions were checked for accuracy and completeness by a second reviewer. Extracted data included: study aims, study design, setting/country, and main findings related to the review question.

Data on population sex ratios from individual studies were harmonised/converted to the international convention of presenting the Sex Ratio at Birth (SRB) as the number of male births per 100 female births, so a population sex ratio of 106 would represent 106 males for every 100 females (Table 2).

Results were synthesised narratively (Mays et al., 2005; Popay et al., 2006; Whitehead et al., 2014).

2.4. Measurement of survival outcomes

2.4.1. Note on estimating the number of 'missing women' in son-preference countries

The concept of 'missing women' refers to the females who would otherwise be alive but for profound sex discrimination. This is a *shortfall* in the actual number of women in a specified population compared with an expected norm derived from a reference population without such profound discrimination against girls and women, i.e. how many girls and women would have to be added to the existing population to eliminate this shortfall? (Bongaarts and Guilmoto, 2015b).

To derive the number of 'missing women', the studies in this review use the population sex ratio (PSR), i.e. the total number of males for every 100 females in the population as a whole (all ages). The observed (actual) PSR in a country is compared with an 'expected' PSR that would prevail if both sexes were treated equally in their access to resources (e. g. nutrition, healthcare, education) that influence survival. "If the actual ratio exceeds the expected, the additional females that would have to be alive in order to equate the actual with the expected PSRs, would then be the number of 'missing women' at this point in time" (Klasen and Wink, 2003).

Choosing a comparable reference population to calculate the 'expected' PSR is crucial and must consider factors influencing the population sex ratio in addition to the profound sex discrimination under study. These factors include the age structure of the population (determined mostly by fertility patterns) and the overall mortality level (and biological differences in survival by sex over the lifecourse, resulting in female survival advantage in infancy and older age groups, as men suffer higher mortality rates than females at various ages). The PSR is also influenced by the natural sex ratio at birth (as described below), which exhibits a slight male excess in all populations, including non-discriminating societies.

The studies in this review (Table 3) took variations in population age structure and mortality level into account by applying modelling and model life tables to a reference group of countries with a wide range of mortality levels but presumedly without profound gender discrimination. The resulting expected age-specific sex ratios by age, country, and year can then be applied in comparing observed versus expected PSRs in

Table 3

Studies estimating the numbers and percentages of 'missing women' in son-preference countries and globally (in millions and percentages of total female population[a]), 1989–2015.

	Sen (1989) [b]		Coale (1991)		Klasen (1994)		Klasen and Wink (2003)		Guilmoto (2012a)		Kahlert (2014) [d]		Bongaarts and Guilmoto (2015a)	
	Millions	%[c]	Millions	%	Millions	%	Millions	%	Millions	%	Millions	%	Millions	%
China	50.0	9.1	29.1	5.3	40.1	7.3	40.9	6.7	66.2	10.3	35.1	5.4	62.3	9.5
India	41.6	10.2	22.8	5.6	35.9	8.8	39.1	7.9	43.3	7.3	32.4	5.5	43.3	7.4
Pakistan	5.2	13.1	3.1	7.8	4.1	10.2	4.9	7.8	2.9	3.4	4.8	5.6	4.4	5.2
Bangladesh	3.8	8.9	1.6	3.8	4.1	9.8	2.7	4.2	2.0	2.8	0.8	1.0	2.4	3.2
Nepal	0.6	7.5	0.2	2.4	0.5	7.1	0.1	0.5	0.1	–	−0.9	−6.3	–	–
Indonesia	–	–	–	–	–	–	–	–	–	–	–	–	1.7	1.5
West Asia[e]	4.7	8.5	1.7	3.0	3.0	5.5	3.8	4.2	–	–	9.7	8.4	–	–
Egypt	1.7	7.2	0.6	2.6	1.2	5.1	1.3	4.5	–	–	1.4	3.9	–	–
Nigeria	–	–	–	–	–	–	–	–	–	–	–	–	1.9	2.5
Sub-Saharan Africa	–	–	–	–	–	–	5.5	1.8	–	–	15.6	3.6	–	–
'Rest of world'	–	–	–	–	–	–	–	–	–	–	–	–	9.6	0.5
Total in 'comparable' son-preference countries[f]	107.5	9.6	59.1	–	89.0	7.9	92.8	6.8	–	–	83.3	5.3	–	–
Global total in son-preference countries[g]	–	–	–	–	–	–	101.3	5.7	116.7	7.7	99.6	4.7	125.6	3.7

Notes.

[a] Figures are rounded. Subtotals include some countries not listed (for brevity and clarity). Estimates by Sen (1986), Klasen and Wink (2002), Organisation for Economic Co-operation and Development (OECD, 2014) are omitted to allow for easier comparison and to prevent duplication. Papers used latest United Nations Population Division and/or national level Census data, for example, Coale's 1991 estimates were based on Census data from between 1981 and 1991, depending on country.

[b] Figures as reported in Klasen (1994) paper.

[c] Percentage of the total population of women in specified territory.

[d] Data time-points, sources, and data time-gaps (a minimum of 10 years for each country/region) between Klasen and Wink (2003) and Kahlert (2014) are shown in Appendix 4.

[e] Turkey and Syria are included in West Asia.

[f] A set of 'comparable' countries (including China, India, Pakistan, Bangladesh, Nepal, West Asia, and Egypt) were used in studies by Sen, Coale, Klasen/Klasen & Wink, and Kahlert to allow for comparisons between studies and over time.

[g] In addition to the 'comparable' son-preference countries (note vi), some later studies also included a larger set of newly recognised son-preference countries in their analyses, adding: Taiwan, South Korea, Iran, Algeria, Tunisia, and Afghanistan, to estimate the 'global total' of 'missing women'.

countries with gender discrimination.

2.4.2. Note on estimating the number of 'missing newborn girls' in son-preference countries

Estimates are derived from comparing observed and expected sex ratios at birth. The 'expected' ratio is based on the level that was observed in all countries pre-1980 and in countries without profound discrimination since then, i.e. in the range between 105 and 107, commonly taken as 105.9 in non-African countries. A slight adjustment is made for a lower natural SRB in sub-Saharan Africa.

3. Results

3.1. Included studies

From an initial 1846 unique records, 34 demographic studies (listed in Appendix 3) on the relative survival impacts of discrimination against girls and women, compared with boys and men, at national level in son-preference countries were included (Fig. 2).

3.2. Evidence of lower-than-expected female survival

3.2.1. Sex ratios at birth

Sex ratios at birth (SRBs) may be influenced by sex-selective abortions, infanticide, and under-reporting of newborn girls.

Eighteen studies found evidence of elevated levels of male births in records of ratios of male-to-female births at national levels in 14 countries in East and Southeast Asia (China, Taiwan, South Korean Singapore, Vietnam), South Asia (India, Pakistan, Nepal), West Asia (Azerbaijan, Armenia, Georgia), and Southeast Europe (Albania, Montenegro, Kosovo). Elevated SRBs were up to 126, against a naturally occurring SRB of 105.9 (Table 2).

3.2.2. Trends in SRBs over time

SRBs varied within countries over time. Most studies, including all in China and India (Figs. 3 and 4, respectively), indicated that male-to-female SRBs rose rapidly between the 1980s and 2000s. Although
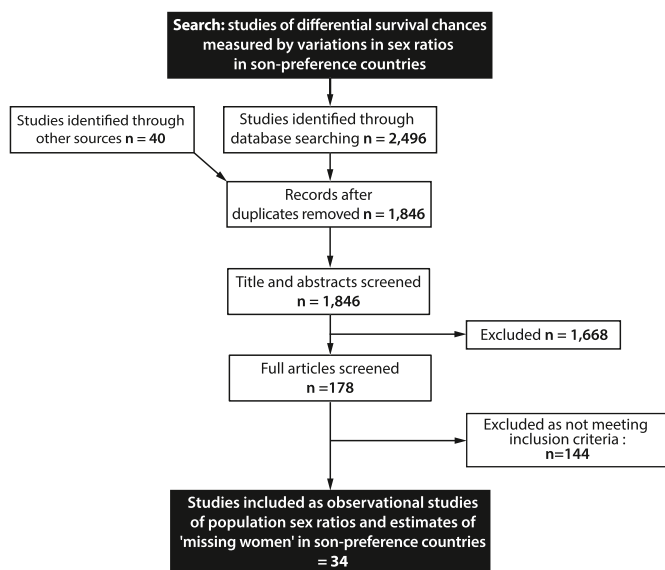
Fig. 2. PRISMA flow chart illustrating the progression of studies through the systematic review of evidence on relative survival outcomes for girls and women in son-preference countries, compared with boys and men.
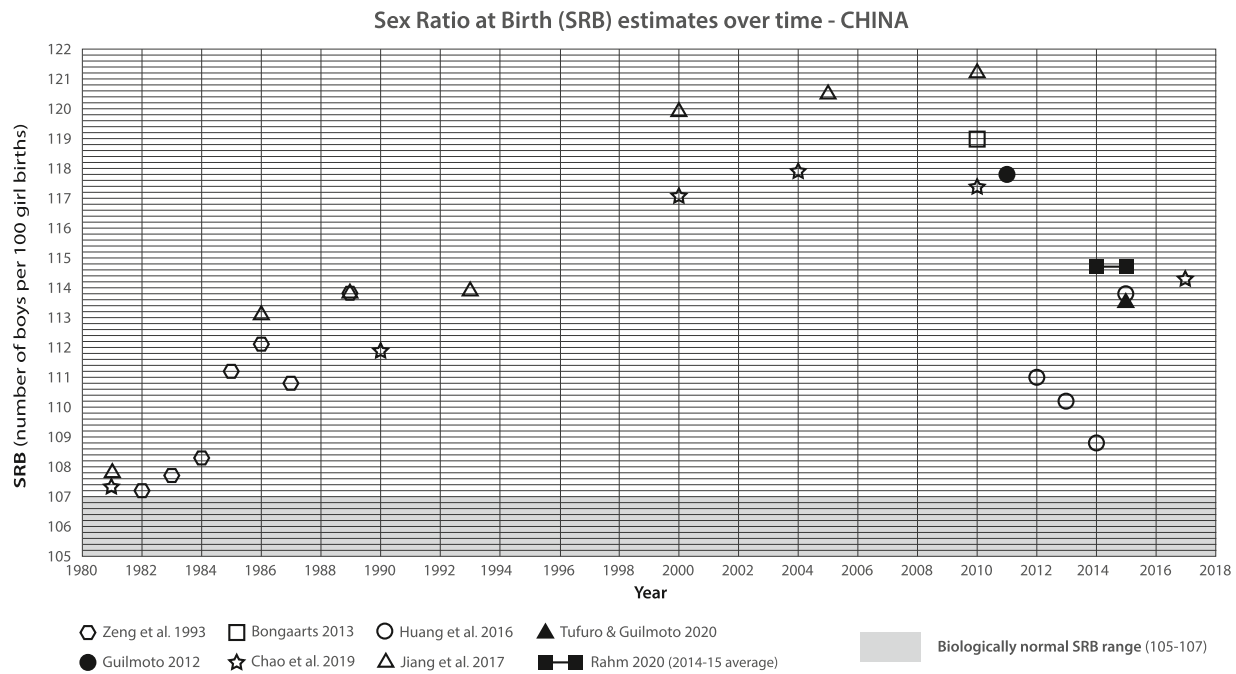
Fig. 3. Findings of included studies giving estimates of male-to-female Sex Ratios at Birth over time in China, compared with biologically normal (reference) range.
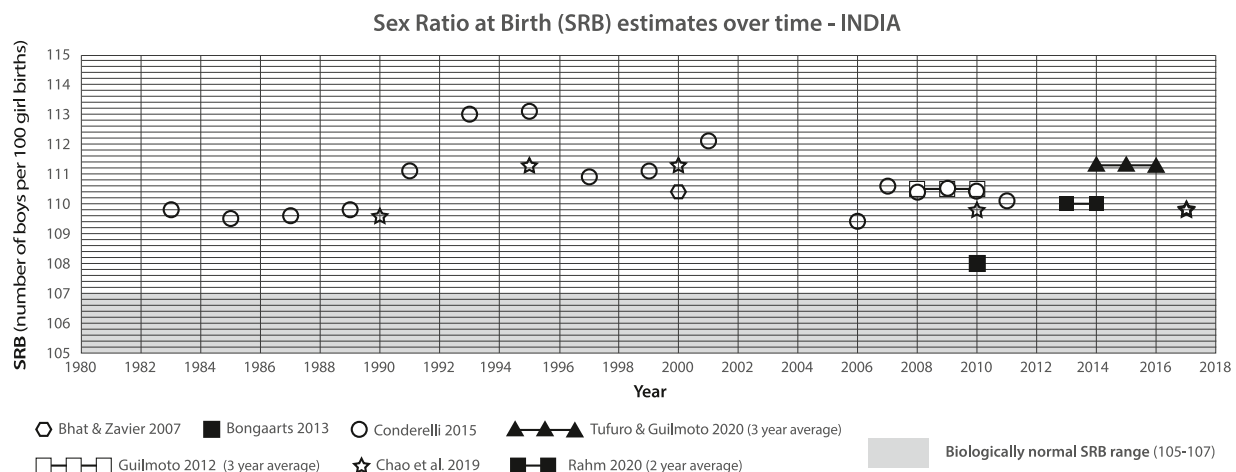
Fig. 4. Findings of included studies giving estimates of male-to-female Sex Ratios at Birth over time in India, compared with biologically normal (reference) range.

