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Parental care, allomothering and child health in north-western Tanzania: who cares for children and does it matter?

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Thesis submitted in accordance with the requirements for the degree of

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Abstract

Human children are unique among primates for the amount and duration of care and provisioning they require from adults during infancy. Studies in anthropology, demography and human behavioural ecology show considerable flexibility across human societies in who provides this care, and a wide variation in how it impacts child wellbeing. However, there is still relatively little research that determines which factors predict who provides this help. Studies exploring allomaternal support in detail tend to have small sample sizes, whereas large-scale studies have used proxy measures for allomaternal care (e.g., absence/presence of kin). Such dichotomous indicators may mask variation in children's caregiving environments, and thus in the relationship between children's care and health.

This thesis has three main aims: (1) to draw on the methodological strengths of anthropological and demographic research on childcare to collect data that overcomes previous limitations; (2) to contribute to a more thorough and interdisciplinary understanding of the patterns and predictors of childcare; and (3) to shed light on potential demographic and health implications of childcare. These aims are addressed in three research chapters, using detailed data collected on parental and alloparental childcare from 808 children aged under 5-years, in two diverse communities in north-western Tanzania representative of on-going demographic and urban transitions.

This research confirms that children receive many different types of care from a variety of individuals, including parents, siblings, various relatives and non-kin. Who cares for children is determined by factors including the child's sex, parental co-residence, and the community's level of market integration; with suggestions of responsive childcare systems. However, relationships between allomaternal care and children's health are inconsistent, implying complexity in children's caregiving environments. This research also highlights the value of understanding how allomaternal behaviour changes with market integration, shedding light on contemporary demographic and health transitions.

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I would first like to thank my two incredible supervisors, Rebecca Sear and David Lawson, who have been integral to this project. Rebecca, thank you for your invaluable guidance over the past few years, and for always being gentle, understanding and patient. David, you have always encouraged me to be my best self (and to make decisions!). I am so grateful that I started this journey with you six years ago, and that you introduced me to Tanzania. You are both intellectual powerhouses and I am lucky to have learnt from you.

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To my older brother Amar, who has been taking care of me since he was three and has been allomother and best friend in equal measure. Thank you for always reminding me to think of the bigger picture. Finally, to my parents Munchi and Qaiser, who have invested huge amounts of love, energy and resources in me even when it cost them so much - I can never thank you enough. This PhD would not have been possible without your belief in me, your motivation, and sacrifices. Baba, your humour and wisdom, and Mama your strength and discipline, have carried me through the toughest moments.

I would like to dedicate this thesis to Baba and Mama, and all my alloparents - there have been so many! - especially Amar and Maryam; my aunt and second mom Da*;* Apa, who has taught me to always be patient and kind; and to my Nana who nurtured my love for writing, education, and research – he would have been most proud.

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1. Introduction

Human children receive care from a wide range of individuals in most populations around the world, including their parents, close and distant kin members, as well as non-kin. This care – consisting of direct caregiving, domestic tasks, and resource production or provision – is considered essential in ensuring survival out of childhood, and a large body of research explores relationships between care, or proxies of care, and a multitude of child outcomes. This study of childcare and its intersection with child health has garnered interest from multiple disciplines; reading through this literature makes evident wide ecological variation in the relationship between children's care and health. Guided by theoretical perspectives in evolutionary anthropology, in particular from human behavioural ecology (HBE), and drawing on concepts and methodology in demography and anthropology, this dissertation seeks to explore what causes variation in the care provided to children and to investigate the influence of caregiving on children's health. These questions are addressed using data from two rural Tanzanian communities undergoing economic and demographic transitions that have diverse types of livelihoods.

1.1 Thesis synopsis

Humans have evolved a system where we require support in raising our young, earning us the title of cooperative breeders in the evolutionary sciences (Hrdy, 2005b; Kramer, 2010). This support – spanning multiple domains, including childcare – is provided to mothers so they have more time and energy to invest in different tasks; and can function to maintain the health of existing children while allowing mothers to redirect their energy towards further reproduction. There is ample evidence that allomaternal care (care from non-mothers) is universal and it impacts both the mother and child, however, who cares and the influence on children's wellbeing (including physical and developmental health as well as survival) is variable. What has been less explored in the current literature is *why* patterns of care vary by context, and what factors determine who helps mothers raise their young. This thesis aims to address these gaps in the literature, and subsequently investigate the relationship between care provision and children's health.

1.1.1 Theoretical overview

Although this research takes an interdisciplinary approach, it is primarily situated in theoretical perspectives in evolutionary anthropology and human behavioural ecology. As such, it seeks both ultimate ('why') and proximal ('how') explanations for the evolution of human behaviour within the constraints of local ecology (Nettle, Gibson, Lawson, & Sear, 2013). A key tenet of human behavioural ecology is life history theory (LHT) which posits that humans have a finite bank of energy which they can expend on different life tasks including, for example, growth, survival and reproduction (Stearns, 1992). A common trade-off faced by mothers due to this limit to human energy is between reproduction (or child quantity) and the success of existing children (or child quality). Allomaternal carers can help off-set these trade-offs between different life tasks by allocating energy towards activities such as childcare (among others) that allow women to re-direct their own energy towards other activities. High levels of allomaternal care provided to young children during human evolution is considered to have facilitated increases in human fertility compared to other great apes – leading humans to be considered as cooperative breeders (Hrdy, 2005a, 2011; Kramer, 2014). The cooperative breeding hypothesis suggests that one of the functions of allomothering is to maintain child 'quality'. In this thesis, child quality is operationalised using children's nutritional status, or anthropometric measurements.

Also key to the research questions being tested here is the demographic transition model. The demographic transition refers to changes seen in population structure over time, caused by falling rates of mortality and then fertility, with an interim period of high population growth (Notestein, 1945). These changes usually coincide with industrialisation and societies shifting from agricultural livelihoods to more market-integrated ones.

This thesis also takes into consideration local motivations and perceptions that shed light on the patterns of childcare behaviour observed; and also aid in causal understandings of these behaviours (Colleran, 2020a). Thus, these proximate explanations also help explain *why* childcare behaviour in the study context varies as it does. These theoretical concepts are further discussed in Chapter 2 and Chapter 8.

1.1.2 Thesis aims and objectives

This thesis aims to draw on the methodological strengths of anthropological and demographic research on childcare to collect data that overcomes some limitations of previous studies; contribute to a more thorough and interdisciplinary understanding of the predictors of childcare; and shed light on potential demographic and health implications of childcare for children and women. The objectives of this project are:

1. To collect novel data on detailed measures of childcare for a large sample of children in two north-western Tanzanian communities that are undergoing the demographic transition
2. To describe the patterning of parental and alloparental (i.e., care from non-parents) childcare in these two communities
3. To explore child-level, parental, and ecological determinants of the care provided to children, e.g., child's sex, parental co-residence with child, and market integration
4. To quantitatively investigate the relationship between parental and alloparental care provision and children's health

Data collected to meet Objective 1 were used to write three research papers in this dissertation (Chapters 5-7). Addressing Objectives 2 and 3, the first two papers examine questions about why childcare patterns vary. Chapter 5 takes an evolutionary anthropological approach and focuses on sex-biased care provision from parents, and the impact of parental marital status and cohabitation on care provision; Chapter 6 is a descriptive demography paper that investigates the impact of market integration and paternal co-residence on the care provided to children. Objectives 2, 3 and 4 are addressed in my third paper (Chapter 7) where I explore whether care provision is a predictor of children's health and whether the relationship between childcare and children's health varies by maternal residence with the child. All three papers utilise multiple measures of childcare, including provision of resources (i.e., provisioning) and direct care (i.e., caregiving). Support provision is measured from numerous potential caregivers, including the child's parents, siblings, grandparents, aunts/uncles and non-kin. Children's nutritional status is used as an indicator of their health, and operationalised through their anthropometric measurements (age, height, and weight).

1.1.3 Data collection aims

This thesis draws on the methodological strengths of both anthropological and demographic studies on childcare. Usually, research in demography – as well as some larger anthropological studies – uses large-scale surveys to collect data. While this results in large sample sizes, these studies often aggregate data across a number of different socio-economic, cultural, or regional groups making it difficult to investigate contextual patterns in particular communities (Lawson & Uggla, 2014). They run into issues regarding depth of data, and research analysing these data often uses substitute measures of caregiving, such as co-residence with or the 'absence/presence' of potential care-providers. Conversely, smaller sample sizes have allowed anthropologists to record instances of care provision in a lot of detail, for example, through methods such as focal follows which involve direct observation of behaviour. However, small sample sizes can be problematic too: results suffer from a lack of generalisability to a wider population, it is difficult to break down (already small) samples to study different effects, and there can be a lack of confidence in observed trends. Data for this thesis were therefore collected using a combined approach. As direct observation of caregiving behaviour was not possible for logistical reasons, quantitative surveys were designed to encapsulate detailed measures of childcare that are not available in large datasets. While, in a way, these too are proxy measures (as I did not observe the study participants' behaviour) they do not assume that the absence/presence, co-residence or residential proximity of an individual translates as that individual providing care to the focal child. At the same time, the project benefitted from a partnership with the Magu Health and Demographic Surveillance System

(HDSS). This allowed minimising of logistical and administrative costs and enabled data to be collected from a relatively large sample of children.

As there is relatively little data available on detailed measures of childcare and child health for a large sample of children in low-income settings, these data were collected in a rural but rapidly urbanising context in north-western Tanzania. The two communities sampled were chosen as they are currently undergoing the demographic transition and represent either extreme of a rural-to-urban gradient in the HDSS area. The socio-economic and demographic differences between the two communities were a key strength of the research plan, allowing me to explore the influence of rural versus urban environments on childcare provision. Primary data collection also fostered active engagement with the local communities and an education about the social and cultural context.

1.1.4 Thesis contribution

This thesis adds to a growing interdisciplinary field of research on the determinants of children's care and wellbeing. I also hope to make a wider contribution to discourse on relevant topics in anthropology, HBE, demography and children's health. There is space for a further understanding of socio-cultural contexts and behaviours underpinning and propelling contemporary demographic transitions; and relatedly, the value of investigating the role of culture, demography and urbanisation in influencing caregiving behaviours. Improving children's health and nutrition remains a global issue today, especially in low-resource settings, and emphasising children's caregiving environments as determinants of their health is increasingly important. Lastly, within evolutionary anthropology and HBE, there is very little research on the role of non-kin as sources of support for children and women. This dissertation contributes some data and empirical evidence on non-kin allocare; and emphasises the importance of broadening our perspective of children's caregiving environments beyond close kin members, and to include distal kin and non-kin in future research. I expand on these ideas in my thesis discussion (Chapter 8).

1.2 Fieldwork

1.2.1 Research setting

All data collection for this project was undertaken within the bounds of the Magu Health and Demographic Surveillance System (HDSS) in north-western Tanzania. The Magu HDSS is situated in Kisesa ward, one of the 31 wards in Magu district, which is one of seven districts in Mwanza Region in north-western Tanzania (Kishamawe et al., 2015). The study area is located about 20km east of Mwanza city, which is the capital city of the region, and where I was based during the length of the PhD fieldwork. The Magu HDSS is home to over 35,000 residents living in seven villages. Data for this thesis were collected in two of these villages: the most rural and the most urban, chosen to represent two extremes of the local rural-urban gradient within the Magu HDSS. Details on the research setting and study population are provided in Chapter 4.

1.2.2 Data used

All data analysed in this thesis were collected from July through October 2017 at the Magu HDSS in north-western Tanzania. Data were collected using household, women's and children's quantitative surveys, as well as through four focus group discussions undertaken with parents who had children under the age of 5 years. The research chapters in this thesis (Chapters 5-7) are primarily written using the quantitative data from the household and child surveys. The focus group discussions were not formally analysed but are used to qualify findings in Chapter 5. All data collected and used for this PhD are fully described in Chapter 4.

1.2.3 Ethical clearance

Ethical clearance for this project was obtained from the Lake Zone IRB, National Institute for Medical Research (NIMR) (MR/53/100/463) and the National Ethical Review Committee (NIMR/HQ/R.8a/Vol.IX/3104) in Tanzania; from the London School of Hygiene and Tropical Medicine (13809) in the UK, and University of California Santa Barbara (1-17-0405) in the USA. Ethics approval certificates from the Lake Zone IRB, NIMR, and from LSHTM are provided in

Appendix 10.1. Informed verbal consent was obtained from all research participants. Written information sheets explaining the aims and objectives of our project were printed and one provided to each household that we contacted, whether or not they consented to take part in the study. Written consent forms were also printed and provided to households that consented to take part in the study. However, consent itself was obtained verbally: the information sheet and consent forms were read aloud to each participant after which they were asked if they consented to take part in the study. If they agreed, they were given a copy of the consent sheet to keep. The forms in English and Swahili are provided in Appendix 10.2.

1.3 Funding

My studentship was funded through a 1+3-year award from the Economic and Social Research Council (ESRC), that covered my first year of training in demography at the European Doctoral School of Demography (EDSD) in 2015-16; and the entirety of my research degree fees. In addition to this I was awarded the Advanced Quantitative Methods (AQM) grant by the ESRC, which promotes training in and the use of AQM in the PhD research. The ESRC also funded my first pre-fieldwork visit to Tanzania to meet research collaborators at the National Institute for Medical Research, who operate the Magu HDSS. Additionally, I made six successful grant applications for my fieldwork funding: the LSHTM Research Degree Travelling Grant; ESRC Overseas Fieldwork Funding; the Royal Anthropological Institute, Ruggles-Gates Fund; European Human Behaviour and Evolution Association (EHBEA) Student Research Grant; the Biosocial Society Small Research Grant; and the Parkes Foundation Small Grant. My second supervisor, Dr David Lawson, was based at the University of California Santa Barbara (UCSB), USA, through the duration of my PhD. The data used for this thesis were collected jointly with one of his projects, which was funded by UCSB, and my fieldwork benefitted from these funds too. Lastly, I received a 6-month extension of my monthly ESRC stipend through a successful application for the ESRC's Difficult Language Training award to undertake training in Swahili prior to fieldwork. The ongoing Kisesa observational HIV

cohort has been funded by the Global Fund grants TNZ- 405-G04-H and TNZ-911-G14-S.

1.4 Role of the candidate

I, the candidate, designed the entirety of this project, including development of the research questions, with guidance and academic support from my two supervisors, Prof Rebecca Sear (LSHTM) and Dr David Lawson (UCSB), and my advisory committee. I designed the survey tools used for all child-level data collection (child survey and focus group discussions with young children's parents) and contributed to the design of the household survey. I trained and co-led a team of interviewers in Tanzania for the duration of the data collection period, supervised interviews regularly, and merged, cleaned and prepared the final datasets used for analysis. I designed and conducted all of the data analysis, interpreted findings and wrote the manuscripts myself, with feedback and advice from my supervisors, my advisory committee and co-authors.

1.5 Structure of the thesis

This is a research paper-style thesis and as such includes three chapters written to comply with the themes and formats of different peer-reviewed journals. Chapter 5 presents work that has been published, while Chapters 6 and 7 are written to be submitted in the upcoming months. As this thesis draws from theory and methods from multiple disciplines, each paper targets a different disciplinary audience too. All chapters utilise data that were collected in Tanzania during the PhD. The references in this thesis are in APA style, and have been included in one bibliography at the end of the thesis for ease of access.

Chapter 2: Background and predictions

In this chapter I provide a theoretical and conceptual background to this project through the review of relevant literature. I first expand on the theoretical framework of this thesis, after which I synthesise key empirical studies that have been conducted on parental and alloparental childcare, especially those in relation to children's outcomes. I then move beyond the anthropological and demographic sciences to briefly explore a wider perspective on children's caregiving and health, drawing on literature in the development and nutritional sciences. Finally, I summarise this literature and the predictions derived from it for this thesis.

Chapter 3: Context of the study

Here, I describe the relevance of situating this study in the Tanzanian context. I introduce a short history of Tanzania, describe the state of the demographic and urban transitions in the country, and the status of children's nutrition and health as well as their caregiving environments.

Chapter 4: Fieldwork, data collection and data analysis

In Chapter 4 I describe the study setting for this PhD, in Mwanza, Tanzania, and all fieldwork activities that were undertaken at the Magu Health and Demographic Surveillance System (HDSS), while based at the National Institute for Medical Research in Mwanza. I also give an overview of the project's sampling protocol, and the quantitative and qualitative data collection instruments used.

Chapter 5: Fathers favour sons, mothers don't discriminate: sex-biased parental care in north-western Tanzania

In this chapter, published in *Evolutionary Human Sciences* (Hassan, Schaffnit, Sear, Urassa, & Lawson, 2019), I test the prediction that parents would be more likely to provide care to their sons than their daughters. This prediction is grounded in evolutionary parental investment theory which posits that parents will favour specific children if this leads to greater fitness returns. As the study population is characterised by high levels of fertility, patriarchal lineage and inheritance norms, and polygynous marriage, I expect sons to have higher reproductive value than daughters; resulting in parents biasing investment towards male children. I examine four dimensions of caregiving: resource provision, six types of direct care (washing, feeding, playing with, supervising, co-sleeping and caring for when sick), breastfeeding duration, and parental marital status and co-habitation. I find that fathers did favour sons for certain direct care activities (washing, feeding and supervising), however direct care from mothers was not biased towards either sons or daughters. Relatedly, there was no difference between boys and girls in regard to the duration of breastfeeding, another aspect of maternal investment. I find no difference in the allocation of resources to sons and daughters by either parent; and parents were neither more or less likely to be married or living together depending on whether the child was a boy or girl. Unsurprisingly, results also show that maternal caregiving was more common than paternal caregiving. Our focus group discussions indicate that the differences in gendered care provision between mothers and fathers may be because of local gender norms around physical care provision (e.g., taboos surrounding fathers washing daughters). While somewhat of a puzzle from an evolutionary perspective, this bias towards sons could result from higher fitness returns for paternal investment compared to investment from mothers.

Chapter 6: Childcare in transition: evidence that patterns of childcare differ by degree of market integration in north-western Tanzania

Market integration or urbanisation is often linked to diffusion in kin networks; subsequently women living in more market integrated settings are expected to receive lower levels of support from their kin as compared to women living more rurally. However, this hypothesis has rarely been tested. In this chapter, I examine the care provided to children by a number of different carers (including fathers, siblings, maternal and paternal grandparents, maternal and paternal aunts/uncles, and distant kin/non-kin) in a rural village compared with a more market integrated town. For this analysis, I categorise five of the direct caregiving variables used in Chapter 5 into two types of care: low-intensity (i.e., supervising the child) and high-intensity (i.e., washing the child, feeding the child, playing with the child, and caring for the child if they had been sick). I predict that children in the village will have higher odds of receiving care from their kin compared to children in the town; and that children in the town will have higher odds of receiving care from non-kin than in the village. Results are mostly in line with predictions: children in the village have a higher likelihood of receiving care from fathers, paternal kin and siblings; and children in the town have a higher likelihood of receiving care from non-kin. However, no difference is seen between the two communities in care from maternal kin. This paper aims to provide a demographic description of variation in childcare patterns between a village and a town, and has been written for submission to *Demographic Research.*

Chapter 7: Which kin matter? The impact of allomaternal care on children's health in north-western Tanzania

In my third paper, I aim to contribute towards research in global health and as such explore the relationship between children's care and their health outcomes. I use the two measures of care developed in Chapter 6, low-intensity and high-intensity care, and predict that receiving this care will be beneficial for children's health. Care is examined from fathers, siblings, maternal and paternal grandparents, maternal and paternal aunts/uncles, and distant kin/non-kin. Children's health is operationalised using two anthropometric measurements: their height-for-age and weight-for-height. Results are inconclusive, indicating scattered associations between the receipt of care and health across allomothers and type of care; raising the concern that the significant associations seen may be spurious associations resulting by chance from the generation of numerous models. This indicates the need for future work that focuses more deeply on the pathways between caregiving and children's health and collects data that measures children's caregiving environments more comprehensively.

Chapter 8: Discussion

In this final chapter, I summarise the findings from my three research papers and describe how my results map onto my thesis aims and objectives. I reflect on the implications of my research findings and suggest avenues for future research. I then discuss some of the issues that were faced during various stages of this project, and how I would implement changes in future work. I conclude the dissertation with a summary of my contributions.

Appendices

The appendices include ethics approval certificates, the survey tools used to collect data for this PhD (quantitative surveys and focus group discussion guides), and informed consent forms; and the supplementary materials for each of the three research papers.

2. Background and predictions

2.1 Theoretical perspectives

In this section, I give an overview of the theoretical concepts that form the foundation of this thesis. I discuss aspects that are most relevant to my overall research questions and outline the predictions that were derived from these concepts. However, literature reviews specific to each of the three research papers, and the predictions tested in each, have been presented in the corresponding chapters (Chapters 5, 6 and 7).

2.1.1 Human behavioural ecology

This thesis is theoretically grounded in human behavioural ecology (HBE), or the evolutionary analysis of human behaviour (Nettle et al., 2013; Winterhalder & Smith, 2000). HBE stemmed from the discipline of behavioural ecology in the biological sciences, which is concerned with how and why behaviour evolves given certain ecological constraints (Davies, Krebs, & West, 2012). Behavioural ecology, whether studying the behaviour of humans or other animals, functions on an assumption that individuals have evolved to respond adaptively to varying ecological circumstances in ways that are fitness-maximising - fitness being the total genetic representation of an individual in future generations (Nettle et al., 2013). Further, while natural selection favours genes that contribute to individuals behaving in optimal ways in their given ecological context, behavioural strategies themselves are not directly determined by genes (Grafen, 2006; Sear, 2015). In fact, human behavioural ecologists believe that an individual's phenotype (physiological traits or behaviour that is observable) is a product of their genotype interacting with their environment. Humans are thus considered to have been selected to have phenotypic or behavioural plasticity – that is, traits that can adapt as a result of environmental change, enhancing their ability to react to different ecological conditions in flexible ways (Borgerhoff Mulder & Schacht, 2012; Nettle et al., 2013; Sear, 2015). This is enabled through the selection of certain mechanisms: proximate mechanisms include adaptations of reproductive physiology, individual and social learning or cultural transmissions, psychological preferences, and decision-making processes (Nettle et al., 2013; Sear, 2015). As these mechanisms assist humans in adapting to different ecological pressures, they also lead to a variety of behavioural strategies across ecological contexts.

As fitness technically refers to future genetic success, it is hard to measure directly especially in cross-sectional studies. Instead, more immediate proxy measures are used as indicators of 'success' in adapting to a specific environment, including survival, physical health and longevity, mating success or fertility/number of surviving children, social status, and energetic returns such as income (Nettle et al., 2013; Sear, 2015). From an evolutionary perspective, behaviour is not considered a product of conscious decision-making; and humans, like other species, are not considered as consciously trying to maximise their fitness (Sear, 2015). Instead, it is these number of evolved mechanisms that shape human behaviour in ways that would improve fitness in a particular environment. However, a point of note here is that in contrast to this, anthropological demographers consider fertility behaviour as consciously strategic, especially in sub-Saharan Africa (Bledsoe, Hill, D'Alessandro, & Langerock, 1994; J. Caldwell & Caldwell, 1987; Colleran, 2020a) It is also important to highlight, especially for the purposes of this thesis, that individuals can maximise their fitness not only through their own reproduction and genetic success (direct fitness), but also through behaving in ways that improve the reproductive success of their genetic relatives (with whom they share genes, thus gaining indirect fitness benefits) – in totality this is referred to as 'inclusive fitness' (Hamilton, 1964).