estimates differed across data sources, looking across the studies, levels appeared to have peaked in South Korea in the mid-to-late 1990s, in India in the late 1990s, in China in the late 2000s, and in Vietnam in the mid-2010s (Table 2).

Male-to-female SRBs remained elevated in all son-preference countries in the most recent data (typically 2017), with the notable exception of South Korea (and Singapore, although levels there were never particularly high). Studies in South Korea showed male-to-female SRBs declining to, and remaining around, a biologically 'normal' level since 2007 (Jiang et al., 2017) (Fig. 5).

3.3. Estimates of the number of 'missing girls' at birth in son-preference countries

Extrapolating from the skewed SRBs, four studies presented estimates of the number of 'missing newborn girls' within and across son-preference countries (Bongaarts, 2013; Grech, 2015; Bongaarts and Guilmoto, 2015b; Chao et al., 2019).

3.3.1. Single year estimates of 'missing girls' at birth

Bongaarts (2013) estimated that in 2010 alone 12.7 percent of girls were 'missing' at birth in China and 1.9 percent of girls in India. Bongaarts and Guilmoto (2015a) estimated that approximately 1.7 million girls were missing at birth across son-preference countries annually by 2010.

3.3.2. Cumulative estimates over time of population effects of 'missing newborn girls'

Annual numbers of 'missing newborn girls' accumulate over time. Based on data from 1985 to 2005, Grech (2015) estimated that a total of 48,734,993 girls were 'missing' at birth in low- and middle-income countries. The most recent global cumulative estimate of 'missing newborn girls' was based on data from vital registration systems, censuses, and surveys from 202 countries (Chao et al., 2019). They identified 11 countries (China, India, Albania, Montenegro, Tunisia, Armenia, Azerbaijan, Georgia, Vietnam, South Korea, Taiwan) with strong evidence of skewed SRBs resulting in an estimated cumulative total of 45 million 'missing newborn girls' globally between 1970 and 2017 (95%

Sex Ratio at Birth (SRB) estimates over time – SOUTH KOREA

Fig. 5. Findings of included studies giving estimates of male-to-female Sex Ratios at Birth over time in South Korea, compared with biologically normal (reference) range.

confidence interval (CI): 36.4–54.8 million). Most were 'missing' from China (23.1 million, 95% CI: 16.5–30.7 million) and India (20.7 million, 95% CI: 15.5–26.6 million).

3.4. Multinational and global estimates of total numbers of 'missing women'

Estimates of 'missing women' include prenatal shortfall in newborn girls plus postnatal shortfall in girls and women throughout the life-course. Discrimination against girls and women in son-preference countries reduces their survival chances at all stages of life, prenatally and from birth, through childhood, adolescence, and into adulthood and older ages. This relative survival disadvantage, compared with males, accumulates over time in populations and leads to the whole-population phenomenon of 'missing women'.

Ten included studies estimated the number of 'missing women' (within and across son-preference countries) (Sen, 1986, 1989; Coale, 1991; Klasen, 1994; Klasen and Wink, 2002; Klasen and Wink, 2003; Guilmoto, 2012a; OECD, 2014; Kahlert, 2014; Bongaarts and Guilmoto, 2015b). Sen's (1989) 'crude estimate' of over 100 million 'missing women' in son-preference countries was followed by studies that used more sophisticated demographic models (Table 3) (Coale, 1991; Klasen and Wink, 2003).

Multinational estimates of 'missing women' across whole populations (all ages combined) ranged from 59 to 108 million across son-preference countries in 1989-94 (Sen, 1989; Coale, 1991; Klasen and Wink 2003), and from 100 to 126 million globally in 2010 (Kahlert, 2014; Bongaarts and Guilmoto, 2015b). Bongaarts and Guilmoto (2015a) found, based on time-series estimates, that the world total of 'missing women' rose steadily from 61 million in 1970 to 125.6 million in 2010. The rate of increase in 'missing women' between 1970 and 2010 was faster than global population growth, with 3.3 and 3.7 percent of women 'missing' in 1970 and 2010, respectively (Table 3) (Bongaarts and Guilmoto, 2015b). They projected that the numbers would rise to 136.2 million in 2015, peak at 149.9 million in 2035, before levelling off

and gradually reducing to 142 million in 2050 (Table 4).

3.5. Misreporting the number of girls born

Misreporting of the number of girls being born leading to 'hidden girls' is another factor that potentially contributes to male-to-female population figures. Self-reported birth data (including Census, survey, and vital registration data) may be deliberately misreported (or subject to errors in reporting or recording). Underreporting of girl births may be a factor in China, where some authors attribute a proportion of 'missing newborn girls' to under-reporting by parents attempting to avoid heavy penalties under the (former) One-Child-policy (Johansson and Nygren, 1991; Zeng et al., 1993). In included studies that investigated differential underreporting (Zeng et al., 1993; Cai and Lavely, 2003; Banister, 2004; Cai, 2017; Goodkind, 2011; Shi and Kennedy, 2016, 2017), the extent is contested.

Shi and Kennedy (2016) argued that, in addition to explanations that include sex-selective abortion, '*the story of 'missing girls' is also an administrative one*' (p1018). They compared the SRBs for younger and older children in Census data from 1990, 2000, and 2010 and found evidence of dramatic increases in the number of reported females after the age of 10 (particularly after age 15). They originally estimated that 15 million of the girls 'missing' between 1990 and 2010 (of over 20 million) were not 'missing' but underreported (or 'hidden') by parents and local officials attempting to avoid penalties under the One-Child-Policy. Following criticisms by Cai (2017) who identified '*oversights in Shi and Kennedy's numeric analysis*' (p797), they revised the estimate to around 10 million 'hidden girls' (Shi and Kennedy, 2017).

4. Discussion

4.1. Summary of findings

There is consistent empirical evidence to support the direct son-preference pathway through prenatal sex selection leading to a

Table 4

Estimates of the total number and percent of 'missing women' across son-preference countries over time (1970–2010) and predictions to 2050.

	Number 'missing' (millions)					Predicted (millions)		
	1970	1980	1990	2000	2010	2015	2035	2050
Total 'missing' across son-preference countries	61.0	72.2	87.6	105.9	125.6	136.2	149.9	142.0

Source: Bongaarts and Guilmoto, 2015b

shortfall in newborn girls. Eighteen studies showed male-skewed SRBs in 14 son-preference countries in East and Southeast Asia, South Asia, West Asia, and Southeast Europe, with elevated SRBs up to 126, against a naturally occurring SRB of 105.9. Male-to-female SRBs rose in son-preference countries from the 1980s onwards (consistent with the spread of the technology) and appear to have peaked in most of these countries during the 1990s and 2000s, before gradually reducing somewhat, but still remaining at high levels in the 2010s. The rapid rise in SRBs in Vietnam during the 2010s is a notable exception. In contrast, male-to-female SRBs in South Korea declined rapidly to reference (biologically normal) levels after 2000. From the SRB data, four studies estimated numbers of 'missing newborn girls' in son-preference countries. One estimate found that approximately 1.7 million newborn girls were missing across son-preference countries annually by 2010. The most recent estimate of the cumulative total over the years 1970–2017 identified 11 countries with strong evidence of skewed SRBs resulting in an estimated cumulative total of 45 million missing newborn girls across these countries.
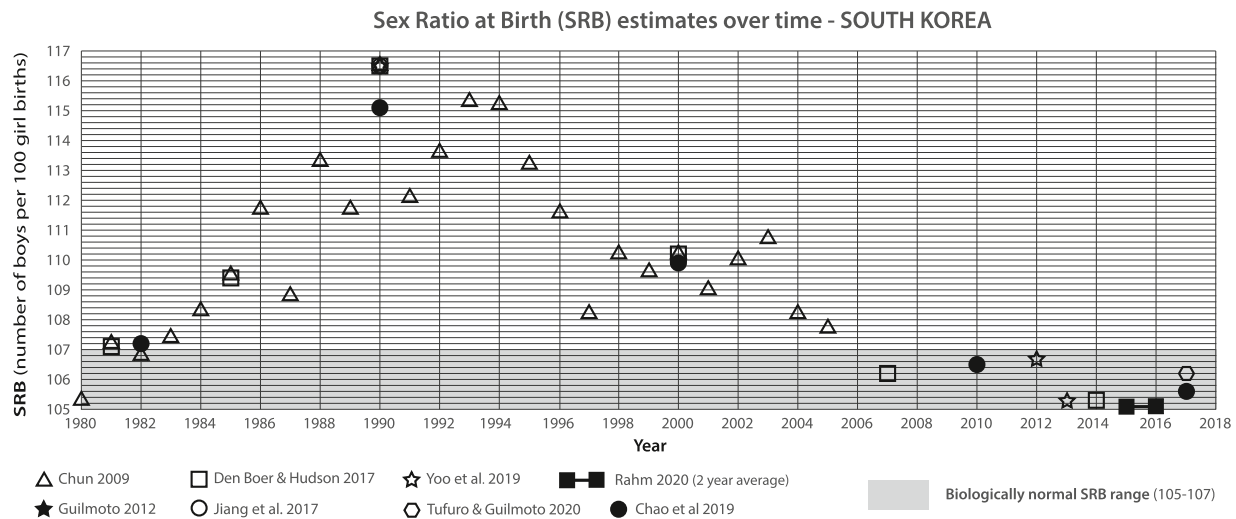
There is also firm evidence for the operation of the postnatal pathway through corrosive gender discrimination affecting women from when they are born and right throughout their lives, leading to relative neglect and excess mortality across the lifecourse. Ten studies estimated the survival impacts of these two pathways combined, to produce figures for 'missing women' overall. Estimates of the number of 'missing women' across son-preference countries rose steadily from 61 million in 1970 to 126 million in 2010. The total number 'missing women' was predicted to continue increasing to a peak of 150 million in 2035. China accounted for 50 per cent (62.3 million) of the 'missing women' in the world, followed by India at 34 per cent (43.3 million).

4.2. Limitations of the reviewed studies

Besides known problems with data quality in low- and middle-income countries such as India and Pakistan (Hesketh and Xing, 2006; Bongaarts and Guilmoto, 2015b; Chao et al., 2019), demographic studies of SRBs were subject to difficulties in attributing differences in aggregate sex ratios to specific causes (sex-selective abortion, infanticide, or sex-selective under-reporting of girl births). The remarkably stable SRBs for most of human history until 1980 and the onset of increasing SRBs in son-preference countries coinciding with the advent of prenatal sex selection technologies argue for a dominant role for sex-selective abortion rather than a sudden upturn in infanticide. There is debate about the possibility of under-reporting of girl births in China as a consequence of the One-Child policy, but studies of births reported by doctors in healthcare settings indicated skewed SRBs of similar magnitudes. There was no evidence that sex-selective underreporting of girl births was important other than in China (Bongaarts, 2013).

Calculation of skewed population sex ratios (PSRs) to estimate the number of 'missing women' rely on the selection of an appropriate comparison population without profound gender discrimination and son preference to derive an 'expected' population sex ratio. Potential bias can be introduced if a study failed to take account of three types of differences between populations that affect the level of PSR: the differing population age structure; the impact of the overall mortality level (and mortality differentials by sex); and the natural sex ratio at birth, which exhibits a slight male excess in all populations, including in societies without profound discrimination. All the studies in this review took account of these biases in the estimation of numbers of 'missing women' to varying levels of refinement and produced estimates that indicate the huge scale of the problem.

4.3. Limitations of this systematic review

The review only included English language studies. It is possible that some non-English language studies were missed by the searches. We are confident that this restriction would have had only a minimal effect on

our ability to pick up relevant studies in relation to 'missing women' for two main reasons. First, we excluded sub-national studies from the review, which are sometimes published in the language of the study country, and only included national and multi-country studies, which are almost invariably published in English in the health field. Second, even though there is a burgeoning literature from China, it is common for Chinese academics to be incentivised to publish in English language peer-reviewed journals, reinforcing the convention of publishing national studies in English.

We used appropriate quality assurance tools in our systematic reviewing whenever available, but, unfortunately, no international standard has been developed for 'scoring' the types of demographic evidence in this review for risk of bias. Demographic studies present a layer of complexity for such scoring even beyond the tricky issues raised by more common types of observational study. Although the ROBINS-E tool (Risk of Bias in Non-randomised Studies of Exposures) was developed for use with observational studies of exposures, it built upon tools for risk of bias assessment in randomised trials, diagnostic test accuracy studies, and observational studies of *interventions*. It has been shown to be inappropriate for the task of evaluating observational studies of exposures for questions of *harm relevant to public and environmental health* (Bero et al., 2018). In the absence of a suitable tool for 'scoring' demographic evidence, the approach we used for quality-assuring the evidence entailed selecting those studies employing good quality national data sources (vital statistics, Census, high quality population surveys) and removing single-centre studies and those using non-representative population samples.

4.4. Implications for research and policy

Several plausible mechanisms for the lower female survival in son-preference countries are postulated in the literature, which require further investigation. These include the growing effectiveness, affordability, and use of new technologies for prenatal sex selection and sex-selective abortion (Devaney et al., 2011; Karabinus et al., 2014), neglect of girls in relation to health care and nutrition, underreported or otherwise 'hidden girls', and the impact of mandatory population control/birth reduction policies.

The studies in this review consistently show large increases in male-to-female SRBs following the introduction and diffusion of prenatal diagnostic technologies in son-preference countries in the 1980s and 1990s. New pre-conception (e.g. sperm-sorting), pre-implantation (e.g. in vitro pre-implantation genetic diagnosis), and abortion technologies (including inexpensive pharmaceutical drugs to induce abortion) may pose additional threats to female survival in son-preference countries as they become increasingly affordable and accessible. The impacts of emerging technologies for sex selection on relative female survival are currently unknown and need to be carefully studied.

The broad searches we conducted before this review identified a very large body of literature on the general health and wellbeing impacts of discrimination and neglect in the distribution of health care and nutrition to girls and women. This body of evidence requires review and synthesis.

Government population control policies introduced in China since 1980 are considered to be major contributors to the toll of 'missing women' in the country. In particular, the One-Child policy, rigorously enforced from 1980 to 2015, has led to far-reaching consequences, some unintended and unforeseen. These include being implicated in the rise of sex-selective abortions and abandonment of girl babies, the development of a thriving trade in commercial adoption services offering girl babies to overseas adoptive parents, and a shortage of women available for marriage (Bhattacharjya et al., 2008; Hesketh and Xing, 2006; Hesketh et al., 2011). On the other side of the same coin are the large cohorts of 'surplus' young men in India as well as China now reaching adulthood who lack available women to marry and therefore may face marginalisation in society with long-term social consequences.

Chakravarty et al. (2022) list some of those consequences as increased migration, bride trafficking, and bride-abduction. There are some indications that the introduction of the Two-Child policy in China from 2015 might soften the effect of the earlier One-Child policy, but it is too early to judge (Jiang and Zhang, 2021; Fan et al., 2020; Tang et al., 2022). Further evidence is needed on the impacts of such mandatory population control policies, including studies over time on SRBs by birth order and on the relative health and survival impacts on girls compared with boys over time.

Other countries, including India, have introduced policies to tackle son preference, including laws banning the use of prenatal sex selection technologies (Kumar and Sunha, 2019), but to date these have proved ineffective or relatively easy to bypass. For example, physicians might hint at the sex of the fetus to parents by using certain descriptors, without actually calling it male or female. Regulatory measures that aim to address the rise in prenatal sex selection need to be evaluated for their effectiveness in tackling the problem, including any unintended side-effects. More promising, according to Kumar and Sinha's policy analysis, are policies that indirectly raise the value of daughters, and there are good examples of such policies, including initiatives in Bangladesh. There is a paucity of causal studies in this field though and these policies need to be subjected to rigorous evaluation (Kumar and Sunha, 2019).

There are also lessons to be learnt from the favourable trends in South Korea. How did the country manage to reverse the trends and bring down the SRBs to normal levels?

4.5. The paradox of opposing forces affecting female survival?

Above all, the findings of this systematic review serve to highlight the tension that has built up between two opposing forces that appear to have been at work in maintaining the high numbers of 'missing women' in the world today. On the one hand, there has been a near universal improvement in female mortality in low- and middle-income countries over recent decades, influenced by improvements in the social determinants of health: reduction in poverty and improvements in nutrition and access to effective healthcare, aided by progress in access to schooling for girls and greater employment/economic empowerment of women. This has improved the survival chances of women throughout the lifecourse. On the other hand, this progress in female mortality rates has been counterbalanced by the widespread adoption of technological innovations, such as ultrasound scans in pregnancy, which have led to the rise of a new phenomenon in son-preference societies - the human manipulation of sex ratios at birth by prenatal sex selection and sex-selective abortions. This adverse trend affecting the sex ratio at birth is not picked up by tools such as the Gender Inequality Index, which continues to show favourable changes in social norms towards women in many son-preference countries (UNDP, 2015). Paradoxically, the influence of the ancient tradition of son preference has become stronger, not weaker, over recent decades as a result of the new technological tools we have at our disposal. These opposing forces need to be considered together to make sense of the population trends and to devise the best possible ways of preventing the tragedy of 'missing women'.

5. Conclusions

There is consistent evidence of a survival disadvantage for girls and women in son-preference countries. There are over 126 million girls and women 'missing' from the world today. The survival disadvantage of girls increased significantly after the introduction of sex-selection technologies, which greatly compounded existing structural inequalities. Despite some improvements over time, male-skewed population sex ratios in many countries are still of concern. Time-series data and projections suggest the problem is getting worse in absolute terms as population levels increase in son-preference countries, which include the most populous nations of the world. New sex-selection technologies and economic downturns pose additional threats. This review highlights, above all, that the phenomenon of 'missing women' is still one of the great inequalities of our time. Profound gender discrimination in son-preference countries has severe and large-scale adverse impacts on the survival of girls and women at every stage of life.

Role of the funding source

Appendix 1. Example, MEDLINE search strategy for systematic review of evidence on relative survival outcomes for of girls and women in son-preference countries

MEDLINE, and MEDLINE In-Process & other Non-Indexed Citations <1980 to 2020>
Searched via OVID 17/11/20. Restricted to English language and human.
Syntax:
1 Son preference.ti,ab.
2 Gender preference.ti,ab.
3 Sex select*.ti,ab.
4 Sex-select*.ti,ab.
5 Gender select*.ti,ab.
6 Gender-select*.ti,ab.
7 Missing women.ti,ab.
8 Lost girls.ti,ab.
9 OR 1 to 8
10 Limit 9 to Humans, English language and 1980 to 2020

Appendix 2. Studies excluded during full text screening, and reasons for exclusion in systematic review of evidence on relative survival outcomes for of girls and women in son-preference countries