In this thesis, I use HBE as a framework to understand who provides care to children in two different ecological contexts (one rural and one urban); and develop and test predictions that rely on the general hypothesis that humans behave in ways that will maximise their fitness.

2.1.2 Life history theory

A key tenet of HBE is life history theory, which suggests that all individuals have limited banks of energy that they can allocate towards different, competing, activities throughout their life. The major life functions towards which energy is allocated are survival, growth and reproduction, but following the principle of allocation, energy used for one function cannot be used for another. As an individual's bank of energy is finite, this can result in trade-offs between the life tasks, e.g. between reproduction and survival or reproduction and growth – in other words, between current and future reproduction (H. S. Kaplan, Hill, Lancaster, & Hurtado, 2000; Stearns, 1992). There can also be divisions of energy within certain functions, e.g., energy allocated to reproduction may be split between investing in current or future children or between the quantity and quality of children. There are some common life-history traits across species, e.g., size at birth, age and/or size at maturity, and length of life (Stearns, 1992), and outcomes of trade-offs between life-tasks are often measured by behaviour. Life-history traits particular to humans (compared to other primates and mammals) are large brain size, early weaning, extended growth periods and dependency on adults, late maturation, high fertility, short intervals between births, and a long lifespan (low mortality) (Borgerhoff Mulder & Schacht, 2012; Charnov & Berrigan, 1993). Also important is that while each individual has a limited energy budget, there is a role played by intergenerational and social transfers (i.e., borrowing and lending across one's life history) (Cyrus Chu & Lee, 2006; H. S. Kaplan & Robson, 2002) in contributing to 'pooled energy budgets' (Kramer & Ellison, 2010) – that is, energetic help received from others for one's own survival and reproductive needs.

2.1.3 Parental investment

Trade-offs are also inherent in parental investment. Parental investment has been defined by Trivers as "any investment by the parent in an individual offspring that increases the offspring's chance of surviving (and hence reproductive success) at the cost of the parent's ability to invest in other offspring" (Trivers, 1972:139). Further, investment in an individual child is considered to be independent from investment in other children, and thus increasing investment in one entails reduction in investment in another (Trivers, 1972). Trade-offs between the quality and quantity of children imply that as parents cannot energetically invest excessively in a large number of children (due to physical limits), they have to choose between investing a lot in fewer 'high-quality' offspring or invest less per multiple 'low-quality' offspring (Hill & Hurtado, 1996). Additionally, not all offspring have equal reproductive value, i.e., survival rates as well as reproductive success can be variable among siblings, and both factors can be associated with the offspring's sex. Thus, when sons have substantially higher reproductive value than daughters, they receive higher levels of investment from parents. Although it is more common to observe son-biased parental investment (Khera, Jain, Lodha, & Ramakrishnan, 2014; Mace, 1996; Williamson, 1976), this too can vary by ecological condition, and the reverse has also been documented, with daughters receiving preferential treatment in certain societies (Cronk, 1989, 1991b; He, Wu, Ji, Tao, & Mace, 2016). In Chapter 5 of this thesis, based on parental investment theory and given the context of this study, I hypothesise that sons have higher reproductive value than daughters. Average fertility levels in rural Tanzania are high and polygynous marriage is common (see Sections 3.2 and 3.4), indicating both higher variation in male than female reproductive success and more opportunities for men to translate invested resources into reproductive success. Further, marital systems in Tanzania are commonly extended patrilocal and wealth and land is often transferred from fathers to sons (Ezer, 2006). Thus, from both an 'ultimate' evolutionary, and 'proximate' cultural perspective, one might expect parents to have a son-bias. As such, I test the prediction that parental care will be biased towards sons.

In this thesis, I use the term parental 'care' rather than 'investment'. The two differ slightly. Parental care refers to parental traits that improve children's fitness – which probably originated and/or are maintained for that purpose – but do not necessarily come at a fitness cost to the parent e.g., a mother can watch over multiple children at the same time. Whereas, a behaviour is described as 'investment' when it comes at the cost of the parent's ability to invest energy in a different component of fitness, specifically another child (Royle, Smiseth, & Kölliker, 2012; Trivers, 1972). I make this distinction because the data on caregiving collected for this thesis does not measure any potential costs of that care to parents' fitness and so cannot speak to caregiving behaviours as being investments. This distinction is relevant because parental patterns of care provision may vary depending on the energetic cost of that care, and we cannot directly ascertain this from my data. However, there are two points of note here: firstly, I measured children's breastfeeding duration which is a form of energetically costly care provided by mothers, and in Chapter 5, I also test whether breastfeeding duration is longer for boys than girls; and secondly, the types of caregiving that I measure can be understood (from previous literature) as being either less or more energetically costly for mothers. For example, while supervising a child is considered to demand low energetic investment, washing or feeding a child is considered to demand high energetic investment (Meehan, 2005, 2008). This is detailed more in Chapter 6 and Chapter 7.

2.1.4 Evolution of allomothering in humans, or humans as cooperative breeders

Although the features of life-history discussed above pose a problem for mothers, i.e., how to meet the various energetic demands of bearing and raising multiple children, these trade-offs can be offset by the 'pooled energy' invested by others. Prosocial behaviour among humans facilitates investments from others, and the high levels of support humans provide to children not their own has gained our species the title of 'cooperative breeders' (Hrdy, 2005b). Cooperative breeding is a system, or evolved behaviour, where individuals other than the mother provide care and/or provisions for a child even when this behaviour may be costly for the provider (West, Griffin, & Gardner, 2007). There is some debate on whether humans are 'cooperative' or 'communal' breeders, with each having slightly different definitions. Cooperative breeding, in its strictest form, is used to define support provided to a dominant female by non-breeding helpers (Hrdy, 2011); while communal breeding can refer to systems where multiple females pool their resources and offspring (Lukas & Clutton-Brock, 2012) and do not necessarily delay their reproduction to aid another's (Lewis & Pusey, 1997). However, these definitions are not applied as strictly in the human literature, and humans have also been suggested as having elements of both 'cooperative' and 'communal' breeding (Hawkes, O'Connell, Blurton Jones, Alvarez, & Charnov, 1998; Lukas & Clutton-Brock, 2012). In this thesis, I refer to humans as 'cooperative breeders' who receive childrearing support from pre- and post-reproductive helpers as well as other currently reproducing individuals. As such, I refer to humans as commonly engaging in the provision of 'allomaternal' support or care. 'Allomothering' or 'allomaternal' care are terms used to describe the care received from (or provided by) any individual other than the child's mother (and 'alloparental' care to describe care from anyone other than the parents), which relieves the mother or reduces her energetic burden, allowing her to invest her energy elsewhere.

Although allomothering is not limited to humans, it has not been documented as extensively among other species (Kramer, 2014). It was initially observed among co-nesting birds (Koenig & Dickinson, 2004), naked mole rats (Nancy Solomon & French, 1997b), and eusocial insects (Wilson, 2008) with research extending to humans in 1988 (Turke, 1988). Since, allomothering has been studied in a number of different animal groups, for example birds, meerkats and canids (Asa, 2009; J. Brown, 1987; Clutton-Brock et al., 2001; Nancy Solomon & French, 1997b); and some non-human primates, for example bonobos, marmosets, tamarins and titi also provide considerable allomaternal care to their young (Nancy Solomon & French, 1997a; Tardif, 1997). However, it is not present among non-human great apes (Hrdy, 2011). Among human populations, in addition to maternal investment which is crucial for child wellbeing, children, perhaps universally, receive care from at least one other individual (Bove, Valeggia, & Ellison, 2002; Crittenden & Marlowe, 2008; Hawkes, O'Connell, & Blurton Jones, 1997; Hrdy, 2005b; Kramer, 2005). And in many societies, mothers are assisted in childcare by not just one but several different people (B. Hewlett, 1991; Hrdy, 2011; Ivey, 2000).

Evolutionary scientists, particularly behavioural ecologists, have done considerable research exploring why allomaternal care evolved differently between humans and other species. Compared to other mammals, primates have longer intervals between births (inter-birth interval) and thus fewer, but more dependent, children who have a slower growth or development trajectory (Charnov & Berrigan, 1993). However, humans are remarkable among primates for our relatively short birth intervals given our body size. In natural fertility settings, human birth intervals are typically around three years, compared to eight years for orangutans and four to five years for chimpanzees (Galdikas & Wood, 1990). Human children are also weaned comparatively early. This enables women to resume ovulation quicker than other apes, reducing their inter-birth intervals and increasing the number of children they can have over their reproductive lifespan (Hawkes & Finlay, 2018; Hawkes et al., 1997, 1998). Conversely, unlike our primate cousins, feeding dependency for human children extends far beyond weaning and these early-weaned infants are unable to provision for themselves. Their survival thus depends heavily on investment from others, such that one or more elder offspring may require provisioning while the mother simultaneously nurses a young infant (Bogin, 1997; Gurven & Walker, 2006; H. S. Kaplan & Lancaster, 2003; Lancaster & Lancaster, 1987). As discussed above, meeting the demands of multiple offspring simultaneously is energetically impossible to do alone, and assistance from others with childrearing can offset life-history trade-offs. Substantial care provision from allomothers during human evolution is thus hypothesized to have facilitated the rapid succession of births or 'stacking' of offspring (high fertility) along with low mortality that we see today among humans, but not in other great apes (Hrdy, 2005a, 2011; Kramer, 2010, 2014; Kramer & Ellison, 2010; Kramer & Veile, 2018).

Allomothering thus plays a key role in contributing to maternal energy banks, allowing them to simultaneously invest in the quality and quantity of their children. It is considered vital for the successful raising of multiple offspring (Hrdy, 2005b).

2.1.5 A note on why others help

While this PhD does not particularly seek to explore *why* others help mothers, there are three evolutionary concepts that are relevant: inclusive fitness or kin selection, reciprocity, and learning to parent. From an evolutionary perspective, helping others at a cost to oneself, or behaving altruistically, is paradoxical. It contradicts the idea of the 'selfish gene': that every gene attempts to increase its chance of survival in future generations (Dawkins, 1989). However, if there are returns to acting *seemingly* altruistically, then such behaviour can be understood as cooperation (i.e. a behaviour which has evolved to benefit others) rather than true altruism (which inherently requires a cost to the giver) (Foster, Wenseleers, & Ratnieks, 2006; Page, 2016; West et al., 2007). Such returns can take the form of indirect (inclusive fitness/kin selection) or direct benefits (reciprocity or learning to parent), and thus be explained through evolutionary theory.

Kin selection is an evolutionary strategy that allows individuals to gain fitness indirectly by helping increase the reproductive success of a relative (by helping the survival and health of her current children as well as her future reproduction), even if this is at a cost to their own survival and reproduction or direct fitness (Hamilton, 1964). Hamilton specifies that an individual may be presumed to provide help to another as long as the benefit received, multiplied by the genetic relatedness between the recipient and actor, is greater than the cost incurred by the actor in providing the help ('Hamilton's rule' - Hamilton, 1964). Kin selection is proposed to be the mechanism that enabled evolution of cooperative breeding systems (Hrdy, 2009a, 2011), and thus it is expected that allomothers are most likely to be closely related to the mother or child (Hamilton, 1964). Kin allomothers can vary considerably, including the child's father, grandparents, siblings, aunts or uncles, and cousins. Empirical research on the role of these different kin allomothers is detailed in Section 2.2.

While studies do document nepotistic caregiving as the most typical type of allocare (Crittenden & Marlowe, 2008; Hrdy, 1999; Ivey, 2000; Kramer, 2005; Meehan, 2005; Turke, 1988) perhaps often due to a lack of consideration of non-kin, some research in hunter-gatherer and other small-scale societies shows allomothering often extends beyond family relations (Crittenden & Marlowe, 2008; Hrdy, 2005b, 2011; Meehan, 2008, 2009; Meehan & Crittenden, 2016). Although humans are not the only species that provide allomaternal care to non-kin (e.g., it has been documented among birds and fish as well (Riehl, 2013; Zöttl, Heg, Chervet, & Taborsky, 2013)), we are unique in the extent of support we receive from non-kin and the variety of sources this help comes from (Bogin, Bragg, & Kuzawa, 2014). Kin selection therefore cannot explain all cooperation between humans. In fact, there are perhaps diverse evolutionary mechanisms at play that promote cooperative behaviour (and breeding), and the role of kin selection may have been overestimated in past research (Clutton-Brock, 2002). One such mechanism is that of reciprocal altruism, used by Trivers to explain the helping behaviour seen between kin (close and distant) as well as unrelated individuals (Trivers, 1971). This (costly) behaviour can be selected for if the cost of providing support is lower than the benefit of receiving help from that person in the future, devalued by the probability that help will be reciprocated (Boyd, 1992). Triver's theory of reciprocal altruism then proposes that an individual, who expects zero indirect fitness gains by helping due to lack of relatedness, may still help if the present cost of doing so is lower than the returns expected in the future. Also important is that these transactions do not need to be balanced, with the value of 'goods' changing with need. Reciprocal exchanges can occur in the same timeframe (e.g., simultaneous reciprocal nursing) or involve different stages in an adult's life (e.g., providing allocare now for support received a few weeks, months, or even years in the future). Exchanges may also be in different forms, e.g., food sharing in exchange for childcare (Jaeggi, Hooper, Beheim, Kaplan, & Gurven, 2016). These technicalities can make it tricky to measure reciprocity, especially in cross-cultural studies (Allen-Arave, Gurven, & Hill, 2008; Gurven, 2004); and it is not measured in this thesis.

Kin and non-kin both, however, may provide care for a number of different reasons, and one of these is learning how to parent, or the 'learning-to-mother' hypothesis proposed by Jane Lancaster (Lancaster, 1971). This is discussed mainly in the non-human primate literature, as in some species, young females in particular can be very interested in other mothers' offspring and try to 'borrow' them. This is suggested to be because non-reproductively active young females want to learn how to parent or gain practice in mothering before they have their own offspring; and since mothers with more experience tend to have better child outcomes (Emmott & Page, 2019). For example, experience in allomothering before their own first birth was correlated with increased survival of firstborn children among female vervet monkeys (Fairbanks, 1990). This is possibly true for juvenile helpers among humans too. Older siblings and other children – male and female both - can gain valuable practice in childrearing, and develop caregiving skills, through caring for infants and younger children (Kramer & Veile, 2018). Gaining such experience in parenting may be adaptive for alloparents in circumstances where children are very vulnerable and their survival is highly reliant on receiving good quality care (Emmott & Page, 2019). Children also incur relatively few costs in providing childcare; while some forms of care may have some energetic costs, the extended childhood of our species means that children might not have a lot else to do and thus face few opportunity costs by looking after other children. Further, if care comprises simply watching over or playing with other children – e.g., through playgroups, as seen among the Agta (Page et al., 2020) – then there are perhaps no costs at all. However, there is little research on the effect of providing allomaternal care as children, on either higher reproductive success or the development of parenting techniques as adults. While one study finds that, among Mayan girls/women, time spent in allocare when young was not associated with number of surviving offspring when adults (Kramer & Veile, 2018), there have been calls for further research on the topic among humans (Emmott & Page, 2019). In this thesis, I do not test whether time spent in allocare by young/adolescent girls is associated with them attaining higher reproductive success. However, I do explore whether children's older siblings provide care to them and find that a high proportion of children do receive care from their siblings (see Chapters 6 and 7). One reason for this could be young females wanting to learn how to parent and develop caregiving skills.

It is possible that different individuals provide care for one or more of the three reasons described above: e.g., grandparents may do so for kin selection, siblings for kin selection and to gain experience in parenting, kin and non-kin both as part of reciprocal exchanges, unrelated children for reciprocity and learning to parent etc. This dissertation draws on all three explanations for why others help with childcare, and as such I expect children to receive allomaternal care from kin, including older siblings, and non-kin.

2.1.6 Demographic, economic and cultural models of fertility and mortality decline

Human history has witnessed numerous ecological transitions that have implications for our health and demography. For example, the historical agricultural revolution describes a transition from foraging to farming livelihoods for human populations living in the Holocene. Archaeological evidence from this period suggests that this shift had serious demographic and biological consequences for our ancestors (Larsen, 2006). Fertility rose and population size began to increase dramatically as a result of new sedentary lifestyles. These populations also suffered from higher numbers of infections that led to child health issues such as low birth weight and iron deficient anaemia, worsening dental health, and nutritional deficiencies (Larsen, 2006). Human fitness (i.e., fertility) and health outcomes have thus not always followed the same path, with increases in fertility and population size during the agricultural revolution leading to worse health. There is thus often a tension between attaining higher fertility and better health outcomes among humans.

In this thesis, I examine another, more recent, demographic and economic transition: one which has seen human populations rapidly shift from rural farming reliant livelihoods to more urban market-reliant ones. I also discuss tensions between fertility and health that have occurred during these relatively recent demographic transitions.

<u>The demographic transition model: historical Europe</u>

The demographic transition is a model that describes shifts in population processes over time, from high to low birth and death rates (fertility and mortality), with a period of rapid population growth in the middle when mortality has begun to decline but fertility rates are still high (Kirk, 1996; Notestein, 1945). This shift has been occurring around the world for approximately 200 years, with all countries in the world having either already experienced it or currently undergoing it. There has been a huge amount of research exploring why these demographic shifts took place, especially in historical Europe where the transition appears to have started (Coale &

Watkins, 1986; Knodel & van de Walle, 1979; Lesthaeghe, 1977). While these changes appear to be demographic in nature, they have economic, political and social causes and consequences and thus the demographic transition has been studied by researchers in other disciplines too, especially economics (J. C. Caldwell, 1977; Cleland & Wilson, 1987; Easterlin & Crimmins, 1985), but also evolutionary anthropology (Borgerhoff Mulder, 1998; Colleran, 2016).

One general consensus is that the transition occurs alongside socio-economic change. For example, in historical Europe, the demographic transition followed the industrial revolution and associated advancements in technology (Coale & Watkins, 1986; Lesthaeghe, 1977). The revolution led to a shift from rural to urban living, and from subsistence-farming economies to ones that were more market-integrated and based on wage-based labour; this also increased the importance of children's education. Further, technological advancements, especially those in medicine, propelled improvements in the quality and range of healthcare provision, helping control epidemics and contagious diseases; drastic declines in mortality followed, particularly for infants and children (Dyson, 2013; R. Lee, 2003). As children began to live longer, family sizes increased. At the same time, greater prospects of formal employment in industrialised or wage-based urban communities resulted in the devaluation of children's work (mostly occurring in agropastoral households), while emphasizing the value of children's schooling, as returns to investment in formal education were perceived to be higher in urban communities than in subsistence-farming ones (H. Kaplan, 1996; Mattison & Neill, 2013; Mattison & Sear, 2016). Thus, children became costlier. Once potential contributors to household economies when these were reliant on agriculture, now children were financially dependent on adults; leading to urban parents having larger and more expensive households to support. However, at the same time there was less of a need to rely on having a large number of children as a guarantee that some would survive to adulthood (Coale & Treadway, 1986); and increases in life expectancy potentially meant investments in children would have greater pay-offs in the future (Chisholm et al., 1993; R. J. Quinlan, 2007). This encouraged higher investment per child, pushing some parents to face a quality-quantity trade-off, and is considered to have encouraged parents to choose higher investment in the quality of fewer children – i.e., reduced fertility (Becker, 1960; H. Kaplan, 1996).

The resource dilution hypothesis

This quality-quantity trade-off relates to the resource dilution hypothesis, which suggests that parents have limited resources available to them (including money and food as well as time and energy) that they share across all their children. Following from this, the more children parents have the fewer the resources available for or allocated to each child (Öberg, 2017). This has led to numerous studies investigating the impact of sibling or family size on children's wellbeing. There is a general consensus across this body of work that higher fertility or larger number of siblings leads to worse outcomes for children, measured through children's health, particularly their height (Bras, Kok, & Mandemakers, 2010; Hatton, 2017; Hatton & Martin, 2009; Öberg, 2017; Roberts & Warren, 2017), as well as their educational outcomes (Downey, 1995). A recent study in China testing the resource dilution hypothesis also found similar results (Zhong, 2017). Further, researchers have also found correlations between sibship size and adverse outcomes for adults (Stradford, van Poppel, & Lumey, 2017).

It is thus important to take into consideration factors such as mother's parity, sibship or family size and birth order when studying children's health. This is discussed more in Chapter 7.

Contemporary demographic transitions

However, the demographic transitions occurring in the world today have some novel features that were not present in historical Europe. For example, these contemporary transitions, largely happening in low-income countries have been massively propelled by the availability of modern contraception and government led family planning programmes (not available in historical Europe) which enable (and at times encourage) couples to control and/or reduce their fertility. As touched upon above, the demographic transition coincides with a number of additional transitions. There is a general understanding in the literature that fertility decline, especially in the contemporary world, is interlinked with aspects of economic transitions as well as with cultural diffusion. As such, drivers of fertility and mortality declines include industrialisation, market-integration or urbanisation, better quality of and access to healthcare, increases in education and family planning programmes (Colleran, Jasienska, Nenko, Galbarczyk, & Mace, 2014; Kirk, 1996; Mattison & Sear, 2016). From an economic perspective, larger families are more beneficial in subsistence-farming and agricultural communities as they are huge contributors to household economies and livelihoods – however, economic growth in urbanising areas is not as dependent on having a large family, which can also drive declines in fertility (Sáenz, Embrick, & Rodríguez, 2015). In his hypothesis on influential wealth flows, Caldwell argues that fertility is high when children are contributing to the household economy, but falls as societies become more market-integrated and children become economically costly (J. C. Caldwell, 1978). Thus, economic models of fertility decline relate to motivations for parental investment and quantity-quality trade-offs (for example, see Shenk et al., 2013). From a cultural diffusion perspective, fertility preferences can be transmitted between individuals, through mediums such as education, social media, migration, and access to healthcare clinics (Colleran, 2016; Kirk, 1996; Knodel & van de Walle, 1979). While, from an evolutionary demography perspective, it is common to focus on ultimate explanations for demographic change (e.g., fertility behaviour understood as a product of humans subconsciously maximising their reproductive success); these explanations are complemented and given important context when cultural mechanisms that drive said behaviour are also considered.