Article	Reasons for exclusion (Number of articles)
Agrawal S (2012) The sociocultural context of family size preference, ideal sex composition, and induced abortion in India: Findings from India's National Family Health Surveys. Health Care Women Int. 33:986-1019.	Outcome - Not survival / 'missing girls or women' (as population ratios) (n=77)
Altindag O (2016) Son preference, fertility decline, and the nonmissing girls of Turkey. Demography. 53:541-566.	
Ambel A (2008) Essays on intrahousehold allocation and the family: Fertility, child education, and nutrition. Doctoral dissertation, Harvard University.	
Amin R, Mariam A (1987) Son preference in Bangladesh - an emerging barrier to fertility regulation. J Biosoc Sci, 19:221-228.	
Arulampalam W, Bhalotra S (2008) The linked survival prospects of siblings: Evidence for the Indian states. Popul Stud (Camb). 62:171-190.	
Bharadwaj P, Lakdawala L (2013) Discrimination begins in the womb Evidence of sex-selective prenatal investments. J Hum Resour. 48:71-113.	
Bhaskar V (2011) Sex selection and gender balance. Am Econ J Microecon. 3:252-253.	
Bose S (2012) A contextual analysis of gender disparity in education in India: The relative effects of son preference, women's status, and community. Sociol Perspect. 55:67-91.	
Bose S, Trent K (2006) Socio-demographic determinants of abortion in India: A north-south comparison. J Biosoc Sci. 38:261-282.	
Chamarbagwala R (2011) Sibling composition and selective gender-based survival bias. J Popul Econ. 24:935-955.	
Chamarbagwala R, Ranger M (2010) A multinomial model of fertility choice and offspring sex ratios in India. J Dev Stud. 46:417-438.	
Chaturvedi S, Chhabra P, Bharadwaj S, Smanla S, Kannan A T, Students Study Group (2007) Fetal sex-determination in Delhi: a population-based investigation. Trop Doct. 37:98-100.	
Chen Y (2008) The significance of cross-border marriage in a low fertility society: Evidence from Taiwan. J Comp Fam Stud. 39:331.	
Chen Y, Li H, Meng L (2013) Prenatal sex selection and missing girls in China: Evidence from the diffusion of diagnostic ultrasound. J Hum Resour. 48:36-70.	
Chun H, Das Gupta M (2009) Gender discrimination in sex selective abortions and its transition in South Korea. Womens Stud Int Forum. 32:89-97.	
Chung W, Das Gupta M (2011) Factors influencing 'missing girls' in South Korea. Appl Econ. 43:3365-3378.	
Clark S (2000) Son preference and sex composition of children: Evidence from India. Demography. 37:95-108.	
Cronk L (1991) Intention versus behaviour in parental sex preferences among the Mukogodo of Kenya. J Biosoc Sci. 23:229-40.	
Dama M (2011) Sex ratio at birth and mortality rates are negatively related in humans. Plos One. 6(8):e23792.	
Das Gupta M (2005) Explaining Asia's "missing women": A new look at the data. Popul Dev Rev. 31:529. den Boer A, Hudson V (2017) Patrilineality, son preference, and sex selection in South Korea and Vietnam. Popul Dev Rev. 43:119-147.	
Detray D (1980) Son preference in Pakistan - an analysis of intentions versus behavior. Popul Index. 46:382-382.	
Dharmalingam A, Rajan S, Morgan S (2014) The determinants of low fertility in India. Demography. 51:1451-1475.	
Dinh T, Borjesson L, Nga N, Johansson A, Malqvist M (2012) Sex of newborns associated with place and mode of delivery: A population-based study in Northern Vietnam. Gend Med. 9:418-423.	
Dreze J, Murthi M (2001) Fertility, education, and development: Evidence from India. Popul Dev Rev. 27:33.	
Ebenstein A (2011) Estimating a dynamic model of sex selection in China. Demography. 48:783-811.	
Echavarri R A, Ezcurra R (2010) Education and gender bias in the sex ratio at birth: evidence from India. Demography. 47:249-268.	
Edlund L (1999) Son preference, sex ratios, and marriage patterns. J Polit Econ. 107:1275-1304.	
Edmeades J, Rohini P, MacQuarrie K, Falle T, Malhotra A (2012) Two sons and a daughter: Sex composition and women's reproductive behaviour in Madhya Pradesh, India. J Biosoc Sci. 44:749-764.	
Eliason S, Baiden F, Tuoyire D, Awusabo-Asare K (2018) Sex composition of living children in a matrilineal inheritance system and its association with pregnancy intendedness and postpartum family planning intentions in rural Ghana. Reprod. 15(1)187.	
Erfani A, McQuillan K (2014) The changing timing of births in Iran: An explanation of the rise and fall in fertility after the 1979 Islamic Revolution. Biodemogr. Soc. Biol. 60:67-86.	
Gangadharan L, Maitra P (2003) Testing for son preference in South Africa. J Afr Econ. 12:371-416.	
Guilmoto C (2017) Gender bias in reproductive behaviour in Georgia, Indonesia, and Vietnam: An application of the own-children method. Popul Stud (Camb). 71:265-279.	
Hamoudi A (2010) Exploring the causal machinery behind sex ratios at birth: Does hepatitis B play a role? Econ Dev Cult Change. 59(1):1-21.	
Haque I, Patel P (2016) Assessing Hindu-Muslim fertility differentials in West Bengal: Insights from the National Family Health Survey-3 Data. J Fam Hist. 41:192-224.	
Hatlebakk M (2017) Son preference, number of children, education and occupational choice in rural Nepal. Rev Dev Econ. 21:1-20.	
Hesketh T, Lu L, Xing Z (2011) The consequences of son preference and sex-selective abortion in China and other Asian countries. CMAJ. 183:1374-1377.	
Hossain M, Phillips J, Legrand T (2007) The impact of childhood mortality on fertility in six rural thanas of Bangladesh. Demography. 44:771-784.	
Hu L, Schlosser A (2012) Trends in prenatal sex selection and girls' nutritional status in India. CESifo Econ Stud. 58:348-372.	
Jayaraj D, Subramanian S (2004) Women's wellbeing and the sex ratio at birth: Some suggestive evidence from India. J Dev Stud. 40:91-119.	
Jha P, Kumar R, Vasa P, Dhingra N, Thiruchelvam D, Moineddin R (2006) Low male-to-female sex ratio of children born in India: National survey of 1.1 million households. Lancet. 367:211-218.	
Jiang Q, Li S, Feldman M (2011) Demographic consequences of gender discrimination in China: Simulation analysis of policy options. Popul Res Policy Rev. 30:619-638.	

(*continued*)

Article	Reasons for exclusion (Number of articles)
Jiang Q, Li Y, Sanchez-Barricarte J (2016) Fertility intention, son preference, and second childbirth: Survey findings from Shaanxi Province of China. Soc Indic Res. 125:935-953.	
Kabeer N, Huq L, Mahmud S (2014) Diverging stories of "Missing women" in South Asia: Is son preference weakening in Bangladesh? Fem Econ. 20:138-163.	
Karki Y (1988) Sex preference and the value of sons and daughters in Nepal. Stud Fam Plann. 19:169-178.	
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Article	Reasons for exclusion (Number of articles)
Grech V (2017) Evidence of socio-economic stress and female foeticide in racial disparities in the gender ratio at birth in the United States (1995-2014) Early Hum Dev. 106:63-65. Grech Victor (2017) Further evidence of male offspring preference for certain subgroups in the United States (2007–2015) Early Hum Dev. 110:9-12. Howell E Zhang H, Poston D (2018) Son preference of immigrants to the United States: Data from US birth certificates, 2004-2013. J Immigr Minor Health. 20(3):711-716. Joseph K, Lee L, Williams K (2016) Sex ratios among births in British Columbia, 2000-2013. J Obstet Gynaecol Can. 38 (10):919. Liu P, Rose G (1995) Social aspects of > 800 couples coming forward for gender selection of their children. Hum Reprod. 10:968-71. Park C, Braun K, Horiuchi B, Tottori C, Onaka A (2009) Longevity disparities in multiethnic Hawaii: An analysis of 2000 life tables. Public Health Rep. 124:579-584. Singh N, Pripp A, Brekke T, Stray-Pedersen B (2010) Different sex ratios of children born to Indian and Pakistani immigrants in Norway. BMC Pregnancy Childbirth. 10:5. Takaku R (2018) First daughter effects in Japan. J Jpn Int Econ. 50:48-59. Tang Z (2013) Sex preference for children and Chinese fertility in America. In: Chan Kwok-bun, ed., International handbook of Chinese families. New York: Springer Science & Business Media: 263-275. Tonnessen M, Aalandslid V, Skjerpen T (2013) Changing trend? Sex ratios of children born to Indian immigrants in Norway revisited. BMC Pregnancy Childbirth. 13:6. Agrawal A (2018) Women's human rights and migration: sex selective abortion laws in the United States and India. Int Fem J Polit. 20:284-285.	
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Brooks R (2012) "Asia's missing women" as a problem in applied evolutionary psychology? Evol Psychol. 10:910-925. Chun H, Doyal L, Payne S, Il-Cho S, Kim I (2006) Understanding women, health, social change: the case of South Korea. Int J Health Serv. 36:575-592. Das Gupta M (2006) Cultural versus biological factors in explaining Asia's "missing women": Response to Oster. Popul Dev Rev, 32:328-332. Das Gupta M, Jiang Z, Li B, Xie Z, Chung W, Hwa-Ok B (2003) Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. J Dev Stud. 40:153-187. Das Gupta M, Bhat P (1997) Fertility decline and increased manifestation of sex bias in India. Popul Stud (Camb). 51(3) 307-315. Dyson T (2012) Causes and consequences of skewed sex ratios. Annu Rev Sociol. 38:443-461. Guo Z, Das Gupta M, Li S (2016) 'Missing girls' in China and India: Trends and policy challenges. Asian Popul Stud. 12:135-155. Hesketh T, Xing Z (2006) Abnormal sex ratios in human populations: Causes and consequences. Proc Natl Acad Sci U S A. 103:13271-13275. Loh C, Remick E (2015) China's skewed sex ratio and the One-Child Policy. China Q. 222:295-319. Murphy R (2014) Sex ratio imbalances and China's Care for Girls Programme: A case study of a social problem. China Q. 219:781-807. Oldenburg P (1992) Sex-ratio, son preference and violence in India - a research note. Econ Polit Wkly. 27:2657-2662. Sen A (1992) Missing women. BMJ. 304:587-588. Basten S, Verropoulou G (2013) 'Maternity migration' and the increased sex ratio at birth in Hong Kong SAR. POP STUD-J DEMOG. 67(3):323-334.	Not a primary-level study (review level) (n=13)
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Article	Reasons for exclusion (Number of articles)
Varghese J, Aruldas V, Jeemon P (2008) Beyond the numbers: Factors distorting sex ratio at birth. Indian J Gend Stud. 15:115-125.	
Seth S (2007) Sex selective feticide in India. J Assist Reprod Genet. 24:153-154.	Not a full published study (n=1)
Almond D, Li H, Zhang S (2019) Land reform and sex selection in China. J Polit Econ. 127:560-585. Bhalotra S, Chakravarty A, Mookherjee D, Pino F (2019) Property rights and gender bias: Evidence from land reform in West Bengal. Am Econ J Appl Econ. 11:205-237. Bhattacharjya D, Sudarshan A, Tuljapurkar S, Shachter R, Feldman M (2008) How can economic schemes curtail the increasing sex ratio at birth in China? Demogr Res. 19:1831-1850. Chakraborty T (2015) Trade Liberalization in a traditional society: Implications for relative female survival. World Dev. 74:158-170. Chakravarty A (2010) Supply shocks and gender bias in child health investments: Evidence from the ICDS Programme in India. B E J Econ Anal Policy. 10(1):88. Frost M, Puri M, Hinde P (2013) Falling sex ratios and emerging evidence of sex-selective abortion in Nepal: Evidence from nationally representative survey data. BMJ Open. 3:e002612. Kalsi P (2017) Seeing is believing- can increasing the number of female leaders reduce sex selection in rural India? J Dev Econ. 126:1-18. Li H, Zheng H (2009) Ultrasonography and sex ratios in China. Asian Econ Policy Rev. 4:121-137. Li J (1995) China One-Child Policy - How and how well has it worked - a case-study of Hebei-Province, 1979-88. Popul Dev Rev. 21(3):563-585. Lin M, Liu J, Qian N (2014) More missing women, fewer dying girls: the impact of sex-selective abortion on sex at birth and relative female mortality in Taiwan. J Eur Econ Assoc. 12:899-926. Nandi A, Deolalikar A (2013) Does a legal ban on sex-selective abortions improve child sex ratios? Evidence from a policy change in India. J Dev Econ. 103:216-228. Sharma B, Gupta N, Relhan N (2007) Misuse of prenatal diagnostic technology for sex-selected abortions and its consequences in India. Public Health. 121:854-860.	Interventional study (for other review) (n=12)
Total excluded at full text screening	N=144

Appendix 3. List of included studies for systematic review of evidence on relative survival outcomes for of girls and women in son-preference countries

1. Banister J (2004) Shortage of girls in China today. J Popul Res. 21(1):19–45.
2. Bhat P, Zavier A (2007) Factors influencing the use of prenatal diagnostic techniques and the sex ratio at birth in India. Econ Polit Wkly. 42 (24):2292–2303.
3. Bongaarts J, Guilmoto C (2015a) How many more missing women? Excess female mortality and prenatal sex selection, 1970–2050. Popul Dev Rev. 41(2):241–269.
4. Bongaarts J, Guilmoto C (2015b) How many more missing women? Lancet. 386(9992):427.
5. Cai Y, Lavely W (2003) China's missing girls: Numerical estimates and effects on population growth. China Rev. 3(2):13–29.
6. Cai Y (2017) Missing girls or hidden girls? A comment on Shi and Kennedy's "Delayed registration and identifying the 'missing girls' in China". China Q. 231:797–803.
7. Chao F, Gerland P, Cook A, Alkema L (2019) Systematic assessment of the sex ratio at birth for all countries and estimation of national imbalances and regional reference levels. Corrected June 26, 2019. Proc Natl Acad Sci USA. 116(19):9303–9311.
8. Chun H, Das Gupta M (2009) Gender discrimination in sex selective abortions and its transition in South Korea. Womens Stud Int Forum. 32 (2):89–97.
9. Coale A (1991), Excess female mortality and the balance of the sexes in the population: An estimate of the number of 'missing females'. Popul Dev Rev. 17(3):517–523.
10. Condorelli A (2015) An emergentist vs a linear approach to social change processes: A gender look in contemporary India between modernity and Hindu tradition. SpringerPlus. 4:156.
11. Den Boer A, Hudson V (2017) Patrilineality, son preference, and sex selection in South Korea and Vietnam. Popul Dev Rev. 43(1):119–147.
12. Duthé G, Meslé F, Vallin J, Badurashvili I, Kuyumjyan K (2012) High sex ratios at birth in the Caucasus: Modern technology to satisfy old desires. Popul Dev Rev. 38(3):487–501.
13. Goodkind D (2011) Child underreporting, fertility, and sex ratio imbalance in China. Demography. 48(1):291–316.
14. Grech V (2015) Evidence of economic deprivation and female foeticide in a United Nations global births by gender data set. Early Hum Dev, 91 (12):855-858.
15. Guilmoto C, Hoang X, Van T (2009) Recent increase in sex ratio at birth in Viet Nam. PLoS ONE. 4(2): e4624.
16. Guilmoto C (2012a) Sex imbalances at birth. Current trends, consequences and policy implications. Bangkok: UNFPA (United Nations Population Fund) Asia and the Pacific Regional Office.
17. Guilmoto C (2012b) Son preference, sex selection, and kinship in Vietnam. Popul Dev Rev. 38(1):31–54.
18. Huang Y, Tang W, Mu Y, Li X, Liu Z, Wang Y et al. (2016) The sex ratio at birth for 5,338,853 deliveries in China from 2012 to 2015: A facility-based study. PLoS ONE 11(12): e0167575.
19. Jiang Q, Li S, Feldman M (2012) China's missing girls in the three decades from 1980 to 2010. Asian Women. 28(3):53–73.
20. Jiang Q, Yu Q, Yang S, Sánchez-Barricarte J (2017) Changes in sex ratio at birth in China: a decomposition by birth order. J Biosoc Sci. 49 (6):826–841.
21. Kahlert M (2014) Trends in missing women in the 2000s. MA dissertation. Göttingen University.
22. Klasen S (1994) "Missing women" reconsidered. World Dev. 22(7):1061-1071.

23. Klasen S, Wink C (2002) A turning point in gender bias in mortality? An update on the number of missing women. Popul Dev Rev. 28 (2):285–312.
24. Klasen S, Wink C (2003) "Missing women": Revisiting the debate. Fem Econ. 9(2–3):263-299.
25. Michael M, King L, Guo L, McKee M, Richardson E, Stuckler D (2013) The mystery of missing female children in the Caucasus: an analysis of sex ratios by birth-order. Int Perspect Sex Reprod Health. 39(2):97–102.
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31. Shi Y, Kennedy J (2017) Missing girls, indirect measures and critical assumptions: A response to Yong Cai's comments. China Q. 231:804–810.
32. Tufuro S, Guilmoto C (2020) Skewed sex ratios at birth: A review of global trends. Early Hum Dev. 141:104868.
33. Yoo S, Hayford S, Agadjanian V (2017) Old habits die hard? Lingering son preference in an era of normalizing sex ratios at birth in South Korea. Popul Res Policy Rev. 36(1):25–54.
34. Zeng Y, Tu P, Gu B, Xu Y, Li B, Li Y (1993) Causes and implications of the recent increase in the reported sex-ratio at birth in China. Popul Dev Rev. 19(2):283–302.

Appendix 4. Data time points, sources, and data time gaps between Klasen and Wink (2003) and Kahlert (2014) studies of 'missing women'

Appendix 4
Data time points, sources, and data time gaps between Klasen & Wink (2003) and Kahlert (2014) studies of 'missing women'

	Klasen and Wink (2003)	Kahlert, 2014*	Data sources (Kahlert, 2014)	Data time gap
China	2000	2010	National Census data	10 years
Taiwan	1999	2012	Statistical Yearbook of the Republic of China 2012	13 years
South Korea	1995	2010	National Census data	15 years
India	2001	2011	National Census data	10 years
Pakistan	1998	2011	United Nations (UN) Population Division	13 years
Bangladesh	2001	2011	National Census data	10 years
Nepal	2001	2011	National Census data	10 years
Sri Lanka	1991	2012	National Census data	21 years
West Asia	2000	2012	Demographic Yearbook 2012	12 years
Egypt	1996	2006	National Census data	10 years
Algeria	1998	2008	National Census data	10 years
Tunisia	1994	2004	National Census data	10 years
Sub-Saharan Africa	2000	2012	Demographic Yearbook 2012	12 years

Note: *Kahlert's 2014 study was supervised by Stephan Klasen. It used similar methods, which allow for comparison between the studies over time. The 2014 study data were graciously provided by Mirjam Kahlert.

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Group-based microfinance for collective empowerment: a systematic review of health impacts

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Objective To assess the impact on health-related outcomes, of group microfinance schemes based on collective empowerment.
Methods We searched the databases Social Sciences Citation Index, Embase, MEDLINE, MEDLINE In-Process, PsycINFO, Social Policy & Practice and Conference Proceedings Citation Index for articles published between 1 January 1980 and 29 February 2016. Articles reporting on health impacts associated with group-based microfinance were included in a narrative synthesis.
Findings We identified one cluster-randomized control trial and 22 quasi-experimental studies. All of the included interventions targeted poor women living in low- or middle-income countries. Some included a health-promotion component. The results of the higher quality studies indicated an association between membership of a microfinance scheme and improvements in the health of women and their children. The observed improvements included reduced maternal and infant mortality, better sexual health and, in some cases, lower levels of interpersonal violence. According to the results of the few studies in which changes in empowerment were measured, membership of the relatively large and well-established microfinance schemes generally led to increased empowerment but this did not necessarily translate into improved health outcomes. Qualitative evidence suggested that increased empowerment may have contributed to observed improvements in contraceptive use and mental well-being and reductions in the risk of violence from an intimate partner.
Conclusion Membership of the larger, well-established group-based microfinance schemes is associated with improvements in some health outcomes. Future studies need to be designed to cope better with bias and to assess negative as well as positive social and health impacts.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

Microfinance initiatives have become popular, particularly in low- and middle-income settings, as a means of promoting rural development,[1] increasing the bargaining power of women and improving household welfare.[2] Such has been the enthusiasm for these schemes that, in 2006, the Nobel Peace Prize was awarded jointly to Muhammed Yunus and the Grameen Bank – a microfinance scheme in Bangladesh.

The potential of microfinance to improve health is now being recognized.[3–5] The impacts of microfinance initiatives need to be considered in current theory debates about the role that control over destiny plays as a fundamental social determinant of health.[6] Poor control over destiny, which is a characteristic of women in some societies, can be damaging to population health. In general, population and child health improve and the life expectancies of both men and women increase as the participation of women in decision-making increases.[6]

Group-based microfinance schemes attempt to harness the collective power of mutual support – with members pooling their savings and making small loans to each other so that they can set up small businesses. Most aim to improve the economic power of – and employment opportunities for – women in their immediate community, and many aim to confront engrained discriminatory attitudes to women.[2] Some aim to facilitate the attendance of girls at school and change attitudes to the paid employment of women outside their homes. The members – who are mostly women – form groups for saving and credit, and are offered literacy classes, legal, social and empowerment training and technical and marketing support (Box 1).

It has been argued that the enthusiasm for microfinance has outstripped the evidence of its effectiveness[7] and that microfinance schemes have the potential to do harm. Schemes can suffer from so-called mission drift and end up favouring those who are more credit-worthy while excluding the ultra-poor.[8–12] In some settings, the imposition of a business model on poor female members of a microfinance scheme may lead to increased debt, repayment stress and exploitation.[13,14] The result may be an exacerbation of inequalities rather than a reduction.

We conducted a systematic review of group-based microfinance based on collective empowerment that covered all health conditions and all countries and assessed the impact on health. We addressed three questions: (i) what impact do group-based microfinance schemes based on collective empowerment have on health; (ii) what role does empowerment play in the pathways from microfinance to health impacts; and (iii) do the impacts of the schemes differ based on the ethnicity, sex and/or socio-economic status of the members?

Methods

We reviewed evaluations of group-based microfinance in any country, using published systematic review methods,[15] and assessed the quality of each relevant study using procedures tailored to social interventions in community contexts.[16]

Search strategy

We searched the databases, Embase, MEDLINE, MEDLINE In-Process, PsycINFO, Social Policy & Practice (Box 2; available at: http://www.who.int/bulletin/volumes/94/9/15-168252), Social Sciences Citation Index and Conference Proceedings Citation Index (Box 3; available at: http://www.who.int/bulletin/volumes/94/9/15-168252) for articles published between 1 January 1980 and 29 February 2016. We checked the reference lists of

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Box 1. **Microfinance schemes based on collective empowerment**

Roughly 5 million poor rural women in Bangladesh are involved in microcredit programmes, most of them associated with the BRAC or Grameen Bank microfinance schemes.

The BRAC scheme is designed for women living in poor and landless households. It involves the formation of women's groups for saving and credit, training and skills development, functional literacy – including legal and social awareness – and technical and marketing support. Money saved by a group is used to make loans to group members to support income-generation activities such as cottage industries and goat rearing. Sometimes these elements are combined with so-called bolt-on public health components such as the promotion of maternal and child health or family planning.

The main aims of the scheme are to reduce women's economic dependence on men, strengthen their positions within their families, draw them into the public sphere and expose them to new ideas and education. The theory is that the scheme may influence health in many different ways – e.g. it may increase demand for family planning services and reduce the social costs of fertility regulation, leading to fewer, healthier children and better maternal health. It may also lead to improvements in the care and nutrition of children and so reduce child mortality in general and, particularly, the high rates recorded among girls.

relevant articles and contacted policy-makers and academics for publications in press and in the grey literature.

Inclusion and exclusion criteria

A report was only included if it described an experimental or quasi-experimental evaluation of a group-based microfinance scheme that: (i) employed collective empowerment strategies; (ii) was targeted at a group with some form of disadvantage; and (iii) was delivered among a free-living population in a community setting. To be included, a report also had to disaggregate data by some measure of socioeconomic status and describe at least one health-related outcome. We also included qualitative reports that related to an included study. No country or language restrictions were applied.

We excluded reports of individual loan schemes that focused solely on poverty alleviation but did not promote group solidarity and empowerment, and reports on schemes that included restrictions on how loans could be used.

Screening and selection

Titles and abstracts were screened before potentially eligible reports were retrieved in full text and assessed, independently, by two reviewers. Reasons for exclusion were recorded. Disagreements were resolved by discussion or by recourse to a third reviewer.

Study data

A single reviewer extracted data from each included report and applied a modified version of the quality assessment tool developed by Lorenc et al.[16] Qualitative studies were assessed using the criteria of Mays and Pope.[17] A second reviewer checked extractions and appraisals for accuracy and completeness. A narrative synthesis was performed.[18,19] Differential impacts were identified – particularly in relation to ethnicity, sex and socioeconomic status. Reporting was based on the PRISMA-Equity 2012 extension guidelines.[20]

Results

From 4050 articles, only 31 reports – covering 23 studies (Table 1) – met our inclusion criteria (Fig. 1). The included studies comprised one cluster-randomized controlled trial and 22 quasi-experimental studies that took advantage of naturally occurring comparisons and pre-existing data – e.g. from demographic surveillance systems and health surveys. All of the interventions targeted poor women living in low- or middle-income countries. Most were based in Bangladesh and many focused on women in rural communities. Although we identified some studies of microfinance schemes in central and south America, all but one were excluded because they did not meet the inclusion criteria.