Demographic transitions and allomaternal support

The provision of allomaternal support to women is also demographically relevant as it affects some of the causes of the demographic transition i.e., fertility decline and improvements in child survival. For example, a number of studies in natural fertility populations show that receiving allomaternal support is beneficial for women's reproductive success (Gibson & Mace, 2005; Sear &

Mace, 2008; Sear, Mace, & McGregor, 2003; Sear, Steele, Mcgregor, & Mace, 2002; Voland & Beise, 2002). Who mothers receive care from is in turn also affected by the demographic transition and its associated features, e.g., market integration, importance of education, economic costs of children, diffusion of kin networks (Colleran, 2020b; David-Barrett, 2019). These result in changes in family or household demographics, which impact who is available and/or able to provide allomaternal support to women and their children. For example, declining fertility results in smaller family sizes, with fewer older children around to help in the household or provide allocare for their younger siblings (Sear, 2018; Sear & Coall, 2011). There is also noticeably more availability of help from non-kin, such as new friends, in post-transition societies; and more institutionalised care services, e.g., day-care, nurseries, babysitters and schools (Mayall, 2009) which can be purchased from the market or in countries with strong social programmes, financed or subsidised by the government (Emmott & Page, 2019).

In short, allomothering is a central feature of two pillars of demographic research in general and the demographic transition in particular: women's fertility and child survival/mortality. By understanding why childcare patterns vary in different ecological contexts, studies may also have the potential to illuminate certain socio-cultural drivers of the demographic transition. In this thesis, I aim to contribute towards this understanding, by situating this research in two communities undergoing the demographic transition, one rural and one urban (detailed in Chapter 4). In Chapter 6, I specifically explore the influence of urbanisation on who provides allomaternal support to mothers.

2.2 Ecological variation in parental care and allomothering

There is a large body of research on childcare spanning demography, anthropology, HBE, sociology, and other disciplines. I do not review all of this literature, but instead provide an overview of some of the key conclusions reached in past studies and highlight the aspects that are essential to this thesis.

Historically, anthropologists and demographers have emphasized the support of different helpers, with evolutionary anthropologists focusing especially on paternal care, as a behaviour unique to humans compared to other primates (Lovejoy, 2017); and demographers exploring the contribution and economic value of older children in the household and their impact on fertility (J. C. Caldwell, 1978). More recently, this literature has both converged, e.g., anthropologists have investigated the role of children as allomothers from economic and demographic perspectives (Kramer, 2005; R. D. Lee & Kramer, 2002); as well as broadened its scope, with behavioural ecologists beginning to study humans as cooperative breeders who receive care from a wide variety of individuals (Kramer, 2010). Combined, this multi-disciplinary literature illustrates the contextual dependency and flexibility of who mothers receive help from and proposes that there is no single crucial allomother across societies (Apicella & Crittenden, 2015; Hrdy, 2005a; Kramer, 2010; Sear & Coall, 2011; Sear & Mace, 2008; Snopkowski & Sear, 2013, 2015). A second point of note deduced from this literature is the dearth of research on non-kin allomothering, and a strong focus on kin-based support (although there are notable exceptions to this which are elaborated upon in Section 2.2.5). Third, given their considerable role in children's lives, allomothers are naturally expected to have significant influences on children's wellbeing. However, this relationship is specific to ecological context. A review of 45 studies examining the impact of relatives on children's survival suggests that both the identity of the allomother and how their presence/absence affects child mortality is context-dependent i.e. the same allomother can have a positive, negative or null effect on child survival depending on the study (Sear & Mace, 2008). Fourthly, the ecological variation seen in caregiving, as well as in the association between different allomothers and children's outcomes, may partly be due to the different ways in which studies have measured care and child wellbeing (further discussed in Section 2.2.8).

Lastly, the diversity seen in who cares for children may partly be due to need-based care provision. A few studies show that care from kin is often directed towards those most in need of it. For example, in Indonesia, Snopkowski and Sear (2015) find that married grandparents and single grandmothers provided more support to their adult children in circumstances where it was needed more, e.g., when they had grandchildren; practical help in the household when their daughters worked outside the house; and financial help to poorer children (Snopkowski & Sear, 2015). In a study in the USA, the authors also show that childcare support from kin was provided to those mothers who most needed it and that both maternal need and kin-support were responsive to socio-economic changes (Brewster & Padavic, 2002). The authors mention however that the mothers who 'did not need' support made do without it, an observation I disagree with: the idea that mothers 'don't need support' is quite Western/US-centric. As the literature reviewed in this chapter suggests, mothers across various contexts receive support from at least someone – what perhaps changes with socio-economic context is not maternal need but the availability of support. Variation in children's need may also influence which grandchild a grandparent chooses to invest in, especially in large households/families – resulting in competition between close relatives (Borgerhoff Mulder, 2007). Research also shows that allocare responds to parental residence patterns. This could perhaps reflect the parent and/or child's need. In households in Rufiji, Tanzania, support from co-resident non-parent adults can vary by cause of parental absence (Gaydosh, 2019). For example, kin are more willing to provide support if parents are absent due to death as opposed to divorce, migration and non-marital childbearing (Gaydosh, 2019). Gaydosh also emphasizes that when children reside with both parents, each of them is able to draw on childcare support from their respective families, thus calling on a 'wide network of non-resident kin' (Gaydosh, 2019). However, residing with only one parent, or without both, can limit sources of support available to the child's primary carer. Studies have also shown that the provision of care may also be moderated by who else the child receives help from. For instance, fathers may provide more care in the absence of any other allomother; but reduce this care when children reside with or are cared for by others (Meehan, 2005).

In the section below, I summarise anthropological and demographic studies on key childcare providers, including close kin (mothers, fathers, grandparents, siblings, aunts/uncles) as well as distant and non-kin; and briefly describe one other feature of variation in allomothering highlighted in the literature: lineage-based biases. Threaded through this chapter is a discourse on contextual variability in the relationship between allomaternal care and child outcomes. I finally discuss the different ways in which care is measured across studies and why this is important.

2.2.1 Mothers

Maternal care is ubiquitous across studies. Mothers provide huge amounts of care in small-scale societies, including hunter-gatherers and horticulturalists, as well as larger populations. Kramer (2010) finds mothers provide at least half of the direct care children need. Further, in their review, Sear and Mace (2008) show that infant survival is strongly correlated with mother's survival. Maternal death was clearly correlated with lower child survival in all 28 populations in this review in which the relationship between maternal and child death was examined (Sear & Mace, 2008). Thus, mothers are considered to be essential to children's care provision and their health. Another point of interest that Sear and Mace note is that the effect of maternal death on child survival reduces with the child's age. That is, children are more susceptible to their mothers' death when they are very young and perhaps extremely dependent on maternal investment; at ages where allomothers can step in for mothers, the effect is not as strong. Other studies have shown that maternal caregiving reduces with children's age too (Crittenden & Marlowe, 2008; Helfrecht, Roulette, Lane, Sintayehu, & Meehan, 2020; Meehan, Helfrecht, & Quinlan, 2014).

In Chapter 5 of this thesis, I examine whether maternal care is sex-biased; and in Chapter 7 I explore whether maternal residence impacts children's health and the allocare they receive. However, aside from this, the majority of this thesis focuses on the role of fathers and other allomothers.

2.2.2 Fathers

From an evolutionary perspective, fathers are expected to allocate reproductive effort to provision/care for their children as they gain direct fitness benefits (i.e. parenting effort model) as well as maintain mating access (H. Kaplan, 1996; Winking, 2006). Thus, children with fathers are hypothesized to do better than those without. However, differences in paternal care may be predicted due to paternity uncertainty, i.e., while mothers are confident of their 50% biological contribution to their child, fathers may not be equally sure. This uncertainty may influence fathers' decisions or motivation to care for a child as the investment may be misdirected (Kleiman & Malcolm, 1981). However, among humans, paternity is only one out of a complex set of factors that influences if and how much care fathers will provide (Prall & Scelza, 2020). Once considered high, evidence points to low levels of paternity uncertainty among humans (Anderson, Kaplan, & Lancaster, 2007), especially in western countries where extra-pair paternity (having children with different women) is also low (Anderson, 2006). However, there are non-western exceptions, for example, the Himba pastoralists, who have high levels of paternity uncertainty. The Himba have strong norms of 'social' fatherhood, and men are expected to make equal investments in both biological and non-biological children (Prall & Scelza, 2020).

The anthropological literature does show wide cultural variation in paternal childrearing practices (Gray & Anderson, 2010; BS Hewlett, 1992; Lancy, 2015). As Sarah Hrdy puts it, *"human males may nurture young a little, a lot or not at all"* (Hrdy, 2011, page 162). Evidence from several different ecological contexts – including foraging, farming and urban-industrialist populations - suggests that men invest in their children both through resource provisioning and direct care (Chagnon, Hewlett, Lamb, Leyendecker, & Schölmerich, 2000). For example, Flinn (1992) finds that fathers in a Caribbean village contribute to activities such as holding, feeding, playing, cleaning, teaching, changing diapers, as well as babysitting in general for young children. They also contribute resources such as money and food; and aid older children in social, political and economic matters (Flinn, 1992). Investment in the form of resources and direct caregiving from fathers is also seen among the Tsimane in Bolivia (Winking, 2005, 2006; Winking, Gurven, Kaplan, & Stieglitz, 2009) and Mayangna/Miskito horticulturalists of Nicaragua (Winking & Koster, 2015). Children also receive considerable amounts of care from their fathers among the Martu Aborigines in Australia (Scelza, 2010); the Aka Pygmy hunter-gatherers in Central Africa (BS Hewlett, 1991); Bondongo fisher-farmers of the Republic of the Congo (Boyette, Lew-Levy, & Gettler, 2018); as well as in Bangalore, India (Shenk & Scelza, 2012); among others. In most hunter-gatherer societies, men also provide significant economic contributions to the family (Kramer, 2010), although these contributions vary by population (Fouts, 2008; Griffin & Griffin, 2017; R. J. Quinlan & Quinlan, 2008). There is also evidence of variation in paternal investment by the status of the father's relationship with the child's mother or by paternal residence, with research showing that some non-resident fathers also provide support to their children. For example, research from South Africa indicates that about one third of non-resident fathers help with children's caregiving or finances (Clark, Cotton, & Marteleto, 2015; Madhavan, 2010; Richter & Morrell, 2006).

Paternal care has also been discussed as key for the survival of children and mothers (H. S. Kaplan et al., 2000). However, being completely dependent on fathers/partners for caregiving may also be a risky strategy (Hrdy, 2008), leading women to rely on a variety of different supporters. In their review on the impact of kin presence on child survival in high fertility high mortality settings, Sear and Mace (2008) conclude that fathers often have *"surprisingly little impact on child survival"* (Sear and Mace, 2008, p.1), and that investment from fathers is frequently, although not always, replaceable by care from other individuals, so that, at least in terms of early life mortality, children growing up without fathers are often indistinguishable from those who grow up with fathers. They find no relationship between father presence and child survival in 53% of studies (8 of 15 studies).

Paternal care may also be provided in specific ways or during specific periods of a child's life; and these aspects may be missed by researchers if they are not within the scopes of a particular study (e.g., work focusing on investment in children under age 5-years, like this thesis or many other studies on parental investment, may not capture investments towards children's education). Observational studies are usually focused on high investment care such as carrying children, and may deduce lack of investment from fathers if paternal care comprises low investment activities such as supervision (Page, 2016). Fathers may also contribute more to older children than infants e.g. through investing in children's education and/or weddings, or engaging in tasks like playing with or teaching children (Scelza, 2009; Sear, 2011; Sear & Mace, 2008). Another reason paternal care may not always be associated with child outcomes is that other, unrelated men step in to fill the 'fathering' role. For example, among the Ache, Hill et al show that help is often received from non-paternal adult men, as it is a partible paternity society where several men support and feed children (Hill & Hurtado, 1996, 2009). This is also reflected in Prall and Scelza's work discussed above, which shows that Himba women often have extra-pair children but social norms encourage women's partners to invest in children who might not be biologically their own (Prall & Scelza, 2020).

To quote David Lancy, *"Of all the cast of characters in this melodrama, the role of father is the most subject to creative script variation"* (Lancy, 2015, page 144). Care from fathers indeed appears to be very variable and context-dependent, suggesting a need for an in-depth focus on fathers' involvement in childcare to fully understand their role in specific environments.

2.2.3 Grandparents

Grandparents, especially grandmothers, have garnered a huge amount of attention as allomothers, and are expected to be beneficial for children's health and women's fertility. The survival of women far beyond their reproductive years, compared to many other species, is debated as resulting from the importance of the support provided by older women to their children and grandchildren; and the association of this support to women's ability to bear multiple children (Hawkes et al., 1997; Hrdy, 2005a). Grandparents tend to provide both financial and practical support for their grandchildren regardless of whether the children's parents are alive or not, and whether or not they co-reside with the child (Gibson & Mace, 2005; Karimli, Ssewamala, & Ismayilova, 2012; Madhavan, 2010; Parker & Short, 2009; Sear et al., 2002; Strassmann & Garrard, 2011). Indeed, a large body of interdisciplinary literature emphasizes grandmothers, especially maternal ones, as one of the most important caretakers of their grandchildren's wellbeing (Adams, Madhavan, & Simon, 2002; Cunningham, Elo, Herbst, & Hosegood, 2010; Gibson & Mace, 2005; Karimli et al., 2012; Madhavan, 2010; Sear & Mace, 2008; Sear et al., 2002;

Strassmann & Garrard, 2011). Grandmothers help in a variety of ways, including assistance when children are weaned (Cassidy, 1980), help with tasks that reduce maternal energy loads (Gibson & Mace, 2005; Meehan, Quinlan, & Malcom, 2013), and taking care of orphans both practically and financially (Karimli et al., 2012; Nyambedha, Wandibba, & Aagaard-Hansen, 2003). In some cases, they also provide more childcare support than fathers (Ivey, 2000; Scelza, 2009). Studies exploring effects of grandmaternal presence and care on child outcomes also show that they have positive effects on children's survival (Sear & Mace, 2008) and health (Gibson & Mace, 2005; Sear, Mace, & McGregor, 2000; Sear et al., 2002). Grandmothers are important even in the absence of mothers: a study in Lesotho shows that children whose mothers had died, and were residing with grandmothers, had the same likelihood of school enrolment as children living with their mothers (Parker & Short, 2009). The authors found living with grandmothers to also be beneficial for children who had alive but non-resident mothers.

Much like fathers however, grandparental assistance can be dependent on the woman or child's needs, and thus vary by socio-economic status (Snopkowski & Sear, 2015), children's ages (Meehan et al., 2014), or the availability of other carers (Meehan et al., 2014). As such, the role of grandmothers may be underestimated in studies with small sample sizes (usually 10-30 infants in observational studies), especially when the likelihood of having a living grandmother is also not very high. A few studies have also found negative associations between grandmothers and child survival/health (Beise & Voland, 2002; Sear, 2008; Sear & Mace, 2008). This tends to depend on lineage, with paternal grandmothers having detrimental effects on children's survival more than maternal grandmothers – although negative associations between maternal grandparents and children's survival have also been documented. This is discussed in more detail in Section 2.2.6. Additionally, in some hunter-gatherer and subsistence farming populations grandmothers are seen to provide very little direct care or provisioning (Crittenden & Marlowe, 2008; Hill & Hurtado, 2009; Kramer, 2005; Page et al., 2020). Grandfathers are rarely found to either invest highly in children or to matter very much for their outcomes. In 83% (n=12) of the studies reviewed by Sear and Mace (2008) maternal grandfathers' presence was not associated with children's survival at all, whereas paternal grandfathers had no effect in 50% (n=12) of the studies. For the remainder of the studies, maternal grandfathers had positive effects in both, whereas paternal grandfathers had a positive effect in three and a negative effect in three. Yet many of the effects seen were only borderline statistically significant. This suggests that grandfathers are perhaps less important, or provide less actual childcare than grandmothers, despite being present. A recent review of 205 studies from low- and high-resource contexts, on custodial (grandparents as primary caregivers) and multi-generational (children cared for by parents and grandparents) grandparental care, also finds extremely mixed results in the relationship between grandparental care and their grandchildren's health and development (Sadruddin et al., 2019). The authors attribute these mixed results to limits in the way that grandparental involvement in their grandchildren's lives is operationalised (which they find to be quite diverse); and a lack of attention to context-specific details that may moderate relationships between care provision and child outcomes.

Overall, in this thesis, I expect grandparents to be helpful allomothers. In Chapter 5, I touch upon whether grandparental care is sex-biased; in Chapter 6, I explore whether the care they provide varies by the child's residence, both urban versus rural, as well as by paternal co-residence; and in Chapter 7, I investigate whether the care provided by grandparents is indeed beneficial for children's health, both in the presence and absence of mothers.

2.2.4 Siblings

Help from older children is recorded in many societies. Older siblings often assume the role of 'helpers in the nest' who support mothers in general household tasks as well as with childcare (Barry Hewlett et al., 1996; Kramer & Veile, 2018; Sear & Coall, 2011; Sear & Mace, 2008; Turke, 1988). Mothers also receive considerable help from their own older offspring with raising younger ones (Meehan et al., 2013). This is particularly common in high fertility populations where children tend to have a number of siblings (Kramer & Veile, 2018). For example, mothers among the Gussi of Western Kenya allocate allomothering responsibilities to elder siblings such as carrying, feeding and looking after younger siblings (Barry Hewlett et al., 1996). Children also help in the household by contributing to economic activities. This is especially the case in households that rely on farming as their livelihood. In fact, children contribute more time to economically productive activities compared to caregiving across subsistence farming populations (Kramer, 2012). These tasks can also vary by children's ages: Mayan children help more with childcare activities when they are younger, with older children helping more with other work (Kramer, 2012); and their sex: in rural Tanzania, boys help with herding work in farming households while girls contribute more to domestic chores (Hedges, Sear, Todd, Urassa, & Lawson, 2018). Juvenile siblings investing energy in caring for each other is 'sensible', in inclusive fitness terms, as they are highly related – the same amount, in fact, that they would be to any future offspring (50%) – and so stand to gain considerable fitness benefits without suffering any direct reproductive costs (Hamilton, 1964; Kramer, 2011).

Sibling care is also subject to ecological variation, and overall, findings are mixed regarding the impact of care from older children on younger children's health (Kramer, 2010). Sear and Mace (2008) primarily found that siblings had a positive impact on children's survival in the majority of studies reviewed (5 out of 6). In the Gambia, the presence of older sisters was also associated with improved survival and anthropometric status of younger children (Sear & Mace, 2009; Sear et al., 2002). On the other hand, a couple of studies have documented negative relationships between number of older/younger siblings and children's nutritional status (Hagen & Barrett, 2009; Magvanjav et al., 2013). This may be because siblings often compete with each other for their parents' investment and resources, especially in households with limited resources and a large number of children (Alam, 1995; Lawson, Alvergne, & Gibson, 2012); and the effect of siblings on child and maternal outcomes is also predicted to be mediated by their birth order (Kramer, 2010).

Sibling care is examined in this thesis along the same lines as grandparental care described above. It is however expected to be more susceptible to the demographic and urban transitions, and the ecological variability in my study sample regarding these factors, due to the increased pressure of education in market-integrated communities.

2.2.5 Distant kin and non-kin

Mothers are quite flexible in who they receive care from, and their support networks often include extended/distant kin and non-kin. This diversity of sources from whom care is received is a feature of the cooperative breeding system (Carter, 2005; Hawkes & Finlay, 2018; Hawkes et al., 1997, 1998; Hrdy, 2005a, 2011) and as such I have mentioned earlier why care from non-kin may be reasonable from an evolutionary perspective. In fact, it is also not surprising from a more proximate point of view: women around the world often reside in communities with a large number of unrelated individuals; and may thus need to seek support from a variety of different individuals over their lifetime (Kramer, 2010).

Studies show extended kin, such as children's aunts and uncles also provide occasional help to mothers (Borgerhoff Mulder, 2007; Gaulin, McBurney, & Brakeman-Wartell, 1997; McBurney, Simon, Gaulin, & Geliebter, 2002; Sear & Mace, 2008; Weinreb, 2002). Aunts and uncles play important roles in children's development too: maternal uncles often foster their nieces and nephews in West Africa (Isiugo-Abanihe, 1985); and in Malawi, both parents' siblings have been documented to provide considerable financial support to children (Weinreb, 2002). Support from aunts/uncles is perhaps expected as they are equally related to a focal child as the child's grandparents (25%). However, from a fitness perspective, the difference between aunts/uncles and grandparents is that aunts/uncles are much more likely to have their own children to care for at the same time as potentially caring for nieces and nephews. Ivey (2000), for example, showed that while Efe children were commonly cared for by allomothers, these allomothers were usually not women who also had nursing infants. Sear and Mace (2008) find very mixed relationships between aunt/uncle care and children's survival in their review, including negative, null and positive effects. Studies have also recorded help from cousins (Jeon & Buss, 2007; Stewart-Williams, 2007); and support from affinal kin (i.e. relatives through marriage) is noted to be especially important in

African kinship systems in instances when there is conflict within a lineage or nuclear family (Borgerhoff Mulder, 2007; Kasper & Borgerhoff-Mulder, 2015; Radcliffe-Brown & Forde, 1950).

The role of non-kin has not been studied very extensively in the evolutionary, demographic and anthropological literature, as there is a strong focus on studying kin allocare, especially siblings, grandmothers and fathers (Apicella & Crittenden, 2015; Apicella, Marlowe, Fowler, & Christakis, 2012). Yet, non-relatives do provide allomaternal support in many hunter-gatherer populations such as the Hadza of Tanzania (Crittenden & Marlowe, 2008); the Aka foragers in Central Africa (Meehan, 2009); the Agta in the Philippines (Page et al., 2020); and the Ngandu farmers of the Central African Republic (Meehan, 2008) among others (Blurton Jones, Hawkes, & O'Connell, 2005; Bogin et al., 2014; Crittenden & Marlowe, 2008; Hrdy, 2005b, 2011; Meehan, 2008; Meehan & Hawks, 2014; Meehan, Helfrecht, & Malcom, 2016; Meehan et al., 2013); as well as rural farming communities e.g. the Beng ethnic minority in Cote de Ivoire (Gottlieb, 2009), and contemporary high-income settings such as the UK (Emmott & Mace, 2014). Among the Efe hunter-gatherers in the Democratic Republic of Congo, women also receive childcare support from their friends in exchange for providing either childcare or other forms of support in return (Ivey, 2000). The importance of reciprocal support between non-kin is also a driver of food sharing and recorded in a number of studies on this topic (Gurven, 2004; Jaeggi & Gurven, 2013; Kasper & Borgerhoff-Mulder, 2015; Page, 2016). Further, the use of kin-selection as an explanation for kin-based support may be overplayed as it is frequently untested: many studies solely focus on kin-based allocare, without collecting data on or exploring the role of non-kin. One study, among the Pimbwe in Tanzania, shows that children's survival to age 5-years is positively correlated to the presence of non-kin in a mothers social network, albeit in a circumstance where the absence of kin from the village is also positively associated with child survival (Borgerhoff-Mulder & Beheim, 2011). In a recent paper, Page et al (2020) find that Agta children receive allomaternal care from their playgroups, another component of non-kin allomothering, but one that has not received much attention in previous literature. Further, another study among the Agta foragers in the Philippines demonstrates that non-kin benefit from providing allomaternal care by receiving childcare support in return for their help (Page, Thomas, et al., 2019).