Assessment of the included studies revealed that even the higher quality studies were potentially at risk from several forms of selection bias.

Impacts

Mortality and morbidity

Two higher quality longitudinal studies revealed that membership of the BRAC initiative, in Bangladesh, was associated with relatively low infant and child mortality compared with non-membership.[21,22] The decline observed in the risk of infant death over a period of 10 years was greatest (53%) for infants of mothers who joined the BRAC scheme, followed by the infants of rich non-members (41%) and then the infants of poor non-members (31%).[21] The risk of death for the infants of poor BRAC members declined to the level recorded for the infants of rich non-members. There was no association between BRAC membership and survival of children aged 1–5 years. In a further study by the same authors, however, the survival of children aged 1–5 years from poor households was found to be significantly improved if their mothers were BRAC members.[22]

Two lower quality studies found that BRAC membership was associated with lower child mortality[23] or lower maternal morbidity.[24] A third study, based in Peru, found no association between length of membership in a group-based microfinance scheme and maternal depression[25] or child illness.[26]

Women's sexual health

Impacts on sexual health were reported in five evaluations, in Bangladesh, Ethiopia, India and South Africa. Of these evaluations, a study of the highest quality assessed the impacts of scheme membership on women's sexual health in South Africa.[28–30] This was a prospective, matched, cluster-randomized controlled trial – with a strong qualitative component – of the South African Microfinance for AIDS and Gender Equity intervention. This intervention included a large human immunodeficiency virus (HIV) health-promotion element, a microfinance component based on the Grameen Bank model and a so-called Sisters-for-Life gender-focused training component. The microfinance intervention was not associated with any significant changes in rate of unprotected sexual intercourse with a non-spousal partner (relative risk, RR: 1.02; 95% confidence interval, CI: 0.85–1.23) or HIV incidence (RR: 1.06; 95% CI: 0.66–1.69).[28] Stratifying by age, there was evidence of several beneficial effects on younger participants after two years of involvement with the programme. For example, when compared with women of the same age and poverty from control villages, female participants aged 14–35 years exhibited higher levels of HIV-related communication (adjusted risk ratio, aRR: 1.46; 95% CI: 1.01–2.12), were more likely to have accessed voluntary counselling and testing (aRR: 1.64; 95% CI: 1.06–2.56) and were less likely to have had unprotected sex at last intercourse with a non-spousal partner (aRR: 0.76; 95% CI: 0.60–0.96).[29] Qualita-

Table 1. Summary of the studies included in the systematic review of group-based microfinance schemes

Study no.	Publication	Country and study design	Follow-up period	Intervention and target population	Study participants	Comparison group(s)	Outcome measures	Quality[a]
1	Bhuiya and Chowdhury[21]	Bangladesh, controlled before-and-after study	1988–1992 and 1993–1997	BRAC,[b] poor women	13 549 children of poor women	Children of poor non-members and children of rich non-members	Infant and childhood mortality rates, recorded as survival status on set date for two birth cohorts	Higher
2	Bhuiya et al.[22]	Bangladesh, controlled before-and-after study	1982–1996	BRAC, poor women	Children of poor women from 12 000 households	Children of poor non-members	Childhood mortality rates, recorded as cumulative child survival probability by household	Higher
3	E-Nasreen et al.[23]	Bangladesh, case–control and qualitative case studies	NA	BRAC, poor women	117 neonates born 1999–2000 who died within first 28 days of life	Live children	Neonatal death	Lower
4	Ahmed et al.[24]	Bangladesh, post-intervention study	NA	BRAC, poor women	Poor women from 3817 households	Non-member households that met eligibility for BRAC, and rich non-eligible households	Self-reported illness episodes over last 15 days and health- seeking behaviour	Lower
5	Hamad and Fernald[25]	Peru, post-intervention study	NA	PRISMA,[c] poor households	1593 adult female members	Long-duration members and short-duration members	Depressive symptoms, contraceptive use, cancer screening: in last year, self-reported days sick in last month	Lower
	Moseson et al.[26]				511 adult female members and 596 of their children aged < 5 years	Long-duration members and short-duration members	Child length-for-age, weight-for-age, anaemia, questions on respiratory infections and diarrhoea in child last 6 months, food security	Lower
	Hamad and Fernald[27]				1593 adult female members	Long-duration members and short-duration members	Age-adjusted BMI, haemoglobin levels and food insecurity	Lower
6	Pronyk et al.[28]	South Africa, cluster-RCT with qualitative component	2 years	IMAGE,[d] poor women	5156 residents of intervention villages aged 14–35 years	Matched controls from waiting-list villages	Rate of unprotected sex: occurrence at last intercourse with a non-spousal partner in past 12 months, HIV incidence	Highest
	Pronyk et al.[29]				220 female members aged 14–35 years	Matched controls from waiting-list villages	HIV-related communication, access to voluntary counselling and testing, rate of unprotected sex at last intercourse with non-spousal partner	Highest
	Kim et al.[30]				860 women from intervention villages, as 430 matched pairs of members and non-members	Matched controls from waiting-list villages	Physical and sexual violence by spouse or other intimate partner within last year, women's empowerment	Highest

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Study no.	Publication	Country and study design	Follow-up period	Intervention and target population	Study participants	Comparison group(s)	Outcome measures	Quality[a]
7	Schuler and Hashemi[31]	Bangladesh, controlled before-and-after study with ethnographic component	Single time-points in 1991 and 1993	BRAC and Grameen Bank,[e] poor women	1305 poor rural married women aged <50 years	Eligible non-members and non-eligible non-members	Respondent or partner currently using any form of contraception	Higher
	Schuler et al.[32]				1305 poor rural married women aged <50 years	Eligible non-members and non-eligible non-members	Relative mobility, economic security, ability to make purchases, freedom from domination and violence, political and legal awareness, participation in political spheres	Higher
8	Souverein et al.[33]	India, longitudinal study	2005–2008	Pragati,[f] female sex workers	20 330 female sex workers	No comparator – women followed up from first point of contact with scheme until last point of reported contact	STI incidence from syndromic surveillance data, condom use at last paid sex	Higher
9	Amin et al.[34]	Bangladesh, post-intervention study	NA	5 small or medium-sized credit NGOs that adopted loan system of Grameen Bank, NS	3564 rural women, aged <50 years	Non-loanees from NGO areas and women from non-NGO areas	Current contraceptive use, freedom to manage household expenses, autonomy in movement, authority in family affairs	Lower
	Amin and Li[35]				3564 rural women, aged <50 years	Non-loanees from NGO areas and women from non-NGO areas	Child immunization, infant and child mortality rate	Lower
10	Desai and Tarozzi[36]	Ethiopia, controlled before-and-after study	2003–2006	Two credit schemes combined with family planning activities, poor women	6440 women aged 15–49 years from poor households	Just the family planning component and just the credit component	Contraceptive use	Lower
11	Schuler et al.[37]	Bangladesh, controlled before-and-after study with ethnographic component	Single time-points in 1991 and 1993	BRAC and Grameen Bank, poor women	1305 poor rural married women aged <50 years	Eligible non-members and non-eligible non-members	Physical beating by husband in last year, relative mobility, economic security, ability to make purchases, freedom from domination and violence, political and legal awareness, participation in political spheres	Higher
12	Chin[38]	Bangladesh, post-intervention study	NA	BRAC, BRDB and Grameen Bank schemes, NS	1843 rural women	Eligible non-members and non-eligible non-members	Spousal violence directed at women – ever and in last year	Lower
13	Ahmed[39]	Bangladesh, post-intervention study	NA	BRAC, poor women	2044 poor women who were or had been married	Non-member households that met eligibility for BRAC	Violence against women from their husbands in preceding 4 months	Lower

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Study no.	Publication	Country and study design	Follow-up period	Intervention and target population	Study participants	Comparison group(s)	Outcome measures	Quality[a]
14	Dalal et al.[40]	Bangladesh, post-intervention study	NA	BRAC, BRDB, Grameen Bank, PROSHIKA or any microcredit organization, NS	4465 women aged 15–49 years who were or had been married	Non-members	Moderate physical, severe physical, sexual and any interpersonal violence in last year, economic empowerment	Lower
	Dalal et al.[41]				4925 women aged 15–49 years who were or had been married	Non-members	Last delivery at home without skilled birth attendant or with institutional delivery services, economic empowerment	Lower
15	Bajracharya and Amin[42]	Bangladesh, post-intervention study	NA	BRAC, BRDB, Grameen Bank, PROSHIKA or any microcredit organization, NS	4195 married women aged 15–49 years	Matched non-members	Physical and sexual violence against women by their husbands in last year	Lower
16	Imai and Azam[43]	Bangladesh, household panel survey	1997–1998, 1998–1999, 1999–2000 and 2004–2005	Any microfinance scheme, NS	Women from >3000 households in 91 intervention villages	Women from neighbouring villages without microfinance	BMI	Higher
17	Khatun et al.[44]	Bangladesh, controlled before-and-after study	3 time-points in 1995–1996	BRAC, poor women	576 children of poor women, aged 6–72 months	Children of poor non-members and children of rich non-members	Stunting, recorded as height-for-age compared with reference median	Higher
18	Jalal and Frongillo[45]	Bangladesh, controlled before-and-after study	3 time-points in 1995–1996	BRAC-based CFPR-TUP initiative, poor women	3551 women and 4131 children from households with child aged 6–60 months	Children and women from non-member households	Nutritional status of women and pre-school children	Higher
19	Deininger and Liu[46]	India, pipeline comparison of current and future members	NA	Indhira Kranthi Patham programme,[g] poor women	Poor women from 1964 households	People who later joined programme when it came to their village	Energy intake, protein intake and food consumption over last 30 days, social capital, economic empowerment, political empowerment	Higher
20	Doocy et al.[47]	Ethiopia, post-intervention study	NA	WISDOM World Vision Microfinance Institution,[h] poor households	Clients from 819 rural households and their children aged 6–59 months	Similar incoming clients and community controls	Arm circumference	Lower
21	MkNelly and Dunford[48]	Ghana, repeat cross-sectional study	1993–1996	Credit with Education scheme, poor rural households	308 mother-and-child pairs from poor rural households that had participated in scheme for at least 1 year, with each child aged <3 years	Non-participants in microfinance areas and waiting-list controls	Child's weight-for-age and height-for-age plus maternal BMI, self-confidence, vision for the future, status and bargaining power within the household, status and networks in the community	Lower

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Study no.	Publication	Country and study design	Follow-up period	Intervention and target population	Study participants	Comparison group(s)	Outcome measures	Quality[a]
22	Mohindra et al.[49]	India, post-intervention study	NA	Self-help groups, poor women	928 poor women aged 18–59 years	Women who had been members for >2 years, women who had been members for <2 years, non-members living in house with a member and non-members living in a house without a member	Self-assessed physical and mental health, exclusion from health care in last year, whether or not husband is sole decision-maker	Lower
	Mohindra[50]				928 poor women aged 18–59 years	Women who had been members for >2 years, women who had been members for <2 years, non-members living in house with a member and non-members living in a house without a member	NA	Higher
23	Ahmed et al.[51]	Bangladesh, post-intervention study	NA	BRAC, poor women	Poor women, from 3 624 households, who were or had been married	Non-member households that met eligibility for BRAC and rich non-eligible households	Three specific questions about emotional stress and its consequences	Lower

BMI: body mass index; BRDB: Bangladesh Rural Development Board; CFPR-TUP: Challenging the Frontiers of Poverty Reduction – Targeting Ultra Poor; HIV: human immunodeficiency virus; IMAGE: Intervention with Microfinance for AIDS and Gender Equity; NA: not applicable; NGO: nongovernmental organization; NS: not specified; RCT: randomized controlled trial; STI: sexually transmitted infection.