Non-kin childcare support can also include that which is purchased from the market i.e. as an exchange for economic incentives (Paull, 2009; Sear & Coall, 2011); and usually in post-industrial societies with social support programmes, paid for or subsidised by the government, or provided through formal education systems (Fiori, 2011; Hank & Kreyenfeld, 2003; Mayall, 2009; Sear & Coall, 2011). I do not distinguish between institutional and personal non-kin in this study, but from observations during fieldwork I largely expect non-kin to comprise of women's friends and neighbours (this is described in more detail in Chapter 4.3.2).

I explore the role of distant kin and non-kin in Chapters 6 and 7. I first explore whether the demographic and urban transitions underway in the two communities studied lead to a diffusion in kin networks, reflected in women receiving more support from distant/non-kin in the urban community compared to the rural one (Chapter 6). Following this, in Chapter 7, I investigate the effect of receiving care from non-kin on children's health.

2.2.6 Lineage based differences

Allomaternal caregiving roles can also vary depending on the family's lineage system or by the carer's relationship to the child - and the most commonly studied distinction is that between maternal and paternal grandparents. In most studies, in low and high-income contexts, maternal relatives, especially grandparents, are found to invest more in their grandchildren than paternal grandparents, even in patrilocal societies. For example, this has been recorded in Britain (Pollet, Nelissen, & Nettle, 2009); historical Germany (Voland & Beise, 2002); and rural Gambia (Sear & Mace, 2008; Sear et al., 2000). Maternal grandparents are also more likely to be beneficial for children's survival than paternal grandparents. Sear and Mace (2008) found maternal grandmothers to have a positive effect on children's survival in 69% of studies in their review, compared to 53% for paternal grandmothers. However, records show that both maternal and paternal grandmothers can also have negative impacts on child outcomes. In a matrilineal society in Malawi, maternal grandmothers and aunts were associated with lower child survival (Sear, 2008); whereas paternal grandmothers were in historical Germany (Beise & Voland, 2002); and in one case, paternal kin were more important in wealthier households, whereas maternal relatives protected children from the adverse effects of living in poorer circumstances (Borgerhoff Mulder, 2007). In their review, Sear and Mace (2008) show that depending on the context of the study, sometimes maternal grandmothers were detrimental for children's survival and at times paternal grandmothers were. This begs the question, why do maternal and paternal kin have differential impacts in different settings? One answer is competition for resources between older and younger individuals in a household; that is, if the elderly consume a large part of the limited resources a household has, without making any contributions, this may deprive younger children of necessary nutrition and have detrimental impacts on their health (Strassmann, 2011). Given that most existing human societies are patrilineal and patrilocal, paternal grandparents are more likely to be in resource competition with children than maternal ones, explaining why positive associations between paternal grandparents and child outcomes are less common. Relatedly, this can help explain why maternal kin were associated with lower child survival in the matrilineal population in Malawi, but paternal grandmothers were not (Sear, 2008). Another explanation is, due to paternity uncertainty, paternal grandparents may be less inclined to invest in the health of a grandchild they are not sure is their own (Danielsbacka, Tanskanen, Jokela, & Rotkirch, 2011; Kleiman & Malcolm, 1981). Thirdly, paternal grandparents may be more disposed towards increasing their reproductive success by investing more in their son's fertility than their grandchild's 'quality' (or health/wellbeing). Paternal grandparents have been noted to affect women's fertility more than maternal kin do (Sear & Coall, 2011; Sear et al., 2003; Snopkowski & Sear, 2013).

Two studies suggest patrilateral biases in childcare, behaviour that the authors ascribe to patrilineal norms of inheritance and land transfer (King & Elder, 1995; King, Silverstein, Elder, Bengtson, & Conger, 2003; Pashos & Mcburney, 2008). In a study in rural USA, children were in more contact with their paternal grandmothers than their maternal grandmothers (King & Elder, 1995). However, Perry and Daly (2017) point out, while this study is frequently cited as an example of patrilineal bias, in fact children rated support from, and their relationships with, maternal grandmothers higher than paternal grandmothers. In the second study, in Greece, the authors indicate that rural respondents reported having received more care from paternal grandmothers when they were children, while urban respondents received more from maternal grandmothers and that paternal grandparents provided more care than maternal ones (Pashos, 2017). Perry and Daly (2017) do not concur on this result either: Pashos' finding was based on a measure of distance between the grandparent and grandchildren's households which is critiqued by Perry and Daly as 'too crude' to justify the conclusion that paternal grandparents invest more than maternal ones. This further suggests evidence for a matrilateral bias in child caregiving.

Overall, this literature suggests that maternal kin should be more important in protecting children's health, or buffering them from adverse life events, compared to paternal kin, especially in patrilineal societies. I explore this question in Chapter 7 of this thesis.

2.2.8 Measuring care

The variation documented in the support received by women, and its impact on both maternal (e.g., fertility) and child (e.g., survival) indicators, can also be attributed to differences in how support is measured. For example, it is common in much of the existing literature on allomothering to use proxy measures for care provision or investment, which can lead to unclear mechanisms and causality between allomaternal support and the outcome of interest. These proxy indicators include the presence or absence of family members in the household (review of studies examining kin absence/presence and child mortality in Sear and Mace, 2008; Sear and Coall, 2011); length of time spent by the woman with either her own or her husband's parents after marriage (Snopkowski & Sear, 2013); contact with the child's grandparents

(Sheppard & Sear, 2016); or even proximity to kin (Hank & Kreyenfeld, 2003; Schaffnit & Sear, 2014; Thomese & Liefbroer, 2013). These measures of presence, co-residence, or proximity do not necessarily mean that children are receiving allomaternal support from the specified individuals; and even if they do, the amount of care being received can be quite variable (Kramer & Veile, 2018). This stresses the importance of data that measure caregiving behaviour to fully understand the impact of allomothering on maternal and child outcomes. While often lacking in-depth measures of 'caregiving' however, these data do have one strength: they are usually collected through large-scale surveys, which are valuable as they can sample large numbers of women and children. On the other hand, studies in small-scale societies have the benefit of utilising techniques such as observations and focal follows which allow researchers to collect in-depth and detailed data on childcare (Crittenden & Marlowe, 2008; Meehan, Hagen, & Hewlett, 2016; Page, Myers, Dyble, & Migliano, 2019). However, these studies tend to have very small sample sizes (on average 10-30 children); and are mostly focused on young infants under 3 years old (Page, 2016).

There are a few exceptions of studies that have utilised direct (non-proxy) measures of support, for example, the role of financial help and childcare support in influencing fertility intentions (Mathews & Sear, 2013; Waynforth, 2012) and child wellbeing (Sheppard and Sear, 2016); work on the importance of grandmothers and fathers in ensuring child wellbeing that measure childcare activities (for review see Aubel, 2010, 2012); and studies on children's nutrition and development (Gladstone et al., 2018). The recent review by Sadruddin et al (2019) collates 205 different studies on grandparental care from very different contexts around the world. The authors highlight the wide variation in indicators used to measure grandparents' involvement and categorise these into (1) contact with grandchildren (co-residence, frequency of visits); (2) caregiving behaviours (participating in child-rearing); and (3) financial support or resource provision. Yet, despite the individual strengths of each of these studies, they either focus on outcomes that are not child health (i.e. fertility); examine a limited number of carers, particularly grandparents and fathers

(Aubel, 2010, 2012; Sadruddin et al., 2019); and measure indirect forms of care such as financial support and advice (Sheppard & Sear, 2016); or specific types of care e.g. feeding practices or playing (Gladstone et al., 2018).

Different allomothers may also provide care in different ways or forms to each other, which in turn can impact child outcomes variably too. Concurrent to the mother's needs, some allocarers may assist through provisioning i.e. transferring resources, money etc. and others through caregiving i.e. transferring energy and time (Emmott & Page, 2019). For example, older adults may provide care differently to children's siblings who, in comparison, are much younger and may lack experience or be less effective in the help they provide. Transfers may be made to the child directly, e.g., allomothers help with tasks including supervising, washing or feeding children (see Chapters 5-7); or indirectly through another individual, e.g., in Ethiopia, grandmothers help reduce the burden of housework so mothers can invest their energy in childcare (Gibson & Mace, 2005). Both high investment (e.g. carrying a child) and low investment (e.g., passively supervising a child) caregiving activities are important as they can equally help relieve maternal workload, allowing mothers to invest their saved energy elsewhere (Emmott & Page, 2019). It is thus important to measure a variety of activities to capture a full picture of a child's caregiving environment.

2.3 Beyond anthropology & demography: wider perspectives on childcare

Much of the literature discussed above pertains to studies conducted in the demographic and anthropological sciences, with a focus on evolutionary and economic understandings of childcare. However, research on the role of care has also been receiving increasing attention in the child development and health arenas. In particular, this body of research focuses on children's (mal)nutrition and feeding practices. Especially in the agricultural sciences, child malnutrition was commonly associated with issues of food insecurity, lack of access to primary health care and children's illnesses (Engle, Bentley, & Pelto, 2000). About two decades ago, researchers widened their focus to the social determinants of children's health as well, when malnutrition was commonly recorded even among children in food secure households that had access to healthcare (Arimond & Ruel, 2003; Deutsch, Lussier, & Servis, 1993; Engle et al., 2000). Since then, the role of care in children's nutritional outcomes has been frequently studied by development agencies and nutritionists; with children's caregiving environment, along with healthcare and food security, considered vital for their successful growth and development (Christiaensen & Alderman, 2004; Engle et al., 2000). In nutrition studies, 'care' is used to describe the behaviours of individuals who are responsible for the child's healthy growth and development, e.g., providing food, healthcare and emotional and mental support (Engle, 1992). The prime focus of these studies is exploring the importance of caregiver behaviours and attitudes during the feeding of complementary foods to children, usually between the ages of 6 months and 2 years.

Children in low-income countries are most at risk of issues like malnutrition, illness and disease, poverty and healthcare access, as well as fewer opportunities of cognitive stimulation (Black et al., 2017). Research also shows that programmes or interventions in low-income countries that promote child feeding practices and education for caregivers have positive outcomes for children's food intake, as well as physical and cognitive development (Abebe, Haki, & Baye, 2017; Vazir et al., 2013). Similarly, interventions on cognitive stimulation, communication, and nurturing care environments have positive outcomes for children (Boivin et al., 2013; Richter et al., 2017; Yousafzai & Aboud, 2014). International organisations, such as the World Health Organisation (WHO), the United Nations Children's Fund (UNICEF), and the World Bank, are incorporating such interventions into existing health sector programmes (WHO & UNICEF, 2012; WHO, UNICEF, & The World Bank, 2018). For example, one module developed is 'Care for Child Development' which promotes playing to improve children's stimulation, enhancing the quality of interactions and communication between caregivers and children, and responsive feeding activities such as breastfeeding and providing complementary foods (WHO et al., 2018). These activities are encouraged not only for the mother but other caregivers too. However, not many of the studies published or the development programmes underway have emphasized whether they are context-relevant and culturally or socio-economically appropriate to the settings they are conducted in (Gladstone et al., 2018). As I have discussed in earlier sections of this chapter, there is substantial evidence from anthropological studies that children's caregiving environments can be very context dependent. Gladstone et al (2018) also highlight this and critique international organisations for not clarifying whether the interventions or programmes they are implementing take into account ecological differences in childcare practices (Barry Hewlett et al., 1996; Lancy, 2010). However, there is little research on how to successfully integrate these programmes into existing care practices, especially in sub-Saharan Africa; and understanding local barriers to childcare will make each programme more effective in its social and cultural setting (Gladstone et al., 2018; Lingam et al., 2014). The importance of specific caregivers (/allomothers) has also been highlighted in this literature. In particular, there is a strong focus on the role of both maternal and paternal grandmothers (Aubel, 2012; Bezner Kerr, Dakishoni, Shumba, Msachi, & Chirwa, 2008; Kerr & Chirwa, 2004) as well as fathers in children's feeding practices and thus nutritional outcomes (Aubel, 2010).

While I have not attempted to review or summarise the entirety of the nutrition literature on childcare, I refer to it to emphasize the importance of children's caregiving environment and how this is understood as a proximate determinant of children's wellbeing. An in-depth understanding of caregiving behaviours in specific contexts may thus also be useful for researchers in disciplines outside of anthropology and demography, especially considering that the role of care provided to children is now frequently incorporated into nutrition interventions in low-income countries.

2.4 Summary and predictions

In short, a large body of empirical evidence supports the viewpoint that humans are cooperative breeders. There is also a lot of evidence of variation in who provides care, ranging from parents to unrelated individuals. The care provided can also vary by child-level features such as the child's sex; structural factors like the dissolution of women's kin networks and geographic (un)availability of certain allomothers; and family-level characteristics such as lineage-systems. Who provides care to children, in turn, can impact their health outcomes. Following from this, I test the following predictions in this dissertation:

1. Parental investment theory in specific hypothesizes that parents will invest in children who have better chances of reproductive success, and this can lead to sex-biased parental investment. In rural Tanzania, fertility is high and polygynous marriage common, indicating both higher variation in male than female reproductive success and more opportunities for men to translate invested resources into reproductive success. Considerable value is also placed on men in many Tanzanian communities, visible in patrilineal systems of marriage and wealth inheritance. As such, in Chapter 5, I test whether sons have a higher likelihood of receiving care from their parents compared to daughters.

2. Factors associated with urbanisation and market-integration can lead to a dissolution of women's kin networks, particularly due to a shift from agricultural to wage-based labour, leading to an increased reliance on non-kin for support. However, there is little research exploring the reasons behind the variation in source of allomothering that is commonly observed. In Chapter 6, I test whether children living in an urban neighbourhood (i.e., the town) have lower odds of receiving care from their relatives and higher odds of receiving care from non-kin, compared to children living rurally (i.e., in the village).

3. Previous large-scale studies on allomaternal care and child outcomes have often used proxy indicators (e.g., absence/presence in the household, co-residence, residential proximity) as measures of care, instead of measuring care provision itself, and rarely explore the role of non-kin in children's health. In Chapter 7, using more nuanced indicators of care from a number of different categories of allomothers, including kin and non-kin, I investigate whether receiving care is beneficial for children's health.

3. Study context: Tanzania

In this chapter, I give a brief introduction to the setting of this thesis, Tanzania, and discuss aspects of the demographic and urban transitions relevant to this context. I then give an overview of the state of children's health and malnutrition and children's caregiving environments in the country.

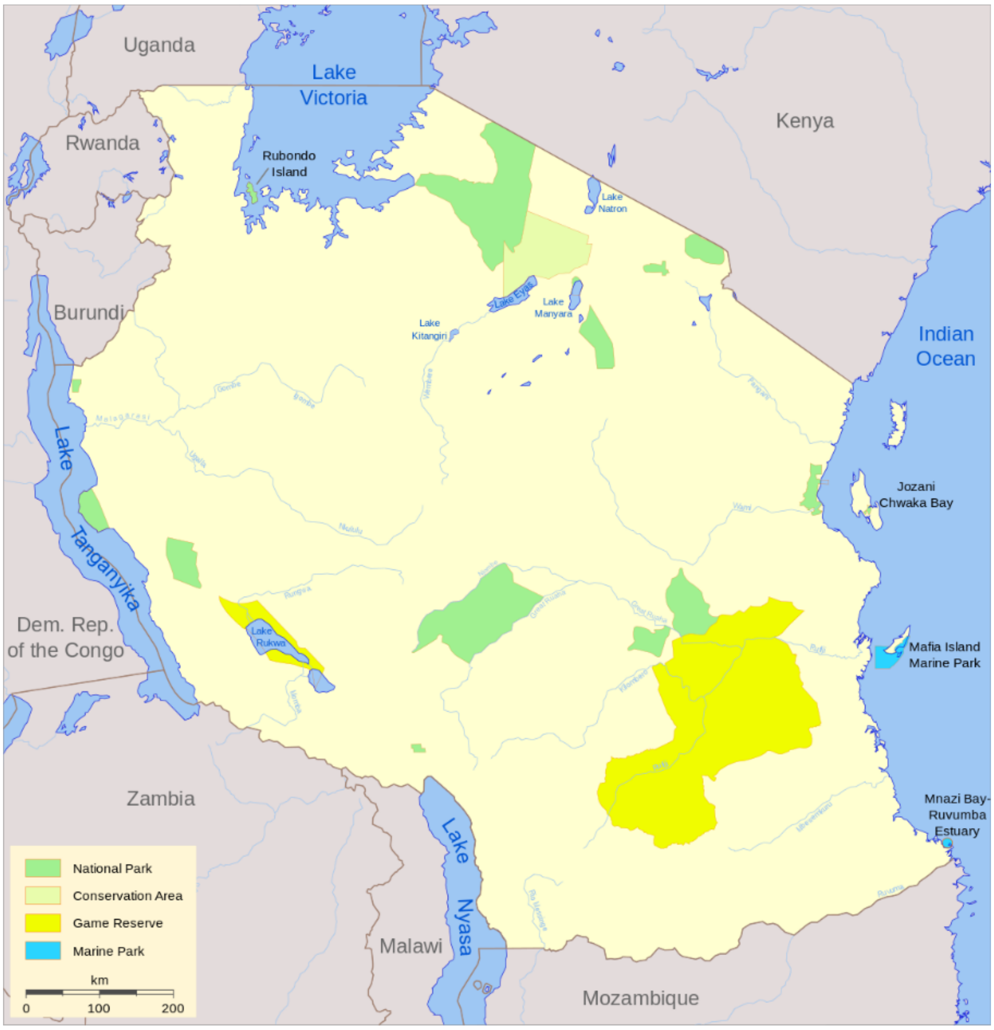

Figure 3.1 Figure 3.1 Map of Tanzania
Courtesy: Bamse, CC BY-SA 3.0, via Wikimedia Commons

3.1 An introduction

The United Republic of Tanzania was formed in 1964. Prior to this, mainland Tanzania, 'Tanganyika', and the Zanzibar Archipelago, had been governed separately (CIA, 2020). The British gained control of Tanganyika in 1922 as part of the League of Nations Mandate after World War 1, while Zanzibar had been a British 'protectorate' from 1890. In 1961, Tanganyika gained independence from British rule, and in 1963, the British terminated their protectorate over Zanzibar. Shortly after this, the two merged in 1964 to form the United Republic of Tanzania. Tanzania is bordered by eight countries, Kenya and Uganda on the north, Rwanda, Burundi and the Democratic Republic of the Congo (the DRC) to the west, Zambia, Mozambique and Malawi to the south. To its east lies the Indian Ocean, with the Zanzibar Archipelago not far offshore. It is home to Mount Kilimanjaro, the highest mountain in Africa; and three of Africa's Great Lakes are partly within Tanzania. Lake Tanganyika borders with the DRC, Burundi and Zambia; Lake Malawi with Malawi and Mozambique; and Lake Victoria with Uganda and Kenya. On the shores of Lake Victoria lies Mwanza city, where I was based for the duration of my PhD fieldwork in Tanzania.

Tanzania is a presidential constitutional republic, with John Magafuli the president at the time this thesis was written. While the city's capital lies in Dodoma, where the president's office and government ministries are also located, the largest, most populated and most metropolitan city in the country (and former capital) is Dar es Salaam. Dar es Salaam is also the country's main port city and its commercial centre.

The majority of the Tanzanian population prescribe to Christianity, but there are minority Muslim groups as well as those with traditional religious beliefs. Over one hundred different languages are spoken in the country (Ammon, Dittmar, & Mattheier, 1984), and there are numerous different ethnic groups. Swahili is however the national language, used in parliamentary debate and the medium of instruction in primary schools. As is common in many countries that were previously colonised by the British, English is also widely spoken and is the language of instruction in secondary schools.

3.2 The demographic transition

Tanzania's demographic profile indicates that the country is currently undergoing the demographic transition. The United Nations estimates the country's total population to have grown rapidly in the past few decades, from 18.5 million in 1980 to approximately 58.6 million in 2019 (United Nations, 2019; United Nations Population Division, 2019). This has been accompanied by an increase in the economy from a GDP (in current US$) of $4 billion in 1990 to $63 billion in 2019 (World Bank, 2019). National trends in mortality, fertility and life expectancy are shown in Figure 3.2. Between 1960 and 2018, the mortality rate for children under the age of 5 years dropped from 241 deaths per 1000 children to 52 deaths per 1000 children, and is lower than the average under-5 mortality recorded for East Africa and sub-Saharan Africa (Figure 3.2) The total fertility rate (TFR) has also decreased from an average of 6.8 children per woman in 1960 to 5 children per woman in 2018. Life expectancy at birth during this period (for both sexes combined) increased from 43.6 years to 65 years. As is common in most countries, the life expectancy at birth for women is a few years higher than that for men (Figure 3.2).

However, the demographic transition is not yet complete in Tanzania, as fertility levels remain high. Fertility in Tanzania is in fact higher than the respective average fertility rates for East Africa and sub-Saharan Africa (Figure 3.2). The Tanzanian Demographic and Health Survey 2015-16 (TDHS 2015-16) recorded a TFR of 5.2 children per woman; this is a slight decline from the TFR recorded one decade ago in the previous TDHS (2004-05), when the TFR was 5.7 children per woman (MoHCDGEC, MoH, NBS, OCGS, & ICF, 2016). Most recent estimates collated by the World Bank indicate that the overall TFR in Tanzania in 2019 was 4.8 children per woman (The World Bank, 2019; United Nations Population Division, 2019), which is a slight decrease from the TDHS 2015-16 estimates.

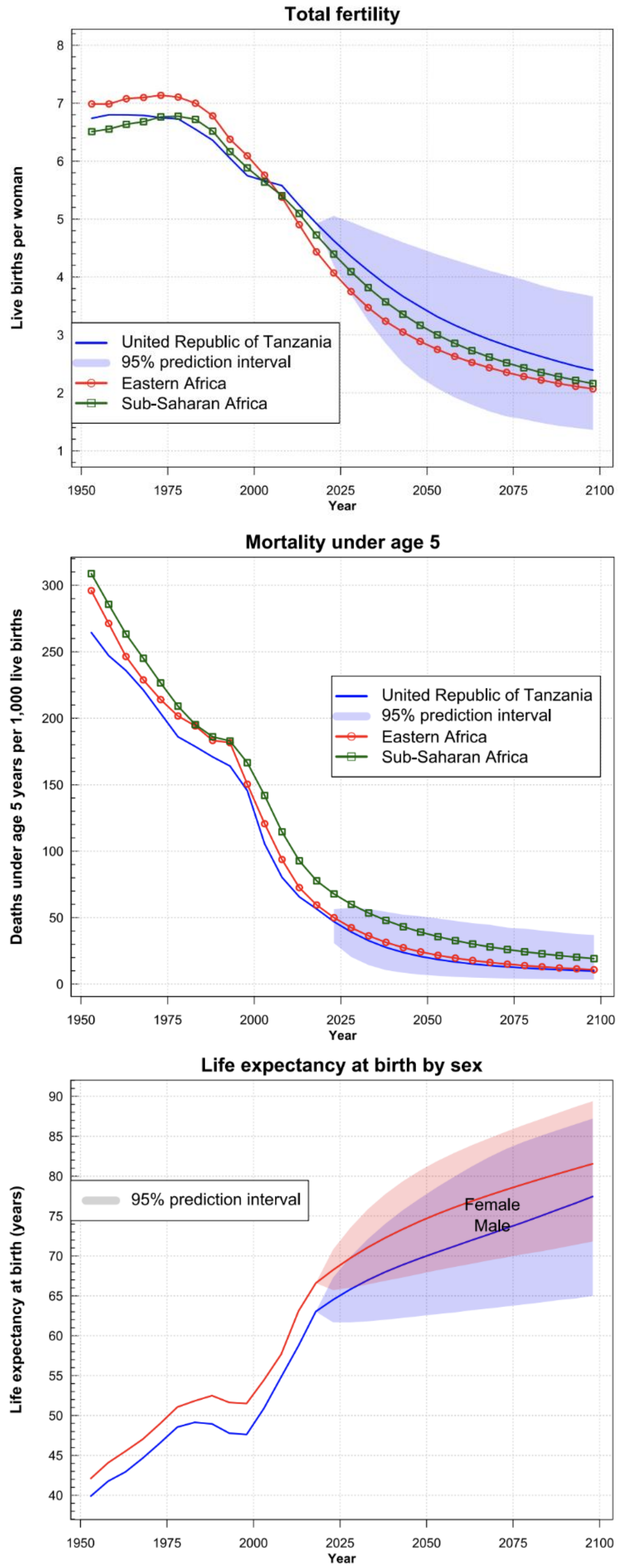

Figure 3.2 Past trends and future projections in total fertility rate (TFR), under-5 mortality, and life expectancy at birth in Tanzania.

Note: *Plot produced by the United Nations Department of Economic and Social Affairs – World Population Prospects 2019: https://population.un.org/wpp/ (United Nations, 2019).*

Fertility rates in Tanzania differ substantially between urban and rural residence, by region, and by women's education and wealth status. The TDHS 2015-16 recorded a TFR of 6 children per woman in rural areas, compared to a relative low of 3.8 children per woman in urban areas. These rural/urban specific TFR may also have decreased slightly since the last round of the DHS, as suggested by the 2019 World Bank estimates for Tanzania.

The TFR in Mwanza Region, where this study was conducted, is also high (6 children per woman). In terms of education, women with no education and those with primary education have the highest TFR (6.9 and 6.2 children per woman respectively); while women with secondary education have a low TFR of 3.6 children per woman. A similar trend is seen when TFR is analysed by wealth quintile (MoHCDGEC et al., 2016).

3.2.1 Trends in urbanisation

The urban transition, usually associated with the demographic transition, is also underway in the country. An analysis of census data indicates that between 1967 and 2002, mainland Tanzania's urban population increased from a low of 5.7 percent to 22.6 percent (Muzzini et al., 2008). However, the majority of the country still remains rural. Evidence shows that, in 2002, an additional 17 percent of the population in mainland Tanzania lived in high-density settlements that were not legally considered 'urban' (i.e., from a politico-administrative perspective) (Muzzini et al., 2008).

In most historical as well as current situations, rural-to-urban migration has been considered the main cause of urbanisation (Dyson, 2011). This is usually because population growth in urban areas is rarely higher than that in rural areas. However, De Vries (1990) and Dyson (2011) propose a 'sector-specific' approach to urbanisation, especially relevant to sub-Saharan Africa, which explains the likelihood of urban growth resulting from a natural increase in urban population (as opposed to rural-to-urban migration) in a society undergoing the demographic transition. This is because in a pre-transition scenario urban areas or towns have very high crude death rates (number of total deaths divided by the total population in a specified period) – at times even higher than the crude birth rates (number of total births divided by the total population in a specified period). In these situations, rural-to-urban migration is vital to sustain the population in an urban area. However, the rapid mortality decline that propels the demographic transition is largely due to reductions in infectious diseases, which tend to be a leading cause of death in densely populated urban areas. Thus, rapid declines in mortality are seen in urban areas leading to natural increases in the urban population (De Vries, 1990; Dyson, 2011). Rural-to-urban migration of course plays a continuous role during the demographic transition, especially when mortality reductions in rural areas lead to increases in rural populations; however, the authors' point is that migration is not absolutely necessary for urban growth during the demographic transition. This process is especially relevant in sub-Saharan Africa, where urbanisation has been occurring without the rapid economic growth that characterised the demographic and urban transitions of historical Europe. These ideas are also supported by what Muzzini et al (2008) show in their analysis of the Tanzanian census data. They find that some urban areas in mainland Tanzania have poverty rates that are much higher than their rural neighbours; and that migration only contributes to approximately 17 percent of urban population growth, with 83 percent of urbanisation occurring in the mainland due to natural growth or re-classification of areas from 'rural' to 'urban'. This suggests that the majority of families living in urban areas in Tanzania have had their communities urbanise around them, rather than having migrated from rural to urban neighbourhoods.

3.3 Children's health and malnutrition

Improving children's health has been part of a long-standing international effort (UNICEF, 2015; United Nations, 2015a). During the past century, both social scientists and public health specialists identified practices that could significantly improve children's circumstances. These ranged from public health efforts such as improving hygiene/sanitation and better child feeding practices; socio-economic changes like improved maternal education and poverty reduction; to medical interventions including mass immunization programs and use of antibiotics (Cutler, Deaton, & Lleras-Muney, 2006; Cutler & Miller, 2005;

Hinde, 2003). Although such advancements led to huge reductions in infant and child mortality in historic Europe and are influencing the world today, international goals to reduce child mortality and malnutrition have still not been met, especially in sub-Saharan Africa (United Nations, 2015b). A better and more holistic understanding of the various determinants – medical, social, economic – that influence child wellbeing is essential for programmes and policies to have further impact (Irwin et al., 2006; Rico, Fenn, Abramsky, & Watts, 2011; Siddharth Agarwal & Aradhana Srivastava, 2009; Victorino & Gauthier, 2009).

In Tanzania, the latest DHS (2015-16) recorded that 75% of children aged 12-23 months had received all basic vaccinations at the time the survey was undertaken. However, children's malnutrition is a bigger issue in the country, which is why this thesis focused on child malnutrition as a measure of children's health and not on other indicators, e.g., immunisation/vaccination. Child malnutrition is mostly preventable, yet it increases the risk of severe illness and leads to approximately 30% of under-5 deaths globally (UNICEF, 2015; UNICEF Tanzania, 2010). In Tanzania, approximately 130 children under 5-years die daily due to malnutrition related illnesses (DPG Nutrition, 2010). The Tanzania National Nutrition Survey 2014 found 35% of children to be stunted (chronically undernourished, or short for age) (Tanzania Food and Nutrition Centre, 2014). The TDHS 2015-16 shows similar results, with 34% of children under 5-years stunted – a decrease from 42% in 2010. Fourteen percent of children under 5-years were underweight (decrease from 16% in 2010). The levels of child wasting (acutely undernourished, or very thin) have reduced slightly between 1999 and 2016 (from 7% to 5%). According to the TDHS 2015-16, a higher percentage of boys than girls were categorised as stunted (37% compared to 32%) and severely stunted (13% versus 11%). Patterns were similar for wasting (5.2% of boys compared to 3.8% of girls) and being underweight (14% of boys and 13% of girls.). Mwanza Region had higher rates of stunting than the national average, with 39% of children classified as stunted (MoHCDGEC et al., 2016).

Poor infant feeding practices, e.g., lack of breastfeeding, and food insecurity, especially of nutritious items, are primary causes of malnutrition, and the burden of disease and malnutrition falls most strongly on the poorest (UNICEF Tanzania, 2010). Breastfeeding is almost universal in Tanzania, with 98% of children having been breastfed for at least some time according to the 2015-16 TDHS; and 59% of children under 6 months having been exclusively breastfed. However, being breastfed within one hour of birth, which is considered vital for infant health, is not as common (51%). Children's diets are more problematic, with only nine percent of children under the age of 2 years having been fed the minimum acceptable diet (MAD) that is deemed necessary by the WHO for appropriate growth and development (World Health Organization, 2010). Further, approximately 60% of children aged 6 months to 5 years were categorised as anaemic (i.e., iron deficient) according to the TDHS 2015-16. This suggests that programmes targeting infant feeding practices are still key in improving children's health in Tanzania, emphasizing the importance of children's caregiving environments.

3.4 Children's caregiving environments

Children's caregiving environments are strongly determined by their residence patterns; and children in Tanzania have very diverse household and family structures. Rural Tanzania specifically is characterized by high levels of polygynous marriage and varied forms of father residence. The 2015-16 Tanzania DHS shows 17% of children under the age of 18 years were fostered (i.e., not living with both parents), and of these 14% had both parents alive. Further, 18% of children under age 18 years lived with their mothers alone (father alive or dead); while only 5% resided with their fathers in the absence of mothers; and approximately 31% of households in rural Tanzania contained either fostered or orphaned children (MoHCDGEC et al., 2016). Further, findings from the Rufiji DSS in Tanzania show that by 10 years of age, 40% of children had experienced some form of father absence (Gaydosh, 2015). In north-western Tanzania, where this study was undertaken, it is common for children to be fostered even when both their parents are alive; and many children subsequently reside with their grandparents or other relatives; this is often done to improve access to school or if the fostering family needs help with housework, among other reasons (Hedges, 2019).

Marital patterns are variable too, which in turn influence young children's social environments. In rural Tanzania, 21% of married women aged between 15-49 years are in polygynous unions. Divorce also contributes to high levels of father absence, with 1 in 10 Tanzanian women between 15-49 years currently divorced or separated (MoHCDGEC et al., 2016). In 2004, 23% of men and 24% of women of reproductive age had experienced at least one marital dissolution, resulting in physical separation between father and child (de Walque & Kline, 2012). An increasing proportion of children in the country are also being born outside marriage, typically residing in mother-only households (Harwood-Lejeune, 2001).

Policy-orientated research and literature typically portrays these family structure forms as having negative consequences on female and child wellbeing. Although there is broad agreement that father absence negatively impacts young children in contemporary high-income populations, this cannot be extrapolated to understand the phenomena across cultures (Lawson & Uggla, 2014; Penn, 2009). Studies of father absence in countries where fostering and orphanage are more common have reached mixed conclusions (Lawson et al., 2017; Sear & Mace, 2008), creating a need for ecologically and culturally context-specific research. Polygynous marriage has also been both positively and negatively associated with child anthropometric indicators of nutritional status, leading to contrasting conclusions on its broader wellbeing implications (Lawson et al., 2015; Omariba & Boyle, 2007). An understanding of these relationships is required to inform population policy concerning the extent to which these variations in family structures should be discouraged; and inform social science theory concerning the social and environmental factors which drive cross-cultural variation in marriage systems (Lawson et al., 2015).

Much research on childcare practices in Tanzania has focused on topics such as medical care, access to healthcare for children, and the care provided to new-borns (Kassile, Lokina, Mujinja, & Mmbando, 2014; Mrisho et al., 2008; Ogbo, Ogeleka, & Awosemo, 2018; Penfold et al., 2010; Vitta et al., 2016). And as discussed in Chapter 2, the majority of research on detailed measures of caregiving behaviour comes from small-scale studies; indeed, a considerable amount of research on allomaternal support has been undertaken with the Hadza hunter-gatherers in Tanzania (Blurton Jones et al., 2005; Crittenden, 2007; Crittenden & Marlowe, 2008; Crittenden & Zes, 2015; F. Marlowe, 2005). However, there is a dearth of research on caregiving behaviours for young children in the general population. This thesis aims to contribute towards filling this gap.

4. Fieldwork, data collection and data analysis

All research papers in this thesis were written using data collected during the PhD in Tanzania. In this chapter, I describe my fieldwork experience including the conceptualisation and design of the study, the research setting, and the various features of data collection itself. Some of the material on fieldwork and data collection presented in this chapter may be repeated in Chapters 5, 6 and 7 as each of those have been written in their own right as research papers for publication. The chapter is not written in chronological order, and I begin by introducing the research setting to give the reader context before delving into logistical details of study design.

4.1 Research setting

All data were collected in Mwanza Region in north-western Tanzania, one of 31 administrative regions in the country. Mwanza Region lies on the south shores of Lake Victoria, and is connected to neighbouring Kenya via the B6, a major road running from southern Tanzania. During the length of the fieldwork period, I was based in Mwanza city, the capital city of the region, at the National Institute for Medical Research (NIMR). Mwanza city is Tanzania's second largest city, has an estimated population of 1.1 million, and is considered one of the 15 fastest growing cities in the world (Hoff, 2020).

Figure 4.1 A picture showing the entrance of the NIMR compound in Mwanza city, Tanzania

Mwanza city is located approximately 20km west of the Magu Health and Demographic Surveillance System (Magu HDSS), where the two villages surveyed for this project – Welamasonga and Kisesa – are located. The B6 also connects Mwanza city to the Magu HDSS and runs through the HDSS study area onwards to Kenya (see Figure 4.2; Popinchalk, 2013). While there are multiple ethnic groups in Mwanza Region, about 90% of the population belong to the Sukuma ethnic group (Malipula, 2016). As such, the majority of the respondents of this study were of Sukuma ethnicity. The Sukuma are also the largest ethnic group in Tanzania, comprising about 17% of the total population (Malipula, 2014).

As I did not conduct formal ethnographic research as part of this project, I draw on previous ethnographies and empirical research to describe Sukuma history and culture. However, it is important to acknowledge that there is not much information on Sukuma life before the 1950s, and what is available is limited to records from missionaries and colonisers (Hedges, 2019). While more research has been conducted since the 1950s, this is not considered very extensive given how many people of Sukuma ethnicity there are in Tanzania (Wijsen & Tanner, 2002:37). Further, the Sukuma people reside across the country in very different social and ecological contexts, and there may be a lot of variability in their livelihoods and cultural norms and practices in different parts of Tanzania (Hadley, 2005). The two main books referenced below are "I am just a Sukuma": Globalization and identity construction in Northwest Tanzania" (Wijsen & Tanner, 2002), which was written by two Christian missionaries working in Tanzania between 1950 and 2000; and "Socialization in a changing society: Sukuma childhood in urban and rural Mwanza, Tanzania" (Varkevisser, 1973), which was written by a sociologist who worked in the area around Mwanza city. Apart from these two works, I draw on both quantitative and qualitative research papers that have been written based on data collected in Mwanza region (particularly in the Magu HDSS villages). While this work is not strictly ethnographic in nature, it helps build a picture about the local communities.

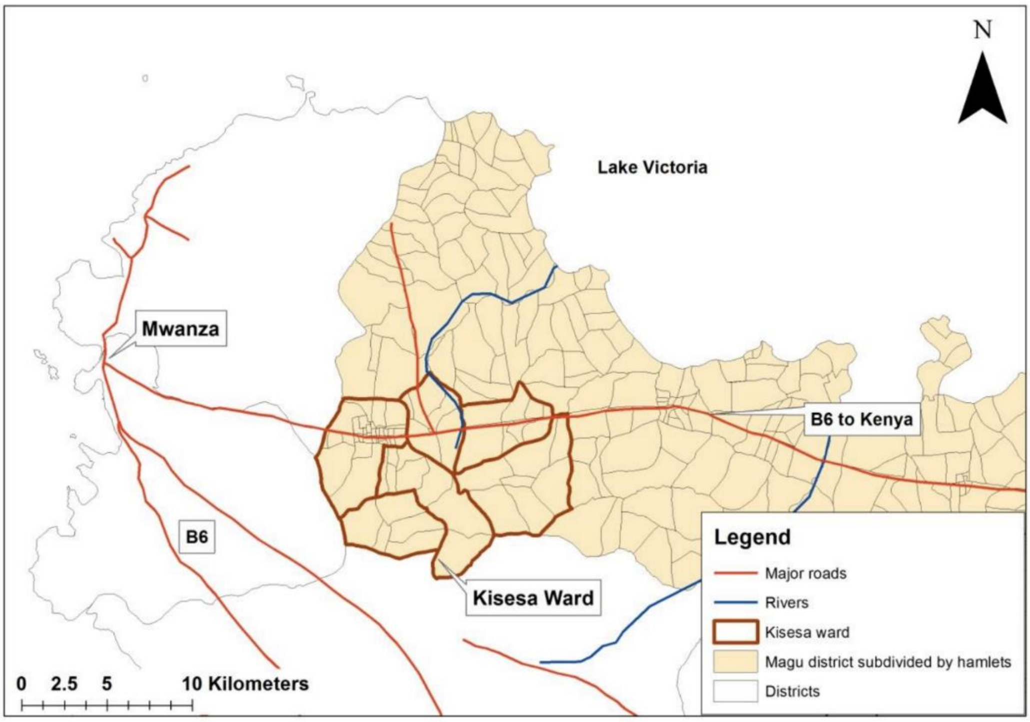

Figure 4.2 Map of north-western Tanzania showing Mwanza city, the seven villages in Kisesa ward covered by the Magu HDSS, and the B6 running through to Kenya. Map courtesy of Jocelyn Popinchalk (Popinchalk, 2013)

Historically, the Sukuma were pastoralists who resided in big, detached houses and kept large herds; however, as a consequence of dwindling land ownership and the introduction of a market economy, cattle-keeping has declined over time (Wijsen & Tanner, 2002). In fact, there were several socio-economic changes in Sukuma life after Tanzanian independence. This was largely due to the socialist policy *ujamaa* or villagisation (the redistribution of land and resettling of households so that people lived in more centralised communities) (Varkevisser, 1973; Wijsen & Tanner, 2002). *Ujamaa* disrupted Sukuma culture of living in dispersed households and being independent. During this period, a lot of women also lost land as authorities just assumed that land was owned by men – and this process coincided with a loss of status and marital stability for women (Varkevisser, 1973; Wijsen & Tanner, 2002). It also used to be Sukuma custom for the oldest son to inherit land, but as a result of scarcity of land and resources, fathers at times distributed their land among their sons before their death; with some daughters inheriting livestock (Varkevisser, 1973; Wijsen & Tanner, 2002). Thus, traditionally, Sukuma families follow patrilineal inheritance and patrilocal residence after marriage (Wijsen & Tanner, 2002). However, these norms are not very strict and are changing with urbanisation: my observations during fieldwork suggested that there was more neolocal residence in the urban community compared to the rural one.

Patrilocal residence and polygynous marriage (which is permitted) have been recorded among different Sukuma groups across the country, including those living in the Rukwa valley in south-western Tanzania (Hadley, 2005) and in Kisesa ward (north-western Tanzania). In Kisesa ward, between 10 and 20 percent of adult men are married to more than one woman (Hedges, Sear, Todd, Urassa, & Lawson, 2019). However, polygynous marriage is more commonly observed in rural areas (Lawson, Schaffnit, Hassan, & Urassa, 2020). Marriage is practiced universally, but getting divorced and remarrying is also common (Boerma et al., 2002); and women often have children before marriage and outside of it too (Schaffnit, Urassa, & Lawson, 2019). Childbearing before marriage, or outside of it, is common and virginity is not obligatory for marriage (Boerma et al., 2002). Transactional sex is also common (Wamoyi et al., 2019). Marriage is widely considered as key in gaining social status within one's community, and many women report that they have independence in choosing their husbands before marriage (although these choices are subject to local constraints) (Schaffnit, Urassa, et al., 2019). Getting married during adolescent years is common, and large spousal age gaps have the potential to underpin gendered power hierarchies (Lawson et al., 2020; Schaffnit, Urassa, et al., 2019). Divorce is permitted and not uncommon, and can be initiated by either the wife or husband; usually, divorce is quickly followed by re-marriage especially for reproductively aged women (Boerma et al., 2002). If women are seen as promiscuous their reputation can be damaged, whereas higher levels of sexual activity actually serve to increase men's reputation; and extra-marital affairs tend to be blamed on women instead of men (Wight et al., 2006). These ideas of men's dominance and women's subservience in marriage are reinforced by and echoed in traditional Sukuma songs (Masele & Lakshmanan, 2021).

Wijsen and Tanner note in their work that Sukuma marriages can be formalised with a religious, legal or traditional ceremony, or be informal with the couple cohabiting without a ceremony or event (Wijsen & Tanner, 2002). A key marker of a formal marriage is the transfer of bridewealth from the husband to the woman's family which is arranged before the marriage and can consist of money, livestock or other goods; in cases of informal marriages, however, the woman's parents tend to expect compensation at a later date in lieu of the bridewealth (Wijsen & Tanner, 2002). These traditions are reflected in recent research in Kisesa ward, where marriage is considered an important social institution and is marked by cohabitation but not always a social event or ceremony (Schaffnit, Urassa, et al., 2019).

Compared to other ethnic groups in Tanzania, Sukuma households are larger and tend to contain both affinal kin and fostered children (Lawson et al., 2015; Urassa et al., 1997; Varkevisser, 1973). For example, research using data collected as part of the Whole Village Project (coordinated by Savannahs Forever Tanzania) in 56 villages in northern and central Tanzania finds that, for male-headed monogamous households (n=1216), Sukuma households had a mean size of 8.2 members (n=289, SD=3.8) compared to a mean household size of 5.4 members (n=143, SD=1.9) for Maasai households, 6.2 members (n=149, SD=2.0) for Rangi households, 5.6 members (n=135, SD=1.8) for Meru households, and 6.3 members (n=500, SD=2.3) for all remaining ethnicities combined. Diversity in family structure, including fostering or living without one or both biological parents is recorded in Kisesa ward as well – a recent study, conducted in the same two villages where data for this thesis were collected, shows 26% of children over 7 years of age to be fostered, and another 25% living with their mothers alone (Hedges, Sear, et al., 2019). However, there are differences in child fostering by age and potentially study region. Another study, using the Whole Village Project data mentioned earlier, found that 5% of Sukuma children under 5 years of age were fostered, and 16% did not reside with their (living) father (Lawson et al., 2017). Children are most likely to be fostered by grandparents and maternal kin, but occasionally also live with stepparents (Hedges, Sear, et al., 2019; Urassa et al., 1997). Hedges, in her study on child fostering described above, also finds that being fostered by kin members did not appear to disadvantage children, and in fact it buffered orphans from the adverse effects of parental death (Hedges, Sear, et al., 2019). Further, Hedges shows that children who were fostered by close kin had similar educational outcomes as those children living with both biological parents; whereas being fostered by distant kin was associated with a lower likelihood of school enrolment or progression to secondary school (Hedges, Sear, et al., 2019). This suggests differences in the quality of care provided by close kin and that by distant kin.

Recent research on Sukuma children's education in Mwanza region indicates that girls' education has been increasing and in some communities has matched or even surpassed boys' education (Hedges et al., 2018). While school enrolment and attendance reduces both farmwork and household work (domestic tasks) this is mostly limited to boys, whereas girls continue to contribute significantly to household chores even when attending school (Hedges et al., 2018). Hedges also finds that, in her sample (of children aged 7 to 19 years), younger girls do lesser work, have more leisure time and are more likely to be enrolled in school than older girls, potentially resulting from labour substitution as older girls are more effective at work tasks (Hedges, Lawson, Todd, Urassa, & Sear, 2019). On the other hand, older boys are more likely to be enrolled in school, potentially resulting from traditional work-related norms such as cattle herding being allocated to younger children. Household work is also gendered: boys residing in households where girls are also present tend to do fewer domestic tasks (Hedges, Lawson, et al., 2019). I discuss gendered parenting norms for children under the age of 5 years in Chapter 5 of this thesis.