a   Assessed using procedures tailored to social interventions in community contexts.[16]
b   The aims of the BRAC scheme are to improve health and socioeconomic condition through group formation, skill training and collateral-free loans for income-generating activities.
c   Scheme based on loan groups run by a nongovernmental organization.
d   Includes a large health promotion component related to human immunodeficiency virus.
e   The Grameen Bank is a bank for poor rural people that focuses on women.
f   Multicomponent microfinance scheme with empowerment approach.
g   Largely based on the creation of self-help groups.
h   Promotes community banking and solidarity group lending.

tive data indicated that the intervention had led to a greater acceptance of intra-household communication about HIV and sexuality and increased confidence and skills that, in turn, appeared to have supported the introduction of condoms in sexual relationships.[29]

Findings on the impacts on women's sexual health assessed in two other higher quality studies were equivocal. In Bangladesh, women in villages participating in the Grameen Bank scheme were more empowered ($P < 0.01$) and more likely to use contraceptives than women in villages without the microfinance scheme (59% versus 43%; $P < 0.01$).[31] In contrast, no significant association was found between BRAC membership and contraceptive use. Ethnographic data indicated that the Grameen Bank scheme may have increased contraceptive use partly by strengthening women's economic roles and empowerment and partly by directly promoting family planning and influencing community norms.[32] Members of microfinance schemes showed relatively high scores for economic security, contribution to family support, freedom and mobility and freedom from domination.[32] A further longitudinal controlled study in India, evaluated the three-year impact of Pragati – a multicomponent microfinance and health-promotion intervention for female sex workers. In this study, the incidence of sexually transmitted infections decreased and the frequency of condom use at last paid sex increased as microfinance exposure increased over time.[33]

Three lower quality studies also assessed women's sexual health. One showed associations between microfinance membership in Bangladesh and higher contraceptive use.[34,35] The other two, in Ethiopia and Peru, found no association between membership and women's health.[36,25]

Violence against women

Impacts on interpersonal violence against Bangladeshi or South African women were reported in seven evaluations. The highest quality study found that, after two years, levels of such violence decreased in all four study villages covered by the South African Microfinance for AIDS and Gender Equity intervention but stayed the same or increased in the four control villages.[30] Women's membership in the intervention was associated with a reduced risk of exposure to interpersonal violence (aRR: 0.45; 95% CI: 0.23–0.91).[30] Improvements in all nine of the investigated indicators of

Fig. 1. **Flowchart showing the selection of studies on group-based microfinance schemes**
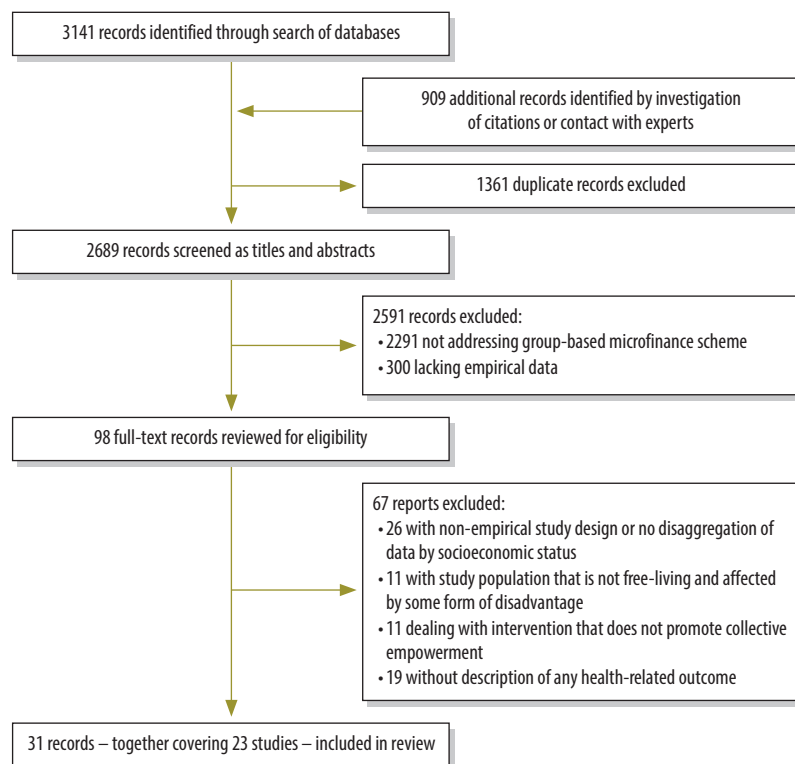
women's empowerment were observed.[30] Women members had a greater say over household decision-making and felt more able to challenge the acceptability of violence, to expect and receive better treatment from their partners, to leave abusive relationships and to raise public awareness of interpersonal violence in their village.[30]

Another study, also assessed as higher quality, measured violence within spousal relationships in Bangladesh. In this study, women who participated in the BRAC or Grameen Bank schemes – and women who were non-members but lived in Grameen Bank villages –were found to be less likely to be beaten by their husbands than women in control villages.[37] In this study, the role of empowerment was not clear and the effect of women's contribution to family support on violence was not significant.[37] Ethnographic data indicated that, in relatively rich households, women's membership of a microfinance scheme may have led to an initial increase in violence as the women's roles and status were redefined and they had increased involvement in the cash economy – leading to a struggle for control over household finances. However, this effect dissipated over time.[37]

Five lower quality studies, all in Bangladesh, gave mixed results. One study found that microfinance participation was associated with a reduction in the likelihood of interpersonal violence against women of 6.8%.[38] In contrast, after controlling for confounders, two studies found no statistically significant association between microcredit participation and current experience of such violence.[24,39] A further lower quality study in Bangladesh found that the better educated women experienced increased exposure to interpersonal violence following membership of a microfinance scheme. This study was poorly adjusted for bias, however.[40] Another study in Bangladesh, that used propensity score matching to construct an appropriate comparison group of non-members, revealed that levels of interpersonal violence did not differ significantly between members and non-members.[42]

Nutrition

Impacts on nutrition were reported in seven evaluations, in Bangladesh, Ethiopia, Ghana, India and Peru. The findings were inconclusive. Some studies showed that scheme membership brought nutritional benefits – mainly for the infants and children of members – and others revealed no significant effects.

Of the three higher quality studies, all from Bangladesh, one found that women from villages with any microfinance scheme showed similar increases in their body mass index to women from neighbouring villages without microfinance.[43] In another study, the prevalence of stunting was found to be higher (84.6%) among children of poor non-members than among the children of BRAC members (67.3%) or rich non-members (69.4%).[44] Weight-for-height z-scores of children aged 24–35 months from BRAC households were significantly higher ($P < 0.05$) than those of their counterparts from control households.[44] The final higher quality study found no significant differences between BRAC households and non-member households in terms of three other indicators of nutritional status in children and women.[45]

We included four lower quality studies relating to nutrition in our systematic review: one each from Ethiopia,[47] Ghana,[48] India[46] and Peru.[26,27] Various outcomes were measured, including: women's and children's body mass indexes, anthropometry, food security, food consumption and haemoglobin. Findings were mixed, with some schemes showing benefits for microfinance members and others showing no effects. Two studies – one with unadjusted selection bias – found that improvements in several empowerment variables were associated with microfinance membership.[46,48]

Well-being and health-care use

One higher quality study evaluated the Indian Self Help Groups scheme and found that membership was associated with significant reductions in emotional stress and significant increases in the use of health care.[49] A beneficial spillover effect was also noted for non-participants who lived in a household with a member. No associations were found between participation and self-assessed health or exposure to health risks. This study excluded a socially marginalized group of women – i.e. Paniya women – because they were considered "prone to underestimate their health". Women members used loans to help cover their health expenditures.[50]

Two lower quality studies in Bangladesh revealed associations between microfinance membership and increases in emotional stress – but only for non-members in households that received loans[51] – and use of maternal delivery

care.[41] A final study from Peru found that length of participation in a microfinance scheme had no association with women's access to cancer screening or their number of sick days.[25]

Discussion

Although we searched for evaluations of group-based microfinance schemes that covered any disadvantaged group in any country, all identified studies that met our inclusion criteria were concerned with the empowerment of poor women in low- or middle-income countries, mainly in Asia.

There is clear evidence of improvements in some important maternal and child health outcomes associated with membership of the long-established BRAC and Grameen Bank microfinance schemes in Bangladesh, including better child survival.[21,22] and use of contraceptives.[31] Results from studies, in a range of countries, on nutritional status and the general health of women who were members of schemes were equivocal. Membership of a microfinance scheme specifically for female sex workers in India was associated with decreases in sexually transmitted infections and increases in condom use during paid sex.[33] A complex picture emerges for the impact of microfinance on interpersonal violence. The evidence indicates that, while microfinance may eventually lead to a reduction in such violence, an initial increase may occur as gender norms are challenged. The most robust study, a cluster-randomized controlled trial, showed that microfinance schemes can reduce the risk of physical or sexual violence by an intimate partner.[30]

The few included studies that measured aspects of empowerment generally found improvements in empowerment associated with membership of the major schemes[30–32,46,48] – though these did not necessarily translate into improved health outcomes.[32] Others have warned that the provision of credit to women does not guarantee their control over the credit's use and may lead to excess anxiety over the pressure to pay back loans – diminishing, rather than increasing, any sense of empowerment.[30] The studies with a strong qualitative component provided some of the most convincing evidence of the role of empowerment in the creation of the beneficial effects of microfinance schemes. In the study of the South African Microfinance for AIDS and Gender Equity intervention, participants revealed how reductions in violence resulted from a range of responses – some linked to increasing confidence and empowerment of the women in handling potential flash points.[30] In Bangladesh, microfinance schemes can empower women by strengthening their economic roles, increasing their say over household decision-making and changing community norms.[32]

We found no relevant studies that assessed the impact of microfinance schemes on ethnic inequalities in health. Some evidence did emerge on how microfinance schemes might help tackle socioeconomic and gender inequalities in health. Most notably, evaluations in Bangladesh indicated that the BRAC microfinance scheme may help to narrow the inequalities in health between boys and girls and the rich and poor.[35,44] Such schemes may work not only through improvements in the economic status of the mothers who become members but also through cultural changes in the way girls are valued and nurtured, leading to additional gains for poor girls in relation to poor boys.

The potential for a microfinance scheme to have adverse health impacts was largely unexplored in the evaluations included in our review. Although there have been indications of increased violence between intimate partners as the result of the female empowerment promoted by microfinance, the most robust relevant studies have shown overall reductions in such violence, at least in the long term.[30,37] The potential negative health impacts of microfinance schemes as a result of the debt stress associated with the repayment of loans have yet to be investigated in detail.[11–14,52]

Research into the positive and negative impacts of microfinance schemes may be particularly challenging, not least because of the potential for selection bias of various forms. Very few of the relevant studies we identified employed the most robust designs. There is a need for more high quality studies that employ appropriate designs that can cope with all of the complexity and potential confounding to be found in the settings in which microfinance schemes must operate. Few, if any, of the evaluations included in our review could disentangle the effects of the main microfinance scheme from those of additional health-promotion and/or health-care components. Even within the microfinance component, it is hard to disentangle the role of the empowerment strategy from that of the poverty-reduction component. Measurement of differential impacts by socioeconomic status is also rare but studies in Bangladesh have shown how this could be done and revealed its potential value.