4.1.1 The Magu Health and Demographic Surveillance System

The Magu HDSS is situated in Kisesa ward, one of 31 wards in Magu district, which is one of seven districts in Mwanza Region in north-western Tanzania (Kishamawe et al., 2015). This HDSS was established in 1994 as part of the Kisesa Open Cohort HIV Study which researched the HIV/AIDS epidemic in the population, and is one of the oldest HIV community cohort studies in Africa (Kishamawe et al., 2015). Since then, the TAZAMA study has been collecting demographic data from every household in the HDSS approximately every 4-6 months (Changalucha, 2014; Popinchalk, 2013). The area is home to over 35,000 residents living in seven villages, which are undergoing different stages of economic and demographic transitions. As shown above, the Magu HDSS is intersected by the B6 road which runs through to Kenya (Figure 4.2). Some parts of the villages in Kisesa ward are closer to the main road than others and have easier access to tarmac roads. This has resulted in certain parts of the HDSS urbanising far more than remote areas, and the location of some households being categorised as trading centre (urban), some as roadside (peri-urban), and others as rural (Isingo et al., 2012; Popinchalk, 2013). The Magu HDSS residents' livelihoods vary substantially, ranging from agropastoralism in the more rural locations to wage-based labour in urbanising contexts. Some households lie in the middle, combining farming and cattle-keeping with different amounts of trading, market-based work, skilled and unskilled labour (Hedges et al., 2018). Even so, the majority of the residents are subsistence farmers, who trade their excess produce in Mwanza city or markets in the more urban villages. Crops grown most commonly include cotton, cassava, maize, rice and sweet potatoes, with small-scale trade of milk, tomatoes, maize and rice. The value of education has been increasing in the area, with primary school enrolment almost universal, and about 50% of children progressing to secondary school (Hedges et al., 2018). During my fieldwork season, levels of food insecurity were poverty levels quite high in the two villages we sampled:

59% of total households classified as severely food insecure, 21% as moderately food insecure, 3% as mildly food insecure, and only 17% as food secure (more details in Section 4.3.1). Food insecurity was measured using a set of nine questions about food insecurity, based on the Household Food Insecurity and Access Scale (HFIAS) (Coates, Swindale, & Bilinsky, 2007). Details about the HFIAS are provided in Section 4.3.1, and the original survey questions included in Appendix 10.3.1 (the Household Survey).

Most of the residents belong to the Sukuma ethnic group (Changalucha, 2014). The government has eleven primary schools and two secondary schools in Kisesa ward (Hedges, 2019). There are four government-owned health facilities across the HDSS area, and three private dispensaries (Kishamawe et al., 2015). In addition to this, each village has its own sero-survey clinic, and serological surveillance is conducted approximately every three years. Data for this thesis were collected in two of the seven villages, Welamasonga, the most rural, and Kisesa, the most urban. Henceforth, 'Kisesa' is used to refer to Kisesa village and not Kisesa ward.

4.1.2 Welamasonga and Kisesa

Data for this study were collected in neighbouring villages, Welamasonga and Kisesa, because they represent the two extremes of a rural-urban gradient within the Magu HDSS. They are, as such, analysed as a setting where the demographic and urban transitions are underway. Kisesa, partly on the main road running to Kenya, is more like a small town than a village, and has a bustling market in its town centre, whereas Welamasonga is situated more remotely and is extremely rural.

There are distinct ecological and socio-economic differences between the two. More village residents rely on subsistence farming (village: 38%, town: 10%); they farm and sell agricultural produce more (45% versus 4% in the town); and own and herd cattle more (44% versus 7% in the town) (Hedges et al., 2018). Children in the villages also regularly contribute to farm-work, while children in the town are more likely to be enrolled in school (Hedges et al., 2018). Relatedly, however, in the village, girls have a higher likelihood of school attendance than boys, possibly attributable to the cattle herding work done by younger boys in the village which is less compatible with schoolwork than domestic tasks which are girls' responsibility. There has been significant market integration in the town over the past decade, with an increase in owning or working in small businesses or partaking in petty trading, labouring or skilled work, which explains the greater emphasis on children's education here compared to the village. In the town, more households have a busines or shop (33% versus 10% in the village), and more have salaried (13% versus 2% in the village) and skilled members (20% versus 3% in the village) (Hedges et al., 2018). Employment and business prospects in the town are thus more varied and abundant than in the village. Further economic and demographic differences between the two sites are described in Chapter 6 of this thesis.

Both villages are divided into sub-villages, and the sub-villages into *balozis*. A *balozi* is in fact not a geographical area, but a person in charge of managing disputes within a sub-village. Kisesa is the most densely populated village in the ward (see Figure 4.4): the 31st round of the HDSS (in 2016) recorded a total of 1,829 households in Kisesa, and 9,157 residents. Kisesa has five sub-villages: Kisesa Kati, Lumve, Wita, Ng'wang'halanga, and Ng'wandulu. Of these, Kisesa Kati and Ng'wandulu were the closest to the main road, and consequently also the most urban. However, Ng'wandulu extends some distance from the main road and there is variability in how urban it is. Welamasonga is located about 10 km from Kisesa but is much less densely populated. In Welamasonga, the 31st round of the HDSS recorded an estimated 495 households, containing 3,006 residents. Welamasonga is split into ten sub-villages: Welamasonga, Nkola, Ilangale, Ikangabuta, Nyamikoma, Nyan'helela, Ikengele, Ikulicha, Mwadubi, and Mwaneneka. Figure 4.4 shows the variation in geographical size and household density between Welamasonga and Kisesa.

Figure 4.3 Rural Welamasonga fields on the left-hand side; and the bustling Kisesa town-centre on the right-hand side

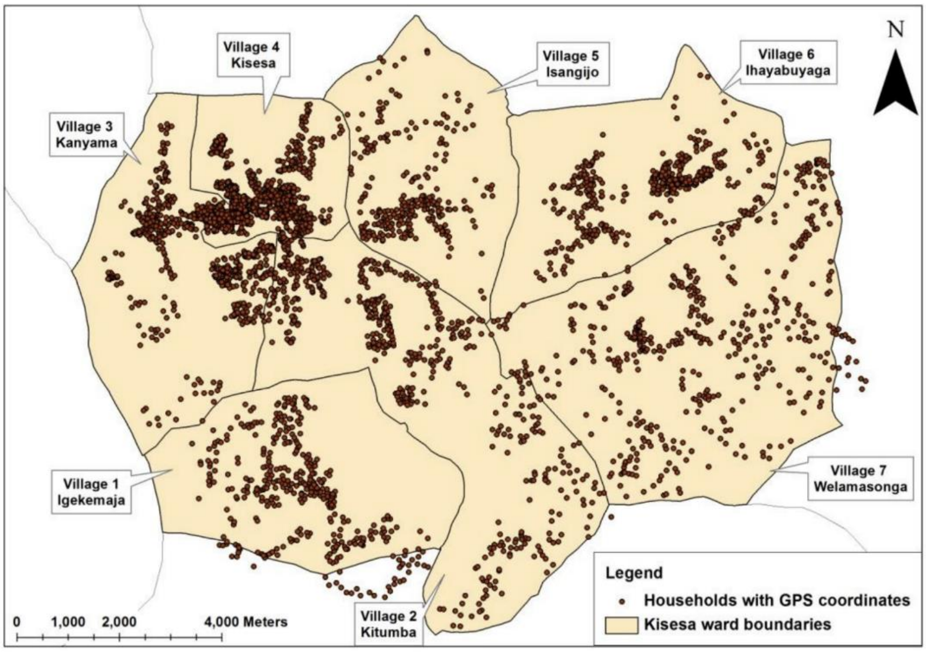

Figure 4.4 Map of the seven villages in the Magu HDSS, with village boundaries and location of households with GPS coordinates – courtesy of Jocelyn Popinchalk *(Popinchalk, 2013)*

4.2 Study design

The study was planned with a mixed-methods design, including both quantitative surveys and qualitative focus group discussions (FGD). While the surveys form the core of this research and were the primary data collection tool used, four FGD were carried out to qualify and understand the quantitative findings more fully, taking into account local norms and perspectives. Data collection was carried out in two neighbouring villages, Kisesa and Welamasonga. The quantitative surveys included a household survey, a woman's survey and a child's survey. The pilot study, sampling protocol for the surveys and the focus group discussions is detailed below. Details on survey tools used and data collection are given in Section 4.3 for quantitative data. All details pertaining to focus group discussions are in Section 4.4.

Prior to the start of the study, Mark Urassa organised meetings with the village leaders for each village and requested their approval for our project to be carried out, and for our presence in their two villages. The village leaders granted permission for us to carry out our project in their villages before the start of data collection. The study was not advertised to the participants before data collection began. As mentioned, we used the HDSS as a sampling frame and selected eligible participants from it. Using the list of pre-selected households, village facilitators found each household for us and introduced our study and us to the household and household head. The village facilitators are local residents of the villages and are paid by NIMR to regularly help with research projects. During our study, the village facilitators were Isaac Sengarema in Welamasonga, and Sunday Kituku in Kisesa.

I have not as yet presented my research findings either at NIMR or to the two study communities, but I plan to do this in the future.

4.2.1 Initial trip to Mwanza

In April 2017 I visited the National Institute for Medical Research (NIMR), Mwanza Centre, for one week, with Dr Susie Schaffnit. During this visit, we held introductory meetings with our project's co-lead Mark Urassa, and the Director of NIMR, Mwanza, John Changalucha; discussed budgetary needs regarding purchasing of equipment and hiring of interviewers for the main project; had administrative meetings with NIMR staff regarding visa applications and ethics queries; and did a soft pilot of the surveys.

The TAZAMA programme at the National Institute for Medical Research (NIMR), Mwanza Centre, led by Mark Urassa in 2017, regularly coordinates the Magu HDSS. NIMR also manage numerous other surveys and projects that are carried out in Mwanza region. Therefore, they regularly work with a number of trained and experienced interviewers. Thus, two interviewers were recruited through NIMR for the pilot study. We spent one day training the interviewers about our project and survey requirements, and working with them through the survey in detail. The survey translations from English to Swahili were finalised while we were in Mwanza and were available in both languages. We could thus go back and forth between the English and Swahili versions during the training to correct any errors in translations. The interviewers' local knowledge of the communities also helped inform our surveys and tweak questions. The training session also helped highlight training needs for the future. After recruitment and training of the interviewers, we visited 5 households in two villages in the Magu HDSS area. All three surveys (the household survey, the woman's survey and the child's survey) were tested over the span of one day. More extensive pre-testing of the surveys was not possible due to budgetary constraints. The household survey was carried out with the head of the household, or another eligible adult if the household head was not present; the woman's survey with the selected eligible woman aged 15-35 years old; and the child survey with each respective mother/guardian of all children under the age of 5 years who were resident in the household. Height and weight measurements were taken for the eligible women and children. For the pilot, the surveys were carried out using paper copies of the questionnaires. Piloting of the survey helped us catch poorly worded questions that either the interviewers or participants did not understand, and hone the survey to make it clearer. The two villages were a 30-40 minute drive away from Mwanza city, thus we also hired a car and driver from NIMR for one day's work. Mr Urassa coordinated the administrative and logistic aspects of the pilot at NIMR, and all costs for the pilot were covered by Dr Lawson's funding (see Section 1.3).

While in Mwanza for the pilot study, we also finalised our Tanzanian ethics applications for submission to both the local and national IRB. During the administrative meetings with Mr Urassa, we worked through the budget requirements for the main project that was scheduled to start in July and planned our next steps, e.g., regarding the recruitment of interviewers, sampling strategies, vehicle and driver hire, and renting an apartment for myself and Susie to stay in for the planned 3 months of fieldwork.

4.2.2 Sampling for surveys

Inclusion criteria

The sampling protocol for the quantitative surveys was guided by the needs of the larger project led by my supervisor, Dr David Lawson, which aimed to survey women aged 15-35 years. The aims of this larger project were to provide a novel source of data to study relationships between family structure and multiple dimensions of female and child wellbeing in rural Tanzania. Specific focus was placed on early/child marriage (i.e., marriage <18 years) and on relatively young women (up to 35 years). This was because women over the age of 35 may not have recalled the details of their first relationships as clearly as younger women; and the context in which they would have made their marital/relationship choices was likely different than the present due to generational and economic changes in the area. Thus, women over the age of 35 years were not included in the study, and the sampling frame included only households that had a resident woman who would be aged 15-35 years during our fieldwork season. As such, all children under the age of 5 years who were sampled for the project were children who lived in a household with a girl/woman aged 15 through 35 years old. The sample of children included in this study is therefore biased towards younger mothers as a result of the sampling design. It is thus also important to note that the findings of this thesis are not generalisable to the overall population of children under the age of 5 years in this area.

Sample selection

The initial target sample size was thus based on the number of total women aged 15-35 years required in order to obtain accurate estimates of the primary variable of interest for that component of the project (age at first marriage). Research at the time indicated that in Mwanza region, an estimated 37% of females married before the age of 18 years old (UNFPA, 2014). Assuming a design effect of 2 for the clustering of women within households, a sample of 678 women was necessary to obtain a 95% confidence interval of +/-5% around an estimate of 37%. To achieve this sample size while allowing for an expected 75% response rate, 904 women were needed to be approached for survey. With an average of 1.3 women per household, 696 households were needed to be surveyed. To achieve this, at least 348 households in each Kisesa Village and Welamasonga were to be surveyed. This led to our initial sample goal of 706 households, 348 each in Kisesa and Welamasonga.

I also carried out power analysis to determine the sample of children that would be needed for my study. The Magu HDSS sampling frame indicated that there was a total of 1,771 children under the age of 5 years resident in both villages in 2017. In Mwanza region, according to the 2010 Tanzanian Demographic and Health Survey, 38.7% of children under the age of 5 classified as stunted (NBS/Tanzania & Macro, 2011). To obtain a 95% confidence interval around this estimate of 38.7%, with a 5% margin of error, a sample of 302 children was required. A design effect of 1 was used, as the survey design was not clustered. Allowing for an expected 75% response rate, 402 children were needed to be approached for survey. As households were to be selected based on the presence of a woman aged 15- 35 years, not all of them would have resident children under the age of 5: calculations using the available Magu HDSS data showed that 455 out of the 700 households had a child under 5 years. With an average of 1.51 children (under 5 years) in each household, the total sample size for this project was required to be 687 children aged under 5 years (I sampled 808).

The Magu HDSS Round 31 (collected in 2016) recorded that Kisesa had a total of 1,829 households, and 9,157 residents; whereas Welamasonga had a total of 495 households, and 3,006 residents. The Magu HDSS Round 31 was used to build a sampling frame, which included all households in Kisesa and Welamasonga with at least one woman aged 14 through 34 years (who would be 15 through 35 in 2017, when data collection was to take place). Using this sampling frame, households were randomly selected from each village. Welamasonga only had a total of 316 eligible households, and all of these were selected. To compensate for this as it was less than our target of 348 households, we oversampled in Kisesa (n=390).

During the course of data collection, four supplementary samples had to be drawn from the sub-villages in Kisesa, as many households had to be dropped from the sample. This was due to a number of reasons: (a) the eligible woman had moved from the household, and there was no other eligible woman resident – this was regardless of whether or not there was an eligible child present in the household; (b) the entire household had migrated; (c) the household head did not consent to participate in the study; (d) the household could simply not be found by the village facilitator despite concerted attempts to do so (i.e., speaking with Balozi leaders and neighbours). The last issue primarily occurred in Kisesa due to high migration rates: 113 households could not be found here, compared to 1 household in Welamasonga. Of the women who were successfully contacted, however, fewer than 1% refused participation.

Eventually, a total of 938 households were sampled in Kisesa (51% of the total recorded households; n=1829) to meet the required sample size for women; and surveys completed at 486 of these households (27% of the total recorded households; n=1829). Of the 319 households sampled in Welamasonga (64% of the total recorded households; n=495), successful surveys were completed at 257 (52% of the total recorded households; n=495). This amounted to a total of 743 households and 995 women included in the final dataset (652 in Kisesa and 343 in Welamasonga).

Of the 743 total households surveyed, 506 (68%) had resident children under the age of 5 years. This led to a total number of 808 children included in the study (which was 46% of the total population of children under age 5 years in the two villages). While there were more households with children sampled in Kisesa (58%, n=294) than in Welamasonga (42%, n=212), due to households being larger in Welamasonga, there was a similar proportion of children sampled in each: 393 (49%) in Welamasonga and 415 (51%) in Kisesa. A breakdown of the initial household sample drawn for the study, and the number of households, women and children finally sampled is shown in Table 4.1.

Table 4.1 A breakdown of households, women and children surveyed during data collection, comparing sample between Welamasonga and Kisesa

	Total	Welamasonga	Kisesa
	n	n (%)	n (%)
Total households recorded (by Magu HDSS Round 31-2016)	2324	495 (21)	1829 (79)
Total households drawn	1254	316 (25)	938 (75)
Households surveyed	743	257 (35)	486 (65)
Total women surveyed	995	343 (34)	652 (66)
Households with children	506	212 (42)	294 (58)
Total children surveyed	808	393 (49)	415 (51)

4.3 Quantitative data collection

Data collection started on July 12, 2017 and was completed on October 31, 2017. Data were collected simultaneously in both Welamasonga and Kisesa by trained interviewers who regularly work with the National Institute for Medical Research (details in Section 4.3.2). Depending on the preference of the participants, all surveys were conducted in either Swahili (the national language of Tanzania) or in Sukuma (the local language spoken by Sukuma people). All data were collected on ASUS tablets using Open Data Kit (ODK) Collect (C. Hartung et al., 2010). Data were collected using three surveys: the household survey, the women's survey and the children's survey. The household survey was conducted with the household head (or another eligible adult e.g., his/her spouse, his/her parent, his/her older child over 18 years) at each household, the woman's survey with all eligible resident women (aged 15-35 years), and the children's survey with the biological mother or other guardian of all resident children under the age of 5 years. Data used in this project primarily comes from the household and children's surveys.

Participants were not compensated in any way for taking part in the quantitative survey. This was done in accordance with NIMR and TAZAMA project's guidelines as participants are not compensated for taking part in the Magu HDSS. However, all residents in the Magu HDSS catchment are provided free healthcare and access to a number of clinics, and NIMR invests a lot in these communities. NIMR thus has a great relationship with the residents of Kisesa ward. Partially due to this, we did not encounter any opposition to our project either, with less than 1% of households that were approached refusing to participate in the study.

4.3.1 The household survey

The household survey was co-designed by myself, Dr David Lawson, my second supervisor and PI of the larger project alongside which my PhD fieldwork was carried out, and his postdoctoral scholar, Dr Susan Schaffnit. This survey was completed before beginning interviews with the women and children's mothers/guardians. A household was defined using the HDSS definition: "*a group of people living together in the same compound and who regularly eat together from the same pot*" (Kishamawe et al., 2015; page 1852); and the household head as the *"person who is responsible for the upkeep and maintenance of the household".* The household heads either always self-identified as such and/or were pointed out as such by a household member. They were not always the eldest members of the household. The household survey comprised of the following components: a household roster; socio-economic and demographic characteristics of the household head and members; a measure for household food insecurity; a household asset score that was used to develop a wealth index; a subjective wealth question; and land and livestock ownership. The household survey is provided in Appendix 10.3.1.

The household roster measured household member characteristics for each member of the household. A household member was defined as "*a person (whether or not present at the time of the interview) who has spent at least the last 6 months in the household*". Other members of the household could include people who may not have spent the previous 6 months with the household but intended to stay there for the next 6 months at least; seasonal workers who returned home after a season; and students who were at boarding schools or hostels at the time of survey. Socio-economic and demographic characteristics asked about were the age, sex, marital status, ethnicity, religion, primary occupation and educational attainment of the household head; and the age, sex, marital status and relationship to household head for all household members. Thus, while data is available on the number of co-residents in a household and each household member's relationship to the household head, we did not measure the relationship between each household member specifically.

Household food insecurity was measured using the Household Food Insecurity (Access) Scale (HFIAS) (Coates et al., 2007). This is a brief survey developed by the Food and Agricultural Organisation (FAO) and the US Agency for International Development (USAID) and is funded by the Food and Nutrition Technical Assistance (FANTA) Project. It aims to improve the measurement of food security and better target interventions to the most vulnerable households. The HFIAS is based on a household's reports of experiencing problems with three domains of food insecurity argued to be universal across cultures: (i) feelings of uncertainty or anxiety about household food supplies; (ii) perceptions that household food is of insufficient quality (including variety and food type preference); and (iii) insufficient food intake and its physical consequences. It comprises of a list of nine questions which have been developed to understand the occurrence and frequency of specific problems related to these three domains. These questions ascertain whether households have experienced problems with food access in the last 30 days, e.g., experiencing anxiety about food supply, having to limit the quality or quantity of food, and how often these experiences occurred. Responses to these questions were scored so that "never" received a score of 0, "rarely" scored 1, "sometimes" scored 2 and "often" scored 3, so that when summed, the lowest possible score was 0 and the highest 27. Thus, a score of 0 indicated that the household was food secure, whereas a score of 27 indicated that the household was severely food insecure. As such, a categorical measure can also be computed on the basis of the HFIAS questions, with four categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The HFIAS has been validated in the rural Tanzanian context (Knueppel, Demment, & Kaiser, 2010).

The woman's survey asked about the women's relationship and birth histories, their family of origin, their views, plans and experiences of marriage, and emotional/mental and physical wellbeing. I do not describe these data in detail here as they were not collected for the purpose of this PhD; and the only woman-level variables used in this dissertation are the woman's age, height and weight in the instances where these women were the mothers of the surveyed children (further described in Chapter 7).

4.3.2 The child survey

The child survey was designed primarily by myself, with input and advice from both my supervisors (Dr Lawson and Prof Sear) as well as Dr Schaffnit. The child survey was conducted only if consent was given by the household head for participation in the household survey, this was completed, a woman's survey was completed at the household, and the mother/guardian of the child agreed to take part in the child survey. It was thus completed at 67% of households in the total sample as not all eligible households (i.e., with at least one woman aged 15-35 years) had a child under the age of 5 years. All children's surveys were directed towards the child's mother or one of the child's guardians. A discussion on why I chose to use self-reported surveys to collect these data, as opposed to observational methods such as focal follows which are commonly used in studies measuring caregiving behaviours, is provided in Chapter 8.