In conclusion, group-based microfinance schemes represent perhaps the largest experiment in collective empowerment in the world to date. These schemes – and their potential impacts on both health and poverty – deserve close scrutiny. In terms of improvements in selected health outcomes, the evidence coming from the larger, long-established schemes is encouraging. Many questions remain, however, including the scale of the potential for microfinance schemes to do harm. These questions need to be addressed by appropriately designed evaluations that incorporate community-wide assessments of all potential impacts. ■

ملخص

التمويل متناهي الصغر القائم على المجموعات بهدف التمكين الجماعي: مراجعة منهجية للتأثيرات الصحية

الغرض تقييم التأثير على المحصلات المرتبطة بالصحة، وبرامج التمويل متناهي الصغر للمجموعات القائمة على التمكين الجماعي. الطريقة قمنا بالبحث في قواعد البيانات مثل Social Sciences Citation Index، وEmbase، وMEDLINE، و MEDLINE In–Process، وPsycINFO، وSocial Policy & Practice، وConference Proceedings Citation Index للعثور على مقالات منشورة في الفترة ما بين 1 يناير 1980 و29 فبراير 2016. وكانت المقالات التي تبلغ عن التأثيرات الصحية المرتبطة بالتمويل متناهي الصغر القائم على المجموعات مشمولة في أسلوب تجميعي سردي.

الصغر التي تتميز بأنها كبيرة نسبيًا ومستقرة إلى زيادة مستوى التمكين ولكن هذا الأمر لم يعبر بالضرورة عن تحسين المحصلات الصحية. وأشار الدليل النوعي إلى أن زيادة مستوى التمكين قد تكون ساهمت في التحسينات الملحوظة في استخدام موانع الحمل والسلامة العقلية والحد من خطر التعرض للعنف من شريك الحياة الحميم.

الاستنتاج إن الانضمام إلى برامج التمويل متناهي الصغر الأكبر والمستقرة والقائمة على المجموعات يرتبط بالتحسينات في بعض المحصلات الصحية. يجب أن تكون الدراسات المستقبلية مصممة للتأقلم بشكل أفضل مع حالات التحيز ولتقييم التأثيرات الاجتماعية والصحية السلبية وكذلك الإيجابية.

النتائج لقد قمنا بتحديد تجربة واحدة عشوائية عنقودية في بيئة مراقبة و22 دراسة شبه تجريبية. واستهدفت جميع التدخلات المشمولة النساء الفقيرات المقيمات في بلدان منخفضة أو متوسطة الدخل. واشتمل بعضها على أحد مكونات تعزيز الصحة. أشارت النتائج الخاصة بالدراسات عالية الجودة إلى وجود ارتباط بين الانضمام إلى برنامج التمويل متناهي الصغر والتحسينات في مستوى الصحة لدى النساء وأطفالهن. واشتملت التحسينات الملحوظة على تقليل نسب وفيات الأمهات والرضّع، وتحسين الصحة الجنسية، وفي بعض الحالات، خفض مستويات العنف بين الأشخاص. وفقًا للنتائج الصادرة عن بعض الدراسات التي تم فيها قياس مستوى التمكين، عادةً ما أدى الانضمام إلى برامج التمويل متناهي

摘要

针对集体权利获得的群体微型金融：健康影响的系统性综述

目的 旨在评估基于集体授权的群体微型金融计划对健康相关结果的影响。

方法 我们通过社会科学引文索引 (Social Sciences Citation Index)、荷兰医学文摘 (Embase)、MEDLINE、MEDLINE In-Process、PsycINFO、社会政策与实践 (Social Policy & Practice) 以及会议录引文索引 (Conference Proceedings Citation Index) 数据库搜索了发表于 1980 年 1 月 1 日至 2016 年 2 月 29 日之间的文章。关于基于群体的微型金融健康影响的报告文章被纳入在叙述性综述中。

结果 我们鉴定了一项集群随机对照试验和 22 项准实验研究。所有干预措施均针对居住于中低收入国家的贫困妇女。有些研究包含健康改善部分。质量较高的

研究结果表明参与微型金融计划与妇女及其子女健康改善之间存在联系。据观察，改善之处包括母婴死亡率的降低、性健康状况更佳，以及在某些情况下，更低水平的人际暴力。根据少数衡量了授权变化的研究结果，参与规模相对较大且体系完善的微型金融计划通常会促进妇女权利获得情况改善，但是这并未绝对性地改善健康结果。定性证据显示妇女权利获得情况的改善可能明显促进了避孕用品的使用、提升了心理健康并且降低了来自亲密伴侣的暴力攻击的风险。

结论 参与规模较大、体系完善的群体微型金融计划与某些健康结果的改善有关。将来研究还需进一步设计，以更好地应对偏见，以及评估负面和正面的社会和健康影响

Résumé

Microfinancement de groupe axé sur la responsabilisation collective: examen systématique des conséquences sur le plan de la santé

Objectif Évaluer les conséquences sur les résultats sanitaires de projets de microfinancement de groupe axés sur la responsabilisation collective.

Méthodes Nous avons recherché dans les bases de données Social Sciences Citation Index, Embase, MEDLINE, MEDLINE In-Process, PsycINFO, Social Policy & Practice et Conference Proceedings Citation Index des articles publiés entre le 1er janvier 1980 et le 29 février 2016. Les articles qui rendaient compte des conséquences sur le plan de la santé liées au microfinancement de groupe ont été inclus dans une synthèse descriptive.

Résultats Nous avons retenu un essai contrôlé randomisé par groupe et 22 études quasi expérimentales. Toutes les interventions incluses ciblaient des femmes pauvres vivant dans des pays à revenu faible ou intermédiaire. Certaines comprenaient un volet axé sur la promotion de la santé. Les résultats des études de meilleure qualité ont démontré un lien entre l'adhésion à un projet de microfinancement et l'amélioration de la santé des femmes et de leurs enfants. Les améliorations observées

se traduisaient par une réduction de la mortalité maternelle et infantile, une meilleure santé sexuelle et, dans certains cas, une diminution des niveaux de violence interpersonnelle. Selon les résultats des rares études dans lesquelles ont été mesurés les changements liés à la responsabilisation, l'adhésion à des projets de microfinancement relativement importants et bien connus a, en règle générale, favorisé la responsabilisation, mais ne s'est pas forcément traduite par de meilleurs résultats sanitaires. Des données qualitatives permettent de penser que le renforcement de la responsabilisation a pu contribuer à des améliorations concernant l'emploi de contraceptifs et le bien-être mental ainsi qu'à la diminution du risque de violence au sein du couple.

Conclusion L'adhésion à un projet de microfinancement de groupe important et bien connu est associée à l'amélioration de certains résultats sanitaires. De futures études doivent être envisagées pour venir à bout de tout parti pris et évaluer les conséquences positives, mais aussi négatives, sur le plan social et de la santé.

Резюме

Групповое микрофинансирование для расширения коллективных прав и возможностей: систематический обзор влияния на здоровье

Цель Оценить влияние схем группового микрофинансирования на конечные показатели в области здравоохранения на основании расширения коллективных прав и возможностей.

Методы Авторами был выполнен поиск статей, опубликованных в период между 1 января 1980 года и 29 февраля 2016 года, в базах данных Social Sciences Citation Index (Индекс цитирования

по общественным наукам), Embase, MEDLINE, MEDLINE In-Process, PsycINFO, Social Policy & Practice и Conference Proceedings Citation Index (Индекс цитирования по трудам конференций). Статьи, содержащие данные о влиянии группового микрофинансирования на здоровье, были включены в нарративный синтез.

Результаты Авторы определили одно контролируемое исследование с кластерной рандомизацией и 22 квазиэкспериментальных исследования. Все включенные в анализ мероприятия касались малоимущих женщин, проживающих в странах с низким и средним уровнем дохода. В программу некоторых из них входило укрепление здоровья. В результате исследований высшего качества была установлена связь между участием в схеме микрофинансирования и улучшением здоровья женщин и их детей. Наблюдаемые улучшения включали сокращение смертности среди матерей и новорожденных, укрепление репродуктивного здоровья и в некоторых случаях снижение уровней межличностного

насилия. Согласно результатам немногих исследований, в ходе которых измерялись изменения в предоставленных правах и возможностях, участие в сравнительно больших и устойчивых схемах микрофинансирования в целом приводило к увеличению возможностей, но не всегда выражалось в улучшении конечных показателей в области здравоохранения. Качественные данные позволяют сделать предположение, что расширение прав и возможностей, вероятно, поспособствовало наблюдаемым улучшениям в плане применения контрацептивов и психического благополучия, а также снижению риска насилия со стороны партнеров.

Вывод Участие в сравнительно больших устойчивых схемах группового микрофинансирования обуславливает улучшение в плане некоторых конечных показателей в области здравоохранения. Необходимо разработать дополнительные исследования для уменьшения искажений и для оценки отрицательных и положительных последствий для общества и здравоохранения.

Resumen

Microfinanciación de grupos para el empoderamiento colectivo: revisión sistemática de los efectos sobre la salud

Objetivo Evaluar el impacto sobre los resultados relacionados con la salud de planes de microfinanciación de grupos basados en el empoderamiento colectivo.

Métodos Se realizaron búsquedas en las bases de datos de Social Sciences Citation Index, Embase, MEDLINE, MEDLINE In-Process, PsycINFO, Social Policy & Practice y Conference Proceedings Citation Index para encontrar artículos publicados entre el 1 de enero de 1980 y el 29 de febrero de 2016. Artículos que informan sobre los efectos sobre la salud relacionados con la microfinanciación de grupos se incluyeron en una síntesis narrativa.

Resultados Se identificaron un ensayo controlado aleatorizado y 22 estudios cuasiexperimentales. Todas las intervenciones incluidas apuntaban a mujeres pobres que vivían en países con ingresos bajos o medios. Algunas incluían un componente de fomento de la salud. Los resultados de los estudios de mayor calidad indicaron una relación entre la pertenencia de un plan de microfinanciación y mejoras en la salud de las mujeres y sus hijos. Entre las mejoras observadas se encontraban una

reducción de la mortalidad infantil y materna, una mejora de la salud sexual y, en ciertos casos, menores niveles de violencia interpersonal. Según los resultados de los pocos estudios en los que se midieron los cambios en el empoderamiento, la pertenencia de los planes de microfinanciación relativamente grandes y bien constituidos ha dado lugar, en términos generales, a un mayor empoderamiento, pero esto no se traduce necesariamente en unos mejores resultados sanitarios. Las pruebas cualitativas sugirieron que un aumento del empoderamiento puede haber contribuido a mejoras observadas en el uso de métodos anticonceptivos y el bienestar mental, así como un descenso del riesgo de violencia doméstica.

Conclusión La pertenencia de planes de microfinanciación por grupos mayores y bien constituidos está vinculada a mejoras en algunos resultados sanitarios. Es necesario diseñar futuros estudios para afrontar mejor la parcialidad y para evaluar los impactos sanitarios y sociales positivos y negativos.

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Box 2. **Embase, MEDLINE, MEDLINE In-Process, PsycINFO and Social Policy & Practice search strategy**

Titles and abstracts of articles published between 1 January 1980 and 29 February 2016 were searched for the following terms: "micro-credit$", "microcredit$", "micro credit$", "micro-finance$", "microfinance$", "micro finance$", "microsaving$", "micro-saving$", "micro saving$", (Bangladesh and BRAC), (IMAGE adj2 (scheme or intervention or initiative)), Pragati, "Bangladesh Rural Advancement Committee", "Grameen Bank" and "credit union".

Box 3. **Social Sciences Citation Index and Conference Proceedings Citation Index search strategy**

Titles and abstracts of articles published between 1 January 1980 and 29 February 2016 were searched for the following terms: "micro-credit$", "microcredit$", "micro credit$", "micro-finance$", "microfinance$", "micro finance$", "microsaving$", "micro-saving$", "micro saving$", IMAGE adj2 (scheme or intervention or initiative)), Pragati, "Bangladesh Rural Advancement Committee", "Grameen Bank", "credit union" and (Bangladesh and BRAC).