The child survey began by asking the child's name, age and sex. Child's age was calculated through their date of birth and their sex was reported by their mother/guardian. Following this, the survey measured the relationship of the respondent to the child, if they co-resided in the household with the child, and if they were the child's primary guardian (i.e., *'the person who is mostly responsible for the child's wellbeing'*). If they were not the child's primary guardian, they were asked to state who the primary guardian was and whether they also lived in the household. The respondent was then asked to answer a few questions on the child's residential history: whether the child had lived in the current household since birth, and if not, when they moved there and who they had resided with prior to moving. The survey then measured if the child's biological mother and biological father (separately) were alive or not, and if they were alive, whether they co-resided with the child in the same household or lived in another household. The parents' marital and co-habitation status (i.e., lived together as married but without being formally married to each other) was also measured (whether they were married to each other or not, and if they co-habited or not); and whether the child's father was polygynously married. If he was polygynously married, we asked how many wives he had, and what the focal child's mother's wife-rank was. The survey also measured whether the child was their father's first-born or not, and this variable is used as a proxy for the child's birth order in this thesis.

If the child's mother or father were not co-resident, the respondent was asked how often the child had seen them in the previous 6 months. I included a detailed section on the activities of the child's biological father if they were alive but not co-resident with the child, out of interest in childcare provided by non-resident fathers. This is because a lot of previous research uses measures of 'father absence' which can pertain to a variety of scenarios including death, being away from home for work reasons (i.e., a scenario in which the father may still be investing in or providing for the child), parental divorce (again a scenario in which the father may live nearby and see the child regularly, or live further but still be investing in the child). This section asked the reason for the alive father's absence, with options including, being away for work, being separated or divorced, child fostering, residing with another wife, the child's parents not being in a relationship with each other, and 'other' to capture any context-specific reasons for absence I may not have thought to include in the survey. I also asked where the focal child's father lived and how far away that location was from the child's household; if the child had ever lived with their father and if so, how old had the child been when the father left; and if/how the child's father communicated with the child. Lastly, I asked whether the child's non-resident father provided any resources (money, food, medicine, clothes, other household items) to the household or to the child, and if so, how often he did this and what resources were provided. I plan to use these data to write a research paper focused on variation in care provision between co-resident and non-resident fathers but have not done so as part of this dissertation. However, some of these variables are used in Chapter 5 and further described there.

Figure 4.5 A Sukuma mother washing her infant in Welamasonga village

Key to this thesis are the measurements of maternal and allomaternal care provided to the child from each of nine categories of allomother: biological mother, biological father, maternal grandparent, paternal grandparent, sibling (brother/sister), maternal aunt/uncle, paternal aunt/uncle, stepmother/stepfather, and other. A note here: the 'other' category is thought of as comprising either distant kin (e.g., cousins, as they were not included in the list of allomothers asked about, or another distant relative) or non-kin (conversations with respondents during fieldwork highlighted that they often chose 'other' when the care was provided by friends or neighbours, and in a few instances, the church). The measures of care included resource provisioning and six types of direct caregiving. For the provision of resources, the respondent was asked whether each of these nine categories of carers had provided money, food, or another household good (e.g., medicine, clothes) to the child in the three months preceding the survey. For direct caregiving, the respondent was asked separately for each carer, whether or not they had been involved in the following six activities in the two weeks preceding the survey: washing the child, feeding the child, playing with the child, supervising the child, co-sleeping with the child, and caring for the child if they had been sick during that time. These measures did not account for frequency of care provision, and only measured whether or not a carer had provided resources or participated in any of the six types of caregiving, at least once in the given time period. Following this, as a measure of maternal investment, the respondent was asked a few questions about the child's breastfeeding status and history. These questions included whether the child had ever been breastfed, was still breastfeeding, how long they had been exclusively breastfed for (i.e., *'they did not eat or drink anything other than breast milk'*); if they were no longer breastfeeding, at what age they had stopped, whether they were eating solid foods, and at what age had they started eating solid foods.

Children's health was measured in three ways. First, a general health question that simply asked the respondent to state how the child's health was in general, choosing from 'always good', 'mostly good', 'mostly sick', and 'always sick'. This was included because self-rated health is considered a robust predictor of mortality in many populations (DeSalvo, Bloser, Reynolds, He, & Muntner, 2006; Idler & Benyamini, 1997; Jylhä, 2009), irrespective of socio-economic status (Frankenberg & Jones, 2004). Secondly, the interviewer listed a number of different food categories, with examples of each category (for example, carbohydrates included cassava, ugali, maize, rice, potatoes; protein was measured in a few different ways including eggs; or beans, legumes, peanuts; or different types of meats; and so on for fruits and vegetables). The respondent was requested to state whether or not the child had eaten any of these food items in the 24 hours preceding the survey. Finally, at the end of each child survey the respondent (child's mother/guardian) was asked for their consent to measure the child's height and weight. Child anthropometry is recommended by the WHO as a measure of young children's growth status and is a validated indicator of malnutrition (de Onis, 2006; de Onis et al., 2012; World Health Organisation, 2014) and was thus collected as the primary indicator of children's health. Details on survey administration and children's anthropometric measurements are provided in Section 4.3.2. The full child survey is provided in Appendix 10.3.2. I use children's anthropometric measurements as indicators of their health in Chapter 7. However, I have not as yet utilised the data collected on children's general health or their food diary, and this is planned for future work.

4.3.3 Data collection

Interviewer recruitment and training

Interviewers were recruited through NIMR, who regularly work with a large number of quantitative and qualitative interviewers due to the projects they coordinate or manage. Thus, NIMR has a standard recruitment process for hiring interviewers for projects, and a standard pay-scale that is adhered to. Five interviewers were hired for conducting surveys during the course of our project, and they were paid according to NIMR's pay scale. Once we had agreed a budget with NIMR and the contract between UCSB and NIMR was signed, all funds for fieldwork were transferred to NIMR's bank account, and Mr Urassa was thus able to use these for all fieldwork expenses related to our project including interviewer recruitment. All five interviewers were fluent in Swahili and English.

One week prior to beginning data collection, I co-led interviewer training with Dr Lawson and Dr Schaffnit, at the offices of the National Institute for Medical Research (NIMR). Interviewer training included working with each interviewer and going through each survey thoroughly to ensure (a) that the Swahili translations were correct and sensible, (b) that the interviewers understood the topics of the study, and (c) that they were comfortable with using ODK on the tablets.

In the training session, we first gave an introduction to ourselves (me, Susie and David) and the project, and explained the study's aims and objectives. We detailed the reasoning behind each of the three surveys and explained the required demographics of the study participants. Then we slowly and carefully worked through each question on each survey and discussed its purpose and the information it was meant to draw from the participant. This was a really useful exercise and helped us tweak the phrasing of a lot of questions, albeit at times after much debate between the interviewers. All interviewers were quite familiar with smart phone technology and were comfortable with using the tablets. Once we had finished training on the content of the surveys, we did a training session on best ways to use ODK on the tablets.

Consent and participation

Each household sampled for the study was first approached by the village facilitator in each village - who introduced the study to the household head (or equivalent) and confirmed that at least one eligible woman was still resident in that household. If the household head verbally agreed for the household to be included in the study, the interviewers approached the household head and began the household survey. At first, interviewers obtained official verbal consent from each household head and recorded this on ODK. If consent was denied, no one in the household was interviewed. Following a successful household survey, verbal consent was obtained from each eligible woman for their participation in the women's survey; surveys were conducted with any women who provided consent. If a woman was under 18 years old and unmarried, verbal consent was additionally obtained from her parent or guardian as per the local laws in Tanzania. Similarly, verbal consent was obtained from the parents or guardians of all children before the child surveys.

Consent was obtained verbally for participation in the surveys as well as the focus group discussions. Before asking for their verbal consent, interviewers read to and then gave all participants an information sheet (in Swahili) about the project (Appendix 10.2). The information sheet included the contact information of the researchers at NIMR so that participants knew where to direct any follow up questions they may have had.

Survey administration

During the course of data collection, the five interviewers were divided into two teams; one team went to Kisesa while one went to Welamasonga, so that all data were collected at the same time. This was important for collecting measures such as food insecurity, which can be seasonal, and results may have varied between the villages simply due to data collected at different times. I was in charge of leading one of these teams for the first three months of the project, while Dr Schaffnit led the other team. In the fourth and final month of data collection, I was solely in charge of managing both teams and divided my time between them. I accompanied the interviewers for the interviews every day for the first month of data collection. Each day, I went to all households visited by one interviewer, and rotated which interviewer I accompanied every day (Dr Schaffnit did the same). Thus, by the end of the first month I had been present during interviews for numerous households, and multiple times with each interviewer. During this first month, interviewers often had questions or clarifications about the survey – e.g., about the meaning of a particular question, or whether the response being provided by the participant matched any of the pre-existing options on the survey – and I was able to answer these as we went along. Participants often had questions too which I was able to answer when I was present (translated into English and/or Swahili by the interviewer). After the first month, the interviewers were much more comfortable answering these questions and little to no clarifications were needed. Thus, for the following three months I accompanied interviewers approximately three times a week instead of five, with the remaining two days spent either on prepping for the focus group discussions, writing code (using Stata do-files) for data cleaning, or generating some descriptive statistics based on the data that were coming in.

Every weekday, two teams (in two separate cars) would drive from the NIMR office in Mwanza city into Welamasonga and Kisesa villages, with one car going to each village. Once at each village, we first picked up or met with the village facilitator (Isaac Sengarema in Welamasonga and Sunday Kituku in Kisesa) who directed us to the households on the list for that day. As mentioned earlier, households that were to be interviewed for the project had already been selected prior to data collection starting. For each household, we had a printed version of the household roster that had been derived from the most recent round of the Magu HDSS. This household roster listed the HDSS assigned household ID, the village, sub-village and *balozi* the household was in, and the name, age and sex of each household member. These printed household rosters were handed to the village facilitator (Isaac or Sunday) who used them to decide which households we would visit each day (usually based on which households were geographically close to each other). Once we drove to a household, the paper roster was handed over to the interviewer (or me if I was accompanying that interviewer). The facilitator then went and first spoke with the household head or an eligible adult in the household and introduced us, and the study, to the household. If the household agreed to take part in the study, the facilitator left the interviewer (and myself if I was accompanying that interviewer) there and went back to the car to take another interviewer to a different household. On average, we spent about 2 hours at each household and each day the number of households visited ranged from 2 to 5, depending on the number of eligible women and children at each household (and thus the number of women and children's surveys that were carried out at each household). Apart from the interviewer, the survey respondent and myself, no one else was present during the survey (apart from infants and children who were being cared for by the respondents).

Data collection usually took place during the week (Monday through Friday), but considering the age of the women we were sampling (15 through 35 years), we encountered difficulties with finding younger girls at home during the week as they would often be at school. To overcome this, we noted their absence and arranged to visit their home again to interview the girl over the weekend (on Saturdays). In these cases, one or two interviewers would go into the villages on a Saturday to solely interview the girls who had been at school during the week.

All surveys were administered using ODK Collect and uploaded to a password-protected server hosted by LSHTM at the end of each day. ODK Collect is open-source and commonly used around the world, especially in low-income countries, and has multiple features apart from gathering simple responses to surveys, e.g., GPS location, photos and signatures (Brunette et al., 2013; C. Hartung et al., 2010). It allows data to be collected on the tablet while the device is offline, and all completed surveys then uploaded at a later time when there is access to internet. Electronic data collection is increasingly used to administer surveys as this saves times in entering, processing and cleaning data, as well as reduces human error (Gravlee, Zenk, Woods, Rowe, & Schulz, 2006).

4.3.4 Data management and analysis

The surveys completed on ODK each day were uploaded at the end of the day, by me and Dr Schaffnit, to a secure ODK server hosted by LSHTM. We then downloaded the data from the server onto our laptops (as .csv files). We used 'odkmeta' to convert ODK .csv files to Stata datasets. We corrected the variable names and removed the group paths in variable names that ODK automatically includes. ODK servers & support were provided by the LSHTM Global Health Analytics Group (odk.lshtm.ac.uk).

We had multiple versions of each survey (saved as excel files formatted for ODK) for two reasons: (1) if a coding error came up in the survey during data collection, or additional options were needed for a question, or a question were to be rephrased, we edited the survey and saved it as a new version; (2) due to the multiple rounds of sampling described in Section 4.2, on multiple occasions we had to add new household IDs to our household ID list (which was pre-loaded onto ODK and from which interviewers selected the household ID for the household they were conducting the survey at when they started the household survey) and this required editing the list of choices in the survey and saving it as a new version. Due multiple versions of each survey, the data that were downloaded from ODK (in .csv format) once data collection ended, was downloaded in multiple files. That is, there were 8 versions (and thus 8 .csv data files) of the household survey; 9 versions (and thus 9 .csv data files) of the woman's survey; and 9 versions (and thus 9 .csv data files) of the child survey. Thus, after the data were cleaned all versions for each survey/dataset were appended resulting in three datasets: one each for the household survey, woman's survey and child survey. We finally removed names of all participants and household members from each dataset and saved both anonymised and non-anonymised versions of each of the three datasets. Data cleaning for the household survey included tasks such as correcting participant or household IDs or other participant or household member information when it were either entered incorrectly by the interviewer and flagged on the paper version of the household roster, or picked up by myself or Dr Schaffnit as we checked the data for consistency after downloading it (for example, we checked the data entered by the interviewer against the paper household roster that was generated using HDSS data). For the child survey, examples of cleaning tasks included correcting birth date entries when the date and month had been confused, when the household ID had been entered incorrectly for a child and we knew the child belonged to a different household (verified using the household roster), and once two households with different IDs had the same head (due to polygynous marriage) and we decided to merge these into one household so as to not double count participants. A few times, children's surveys were conducted in households with no eligible woman (aged 15-35 years) and these children were dropped from the dataset. Mothers of 74% of the children sampled were the focal women interviewed for the woman's survey. Thus, the child and woman's surveys were merged to match children's data with maternal data. I also merged the children's dataset with the household dataset so that household level data (n=506) could be analysed for all children (n=808).

All data were cleaned, anonymised and merged into datasets for analysis using *Stata version 14*. I took the lead with data management and cleaning for the child survey while Dr Schaffnit took the lead with the woman's survey and we shared work for the household survey. Details of data analysis techniques utilised for each research paper are included within the relevant chapters in this thesis (Chapters 5-7).

4.3.5 Basic description of data

For the majority of the child surveys, the child's mother was the respondent (87%). In most cases, if the mother was not available, the child's maternal grandmother answered on her behalf (7%). For a few children only, paternal grandmothers (2%) and maternal aunts (2%) responded. The child's father only responded for 4 children (0.5%). No substantial differences were seen among survey respondents between the two villages.

Figure 4.6 Interviewer Joyce Mbata measuring a girl's height using the stadiometer

Households with at least one child under the age of 5 years had a mean size of 7.7 members per household (SD: 3.1; min, max: 3, 25). On average, households containing children under 5 years were larger in Welamasonga (mean: 8.5; SD: 3.2; min, max: 3, 25) than in Kisesa (mean: 7.1; SD: 2.9; min, max: 3, 25). In households with children under the age of 5, the average number of under-5 children per household was 1.7 (SD: 1.0; min, max: 1, 7). This was slightly larger in Welamasonga (mean: 2.0; SD: 1.1; min, max: 1, 6) than in Kisesa (mean: 1.6; SD: 0.8; min, max: 1, 7).

There were a few more male than female children interviewed with an overall of 49% girls and 51% boys making up the total sample. Children's ages ranged from 7 days old up to 60 months (5.07 years), with a mean age of 2.4 years or 29 months: 2.5 years in Kisesa and 2.4 years in Welamasonga. The majority of children were not their biological fathers' first-born (78%). This was true for both villages, however the proportion of first-borns was slightly higher in Kisesa (24%) than in Welamasonga (19%). The age distribution of children who were first-born was very similar to those who were not first-born.

Each respondent was asked whether they were the primary guardian of the child they were answering the survey for. If they said yes, they were listed as such solely and shared guardianship of child (e.g., by both parents) was not captured. If the respondent was not the primary guardian, they were asked to state who the primary guardian was. As majority of the respondents were the child's biological mothers, a corresponding number of children (86%) had only their biological mother listed as primary guardian. 7% and 2% of children had their maternal and paternal grandmothers listed as primary guardians respectively; and only 0.5% of children had their fathers as sole primary guardian.

As a crude measure for children's health, we asked each respondent to select one of 4 responses that pertained best to the child's health in general: always good; mostly good; mostly sick; always sick. Approximately half the respondents stated that the child's health was 'always good' (52%). Another 39% stated that the child's health was 'mostly good'. Very few children were considered to be 'mostly sick' (8%) and only 5 out of the total 808 (<1%) children were considered as 'always sick'. Children's health was stated to be 'always good' more in Kisesa (58%) than in Welamasonga (47%); whereas it was stated to be 'mostly good' more in Welamasonga (44%) than in Kisesa (35%). Children were 'mostly sick' slightly more in Welamasonga (9%) than in Kisesa (7%).

We were able to measure the height/length and weight of the majority of children: height/length for 94% of children (n=757) and weight for 96% of children (n=769). All children were measured with minimal clothing and no shoes. Child height was measured to the nearest millimetre using a stadiometer for those children who were able to stand on their own (Figure 4.4); a measuring mat was used to measure the length of infants who could not stand (Figure 4.5). Both length and height are referred to as 'height' in this thesis. Child weight was measured to the nearest 100 grams using an electronic weighing scale on solid ground. For babies and infants who could not stand on their own we first measured the weight of their mother/guardian, and then of the mother/guardian holding the child. Both weights were entered into ODK on the tablet, which was programmed to subtract the mother/guardian's weight from the weight of the mother/guardian with child, to calculate the child's weight. All measurements were made twice and entered into ODK. If there was a discrepancy of 5cm or more between the two heights entered, the program automatically requested a third measurement. Similarly, if there was a discrepancy of 2kg or more between the two weights entered, the program requested a third measurement. Once the final data were uploaded, we corrected for any odd or extreme entries, and a mean height and weight was calculated for each child. Children were measured by one of five different enumerators, who were rotated between both villages and assigned households randomly.

Figure 4.7 Interviewer Joyce Mbata measuring the length of an infant using the measuring mat, with the help of their mother

4.4 Focus group discussions

4.4.1 Inclusion criteria and sampling

Participants for the focus group discussions were recruited on the day prior to holding each FGD. The quantitative survey sample was used to create a list of potential FGD participants – so that responses to both the qualitative and quantitative components of the study were obtained from the same population. Four FGD were planned: two with mothers of children under the age of 5 years, one in the village and one in the town; and two with fathers of children under the age of 5 years, one in the village and one in the town. For each of the four FGD, the aim was to invite 10-12 participants, with 6-8 of them expected to show. The focus group discussions were not piloted.

Once the FGD participant list was selected from the quantitative sample, the village facilitators in each village - Isaac Sengarema in Welamasonga and Sunday Kituku in Kisesa – were asked to recruit between 10 and 12 people per FGD, with the hopes that at least 6 of these participants would attend the discussion.

Isaac and Sunday reached out to the potential participants (by calling them or visiting their households) and invited them to participate. If a participant on the list was not available or did not agree to participate, Isaac and Sunday were asked to reach out to another individual who met the inclusion criteria (as they are extremely well known in the villages this was a simple task for them). The criteria for inclusion were that the participant should have at least one child under the age of 5 years, and the group should represent a range of marital statuses. For fathers, this included those who were monogamously and polygynously married. For mothers, the aim was to recruit monogamously and polygynously married women, those who were widowed or separated, and those who were married but whose partner lived in a different home (e.g., due to employment in a different area). Further details on focus groups are provided in Section 4.4.

4.4.2 FGD themes and administration

I designed the focus group discussions to complement the questions that were included in the child survey and to provide cultural context to the quantitative findings. Thus, the main objectives of the FGD explored features of parental and alloparental care: (1) understanding how fathers view their roles and responsibilities towards children under the age of 5 years; (2) understanding how mothers view the roles and responsibilities of their husbands/partners/children's fathers towards children under the age of 5 years; (3) understanding who helps mothers care for their children, including fathers and other family members/friends/neighbours; and (4) understanding the role of non-resident fathers in their children's lives.

The content of the discussion guides was the same in Welamasonga and Kisesa, however as some questions were directed towards fathers, and others towards mothers, these differed slightly between each of those FGD. Thus objective 1 was only explored in the FGD with fathers, and objective 2 was only explored in the FGD with mothers – resulting in three 'themes' per FGD: the roles and responsibilities of fathers towards children aged under 5 years, as viewed by mothers and fathers separately; who helps mothers care for their children; and the role of non-resident fathers in their children's lives. These themes were explored using questions and prompts, as well as a vignette to understand the role of fathers in more depth. The FGD topic guides are provided in Appendix 10.4.

Two FGD took place in Welamasonga, and two in Kisesa, in September 2016. Each FGD approximately lasted for 1.5 hours, and all participants received a 5000 Tanzanian Shilling (~2.23 USD) compensation. In Kisesa, both discussions were held at the HDSS office while in Welamasonga, they were held at a local school. Participants were reimbursed their travel costs for attending the FGD and provided sodas as refreshment during the discussion. Tables 4.2 and 4.3 show the number and characteristics of the participants who attended each FGD. All participants in Welamasonga – men and women – listed 'farmer' as their occupation. There was more variability in Kisesa, where six of the eight male participants listed 'farmer', one said 'farmer/entrepreneur' and one was a skilled worker. Among the women in Kisesa, only four of the ten participants listed 'farmer'; three said 'entrepreneur'; two had a business/shop; and one said she was a homemaker. Of all the male participants, three fathers in Kisesa and two in Welamasonga were in a polygynous marriage, while the rest were monogamously married. Among the mothers, in Kisesa seven were monogamously married, two were divorced/separated, and one was widowed; whereas in Welamasonga, nine were monogamously married, one simply stated 'married' and one had never been married. The women's ages ranged from 18 years to 54 years, and they had between one and eight children; the men's ranged between 22 and 52 years and they had between two to ten children.

Table 4.2 Characteristics of mothers who attended each FGD

	Welamasonga	Kisesa
Mothers - n	11	10
Ages – n (%)		
18-30 years	10 (91)	5 (50)
31-40 years	-	4 (40)
41-50 years	1 (9)	-
51+ years	-	1 (10)
Marital status – n (%)		
Married monogamous	9 (82)	7 (70)
Married (no detail)	1 (9)	-
Never married	1 (9)	-
Widowed	-	1 (10)
Divorced/Separated	-	2 (20)
Number of children – n (%)		
1	1 (9)	1 (10)
2	2 (18)	2 (20)
3	2 (18)	4 (40)
4	3 (27)	-
5	1 (9)	-
6	2 (18)	2 (20)
7	-	-
8	-	1 (10)
Occupation – n (%)		
Farmers	11 (100)	4 (40)
Entrepreneur	-	3 (30)
Business/shop	-	2 (20)
Homemaker	-	1 (10)

Table 4.3 Characteristics of fathers who attended each FGD

	Welamasonga	Kisesa
Fathers - n	11	8
Ages – n (%)		
22-30 years	2 (18)	1 (12.5)
31-40 years	5 (45)	3 (37.5)
41-50 years	4 (36)	3 (37.5)
51-55 years	-	1 (12.5)
Marital status – n (%)		
Married monogamous	8 (73)	5 (62.5)
Married (polygynous)	2 (18)	3 (37.5)
Missing	1 (9)	-
Number of children – n (%)		
2-3	3 (27)	1 (12.5)
4-5	4 (36)	6 (75)
6-7	3 (27)	-
8-9	-	1 (12.5)
10	1 (9)	-
Occupation – n (%)		
Farmer	11 (100)	6 (75)
Farmer/Entrepreneur	-	1 (12.5)
Skilled worker	-	1 (12.5)

The FGD were carried out by facilitators with qualifications and considerable previous experience in conducting qualitative research and running focus group discussions. Five research facilitators were hired following NIMR's standard procedures; these individuals often work with NIMR on numerous different studies and have valid credentials. The FGD with mothers were run by three female facilitators, and those with men were run by two male facilitators. All facilitators were Tanzanian and fluent in both Swahili and English. At least one female and one male facilitator was also fluent in Sukuma, so that in case any of the FGD participants felt more comfortable speaking in Sukuma than in Swahili they were able to do so. One facilitator led the discussion, while the other(s) took notes. All FGD were recorded, with consent from the participants. To start the FGD, the participants were introduced to the study by the facilitators and told the aims of the research. The informed consent form was read out to each participant and their verbal consent taken for participation in the FGD as well as for the discussion to be recorded. The participants were told the discussion was confidential. Most participants conversed in Swahili, however some contributed in Sukuma. During each FGD, discussions were allowed to flow, but facilitators guided participants back to the primary themes if conversations strayed too far. They also asked probing questions to ensure that each main topic of interest had been saturated within the group before moving on to the next topic.

I was present for all four FGD. I helped set up the room prior to the discussion, greeted the participants as they arrived and asked them to confirm their attendance and record their demographic characteristics on the required form before being seated. I then remained in the room and observed the discussion while it was underway, and was available if the facilitators wanted to make any clarifications about a theme or topic during the discussion or if they had any questions. After each discussion, I sat with the facilitators to discuss (in English) their first impressions of the FGD and I made a record of their notes (in English). They provided a general overview of the discussion, and any particular points or moments that had stood out.

All FGD recordings were transcribed and translated from Swahili into English by Tanzanian researchers (fluent in both languages) who were employed at NIMR, Mwanza Centre, and usually work for different NIMR research projects. These transcription and translation services were paid for by our project's funding. These FGD have not as yet been analysed in their own right; I plan to conduct a thematic analysis in the future which will be the focus of a separate piece of research. However, I have drawn from them to provide some cultural context and qualify the findings in Chapter 5.

5. Fathers favour sons, mothers don't discriminate: sex-biased parental care in north-western Tanzania

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SECTION A – Student Details

Student ID Number	1401598	**Title**	Ms
First Name(s)	Anushé		
Surname/Family Name	Hassan		
Thesis Title	Parental care, allomothering and child health in north-western Tanzania: Who cares for children and does it matter?		
Primary Supervisor	Rebecca Sear		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	Evolutionary Human Sciences		
When was the work published?	December 2019		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	NA		
Have you retained the copyright for the work?*	**Yes**	Was the work subject to academic peer review?	**Yes**

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For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I am the first author on this paper. I was responsible for the study design, the data analysis, and preparation of the manuscript. I was primarily responsible for writing this work and responding to reviewer comments. My co-authors supported this work in an advisory capacity and helped edit the writing.

SECTION E

Student Signature	[redacted]
Date	19/11/2020

Supervisor Signature	[redacted]
Date	19/11/2020

5.1 Abstract

Variation in parental care by child's sex is evident across cultures. Evolutionary theory provides a functional explanation for this phenomenon, predicting that parents will favour specific children if this results in greater fitness pay-offs. Here, we explore evidence for sex-biased parental care in a high-fertility, patriarchal and polygynous population in Tanzania, predicting that both mothers and fathers will favour sons in this cultural setting. Our data come from a cross-sectional study in rural north-western Tanzania, which included surveys with mothers/guardians of 808 children under age-5. We focus on early childhood, a period with high mortality risk which is fundamental in establishing later-life physical and cognitive development. Examining multiple measures of direct/physical care provision (washing, feeding, playing with, supervising, co-sleeping, and caring when sick) we demonstrate that fathers favour sons for washing, feeding and supervising, while maternal care is both more intensive and unrelated to child sex. We find no difference in parental care between girls and boys regarding the allocation of material resources and the duration of breastfeeding; or in terms of parental marital and co-residence status. This bias towards sons may result from higher returns to investment for fathers than mothers and local gender norms about physical care provision.

5.2 Introduction

A broad principle of parental investment theory posits that natural selection will favour equal parental care for sons and daughters if rearing both sexes is equally costly, as each sex provides exactly half the genes for all future descendants (Fisher, 1930). However, the costs and benefits of investment in each sex are rarely uniform (Hamilton, 1967; Trivers & Willard, 1973), and discriminatory parental care by offspring sex is observed across human cultures. Parental investment is defined as any allocation of resources which benefits offspring at a cost to a parent's ability to invest in other components of fitness, while parental care more broadly refers to any parental trait that enhances the fitness of offspring, and is likely to have originated and/or to be maintained for that function, without necessarily being costly to the parent (Royle et al., 2012; Trivers, 1972). Parental care is the more appropriate term when costs to parental fitness are not directly estimated. The focus of this paper is on post-natal parental care, as opposed to biases in sex ratio at birth. Sex-biases in post-natal care may include such factors as discriminatory feeding, supervision, expenditure on health care and schooling, along with differential allocation of resources throughout life, including the transfer of inheritance.

When sex-biased parental care is observed it is most commonly biased in favour of sons (J. Hartung et al., 1976; Khera et al., 2014; Williamson, 1976). Son-preference is perhaps most evident in some East and South Asian societies (Das Gupta et al., 2003; R. Murphy, Tao, & Lu, 2011) but has also been widely reported in sub-Saharan Africa (E. K. Campbell, 1991; Fayehun, Omololu, & Isiugo-Abanihe, 2011; Frempong & Codjoe, 2017). Parental biases favouring sons will be adaptive when the marginal returns to investing in sons is greater than for daughters (Keller, Nesse, & Hofferth, 2001; Ross et al., 2016; Veller, Haig, & Nowak, 2016). This scenario may especially characterize contexts where variability in male fitness is extended via polygynous marriage so that successful males obtain particularly high reproductive success (Clutton-Brock, Albon and Guinness, 1981; Leimar, 1996; Irwin *et al.*, 2006; but see Brown, Laland and Borgerhoff Mulder, 2009). From a proximate economic viewpoint, investing in a son may also maximise chances of future financial and social returns and support in old age if men are valued over women for providing family labour and financial security for parents throughout their life-course (Becker & Tomes, 1976; Mutharayappa, 1997).

On the other hand, in some populations, parents invest more in daughters. This has been recorded, for example, among the Mukogodo of Kenya (Cronk, 1989, 1991b), and the Mosuo of China (He et al., 2016). One hypothesis suggested by researchers to explain daughter-preference is the concept of 'local resource enhancement' or 'helpers at the nest' (Pen & Weissing, 2000; M. Quinlan & Quinlan, 2005). This hypothesis posits that a disparity in the productivity of boys and girls as helpers in the household may bias favour towards the more helpful sex when that family does not have a sufficient number of that sex, whether male or female (M. Quinlan & Quinlan, 2005). In societies that favour daughters, girls tend to partake more than boys in activities that benefit the family economically and/or help more with housework and caring for younger children (Bereczkei & Dunbar, 1997, 2002; Hames & Draper, 2004; Margulis, Altmann, & Ober, 1993). However, helpers in the nest are not necessary for investment to be favoured towards daughters; in cases of very high male reproductive skew, most parents are expected to bias investment towards daughters, as in these cases most males will have almost no offspring, and only the highest quality males will be reproductively successful. Daughter-biased investment has been recorded among multiple populations, including American Hutterites (Margulis et al., 1993), communities in Tibet and China (Childs, Goldstein, & Wangdui, 2011; Du & Mace, 2017; Zhan & Montgomery, 2003) as well as the !Kung in Botswana (Hames & Draper, 2004).

Complicating the study of parental care, previous studies often quantify discriminatory treatment of sons and daughters using measures that may not accurately reflect parental intentions or capture actual parental behaviour. Such measures include self-reported preferences of parents (Brunson, 2010; Cronk, 1991a; Du & Mace, 2017); child outcomes such as health and mortality as proxies for differential investment (Arnold, Choe, & Roy, 1998; Chen, Huq, & D'Souza, 1981; Klasen, 1996; Svedberg, 1990); along with skewed sex ratios at birth and/or other ages (Guilmoto, 2012, 2015). These measures may be problematic for a number of reasons. First, there are often discrepancies between stated sex preferences and who parents actually invest in: one study in Amdo Tibet found girls were favoured due to their increasing economic value in a community where stated cultural norms favour males (Du & Mace, 2017); and similar discrepancies have been documented among the Mukogodo in Kenya, where there is a dissonance between stated cultural norms, which favour boys, and parental behaviour which is daughter-biased (Cronk, 1991a). Second, using differences in the wellbeing or survival of males and females to infer differences in care is problematic because such measures can vary independently of parental care in non-trivial ways. Male and female developmental trajectories are distinct, and males are generally subject to higher neonatal and infant mortality than females independently of parental behaviour (Wells, 2000). Likewise, educational attainment is now higher for females in most high-income populations, but this may reflect male vulnerabilities to mental health issues or other factors which favour school dropout (e.g. incarceration) rather than higher parental investment in daughters (Grant & Behrman, 2010; McDaniel, 2012). Finally, it is important to note that natural selection is anticipated to act independently on sex-ratio biasing and post-natal investments (Veller et al., 2016), so that evidence of one (e.g., a male biased sex ratio) should not be taken as evidence of the other (e.g., indication that male offspring are treated differently by parents after birth).

Quantifying differences in parental behaviour is thus preferable, especially behaviours most likely to be both costly to parents and beneficial to offspring (and so fitting the formal definition of parental investment) (CLUTTON-BROCK, 2019; Royle et al., 2012). Such measures can include conspicuous transfers of capital (e.g. at inheritance – Hartung et al., 1976; Hrdy & Judge, 1993); and observations or reports of provisioning that requires physical proximity and/or possibly energetic expenditure on the part of the carer (Baker & Milligan, 2016; Bereczkei & Dunbar, 1997; Cronk, 1991b; Lawson & Mace, 2009; Nikiforidis, Durante, Redden, & Griskevicius, 2018). In this paper, we explore evidence of sex-bias in post-natal parental care in a rural north-western Tanzanian population. We focus on children under 5-years because providing adequate care at this age is crucial for child health (Bhandari & Chowdhury, 2016). Children are vulnerable during this period, experiencing a high rate of preventable mortality [41 deaths per 1000 live births globally in 2016 (WHO, 2017)]. Additionally, this life-stage sets future trajectories of child growth; among other complications, poor feeding practices and malnutrition can result in stunting, wasting, underweight or overweight and obesity, which may have health implications throughout the life-course (Almond & Currie, 2011; Maluccio et al., 2009; Palloni, 2017). We consider four dimensions of parental care, measured through behaviour reported by children's mothers or guardians: (i) allocation of material resources, which we classify as indirect care provision as this can take place without any interaction between the child and carer; (ii) provisioning that requires the carer to expend energy, interact with the child, or be in physical proximity to the child (washing, feeding, playing with, supervising, co-sleeping, and caring for when sick), which we classify as direct/physical care provision; (iii) breastfeeding duration, a well-established determinant of child survival and nutrition outcomes (Lawson, Alvergne, & Gibson, 2012; Sellen, 2007); and (iv) parental marital status and co-residence, which we treat as a commitment to parental care, especially from fathers (see Dahl and Moretti, 2008).

In the study population, girls play a valuable role in contributing to household work (Hedges et al., 2018) and bridewealth is commonly practiced (Schaffnit, Urassa, et al., 2019) indicating that daughters may perhaps be energetically and financially beneficial for parents. However, high levels of fertility and polygynous marriage in Tanzania (total fertility rate: 6.4 births per woman; 18% of married women in the country have at least one co-wife (MoHCDGEC et al., 2016)) indicate both higher variation in male than female reproductive success as well as more opportunities for men to translate invested resources into reproductive success. Additionally, substantial value is placed on men in many Tanzanian communities, visible in traditionally practised patrilineal systems of marriage and wealth inheritance among local peoples e.g. marital systems are usually extended patrilocal, with women moving into their husbands' households after marriage; and wealth and land is most often passed primarily from father to son (Ezer, 2006). Investment biases favouring sons are usually present in such contexts, especially where polygynous marriage is common (Das Gupta et al., 2003; J. Hartung et al., 1976; Mace, 1996; Williamson, 1976). Therefore, we expect that parents will bias care towards their sons across all measures.

Our study has two major strengths. First, we consider a wide range of measures of parental care within the same population. Second, we explore provision of care from both mothers and fathers. Most studies of sex-biased care either focus on mothers, or investment from both parents, neglecting the role of fathers even though parental behaviour (and the subsequent fitness returns to investment) may vary by *both* the child's and parent's sex (as documented in some high-income populations: Lawson & Mace, 2009; Nettle, 2008; Nikiforidis et al., 2018).

5.3 Data and Methods

5.3.1 Data Collection

Our data come from two rural communities (one rural but rapidly urbanizing town and one rural village) in north-western Tanzania situated within the bounds of the Magu Health and Demographic Surveillance System (HDSS), which has been active in the area since 1994 (Kishamawe *et al.*, 2015; see also Hedges *et al.*, 2018). The area is primarily Sukuma. Although Tanzania is home to considerable ethnic diversity, the Sukuma are the largest ethnic group in the country, comprising approximately 17% of the national population (Malipula, 2016). We randomly sampled 743 households for the requirements of a larger project studying the wellbeing of women aged 15-35 years and their children (see Schaffnit, Hassan, Urassa, & Lawson, 2019). The data used for this paper comes from surveys conducted in the 506 households that had a resident child aged under 5 years, with 808 children surveyed. Each household survey recorded household membership, size and composition, and the demographic and socio-economic characteristics of the household head and all household members, including members' relationship to household head, household food insecurity and land ownership. All indicators used in this paper that pertain to the child and the child's parents were then measured via a child survey. The child survey was directed to either the child's biological mother or primary guardian if the mother was unavailable (with 87% of surveys being completed by the child's biological mother). The subsequent respondent answered all questions on the survey including those about behaviours (i.e., care and resource provisioning) from other relatives, including both biological parents. All interviews were carried out in Swahili or Sukuma using Open Data Kit (ODK) Collect software on electronic devices. Ethical approval was granted by LSHTM (13809), UCSB (1-17-0405), and NIMR (MR/53/100/463).

5.3.2 Variables Used and Data Analysis

Parental care was measured across several dimensions (our dependent variables) and associations with sex of the recipient child (the primary independent variable) were analysed using logistic regression and survival analysis depending on the measure of care (see below). Treating child's sex as an exogenous variable (i.e., there are likely to be few confounders of the associations we test), in all models, we adjusted only for child's age (continuous measure) and age-squared. We did not run multi-level models as we surveyed an average of 1.75 children per household and research shows that fixed and random effects both may be overestimated in two-level models when clusters are unbalanced and observations per group are sparse, i.e., less than 2 observations per group (Clarke, 2008). We acknowledge that this may result in standard errors being biased downwards.

Allocation of material resources was captured in a binary variable indicating whether the child had received resources from mothers and fathers (whether coresident or non-coresident with the child) in the 3 months preceding the survey (Mothers: n=807, 1 refusal; Fathers: n=807, 1 'don't know'). Resources could include food, medicine, clothes, money, household goods or 'other'. Direct/physical care provision was captured in six binary variables (n=808 for both parents unless stated otherwise) indicating whether mothers and fathers had washed, fed or cooked for, played with, supervised or monitored, slept in the same room as the child (Mothers: n=807, 1 missing), or cared for the child if sick in the two weeks preceding the survey (215 children had been sick in this time period: 103 girls and 112 boys; n=215 for both parents). Children whose mothers or fathers were not alive at the time of survey (Mothers: n=6; Fathers: n=9) were excluded from the analysis. Logistic regression models were used to test for associations between each measure of parental care and child's sex.

Mothers' investment in breastfeeding was measured in two ways. Firstly, for children who had stopped breastfeeding, we asked the respondent to report on time spent exclusively breastfeeding (i.e., a time period during which the child was given no other drink or food apart from breastmilk). A binary variable indicated exclusive breastfeeding for "Less than 6 months" or "6 or more months" (n=541; excluded: 5 children whose mothers had died, 5 who had never been breastfed, an additional 3 who had never been exclusively breastfed, 14 for whom the respondents did not know if they had ever been exclusively breastfed, and the 240 babies who were still breastfeeding at time of survey). Secondly, for all children, we asked the respondent what age the child had stopped breastfeeding completely. Child's age at breastfeeding termination was measured in months and coded as a continuous variable (n=798; excluded: 5 children who had never been breastfed and 5 whose mothers had died. All non-resident mothers (n=74) had breastfed their children so were included in the analysis). The 240 children still breastfeeding at time of survey were included in the analysis as right-censored cases (see below).

A logistic regression model was used to explore whether girls had higher odds of terminating exclusive breastfeeding before six months. Discrete-time event history analysis was used to test for an effect of child's sex on duration of overall breastfeeding: heaping of events at ages 6, 12 and 18 months meant that discrete-time survival analysis was the most appropriate method to use.

Two indicators measured parental relationship status. Firstly, whether the child's parents were married or divorced, regardless of co-residence or marital type (i.e., polygynous or monogamous). This included only those children whose parents were currently married (n=555) and those whose parents were separated or divorced (n=98), with a total sample of 653 children. Children were excluded if the respondent did not know (n=1) or refused to answer (n=1); if one or both parents were not alive (n=14); or if the parents were not in a relationship during the survey period and had never married and those who were in a relationship but unmarried. Secondly, parental relationship status was measured as whether the child's parents co-resided or not, regardless of marital status (n=793; excluded: if one or both parents not alive (n=14); refusal (n=1)). We acknowledge that parents' relationship status can be contingent on a complicated decision-making process, which may not always (or entirely) reflect investment in children, and is thus not an obvious or refined measure of parental care. However, we believe it can still provide important information about parenting in our study population.

We fit multivariate logistic regressions to examine the association between child's sex and parental marital status or co-residence. Considering we do not have data on children's elder siblings, whose sex may impact parental relationships, we also ran a sensitivity analysis restricting our sample to only first children of parents (n=101 for marital status and n=166 for co-residence).

5.4 Results

5.4.1 Household and Child Characteristics

There was an average of 7.7 household members and 1.7 children under age 5-years resident in each of the 506 households containing at least one child (Table 5.1). The majority of households were of Sukuma ethnicity (90%), identified with a form of Christianity (Roman Catholic: 36%; Other Christian 36%) and had a male household-head (81%). Most households-heads were educated to primary level (66%) with very few having progressed further (11%), and the remaining had no education (22%; don't know=1%). A little more than half of the household-heads listed farming as their main occupation (55%) followed by trading (21%). A large percentage of households scored high on food insecurity; 57% were categorised as severely insecure and 21% as moderately insecure. Food insecurity was measured using the Household Food Insecurity (Access) Scale (Coates et al., 2007), which records whether the household experienced problems with accessing food in the past month.

An equal proportion of girls and boys were surveyed with ages ranging from 7 days old up to 5 years. Whereas almost all children resided with their biological mothers (90%), one-third did not live with their biological fathers (of those with a living father). Almost one-third of children's biological parents were not married to each other, and the most common reason for this was separation or divorce.

Table 5.1 Household and Child Level Characteristics

	Girls	Boys	Total
Households with children 0-5 years			506
Total children 0-5 years	397	411	808
HOUSEHOLD CHARACTERISTICS			
Household size - mean (min, max)			7.67 (3, 25)
0-5y olds in household - mean (min, max)			1.75 (1, 7)
Food insecurity - n (%)			
Food secure			94 (18.61)
Mildly food insecure			19 (3.76)
Moderately food insecure			106 (20.99)
Severely food insecure			286 (56.63)
CHILD CHARACTERISTICS			
Age Continuous - mean (min, max)	2.44 (0, 5)	2.42 (0, 5)	2.43 (0, 5)
Age in Years - n (%)			
0-1 years	76 (19.14)	83 (20.19)	159 (19.68)
1-2 years	78 (19.65)	78 (18.98)	156 (19.31)
2-3 years	81 (20.40)	85 (20.68)	166 (20.54)
3-4 years	94 (23.68)	90 (21.90)	184 (22.77)
4-5 years	68 (17.13)	75 (18.25)	143 (17.70)
First Child of Biological Father - n (%)			
Yes	89 (23.06)	78 (19.65)	167 (21.33)
No	291 (75.39)	314 (79.09)	605 (77.27)
Don't know	6 (1.55)	5 (1.26)	11 (1.40)
Breastfeeding Duration* - n (%)			
0-5 months	11 (4.01)	6 (2.11)	17 (3.05)
6-11 months	18 (6.57)	19 (6.69)	37 (6.63)
12-17 months	113 (41.24)	132 (46.48)	245 (43.91)
18-23 months	83 (30.29)	83 (29.23)	166 (29.75)
23-26 months	49 (17.88)	44 (15.49)	93 (16.67)
PARENT CHARACTERISTICS			
Mother's Residence/Death - n (%)			
Lives in household	361 (90.93)	367 (89.29)	728 (90.10)
Does not live in household	32 (8.06)	42 (10.22)	74 (9.16)
Dead	4 (1.01)	2 (0.49)	6 (0.74)
Father's Residence/Death - n (%)			
In the household	265 (66.75)	282 (68.61)	547 (67.70)
Not in the household	123 (30.98)	117 (28.47)	240 (29.70)
Dead	4 (1.01)	5 (1.22)	9 (1.11)
Don't Know / Refusal	5 (1.26)	7 (1.70)	12 (1.49)
Parents' Marital Status - n (%)			
Married	275 (71.24)	280 (70.53)	555 (70.88)
Not Married	110 (28.50)	116 (29.22)	226 (28.86)
Don't Know / Refusal	1 (0.26)	1 (0.25)	2 (0.26)

**among weaned children only (n=558)*

5.4.2 Resource Allocation and Direct/Physical Care Provision

A breakdown of resource and direct/physical care provision by child's age and parent's gender is presented in Figure 5.1. Of the total sample of children, a majority were reported to have received resources from their mothers and fathers in the 3 months preceding the survey, and both parents were equally likely to have provided resources in this time period (81% from mothers; 81% from fathers). However, resource provision from fathers differed by paternal residence: 99% of coresident fathers (n=547; 68% of total sample) had supported their child by providing resources. In contrast, among non-coresident fathers (n=240; 30%) only 45% had provided resources in the past 3 months. Due to the lack of variation in resource provisioning by fathers among children with coresident fathers, we restricted analyses regarding resource provision from fathers to children with non-coresident fathers only. There was no evidence of a difference between resource provision to boys and girls from either parent (Table 5.2; Supplementary Tables S5.2.1 and S5.2.2).

With regards to direct/physical care, survey respondents stated that mothers provided all six types more often than fathers in the two weeks preceding the survey (Figure 5.1). Very few non-coresident mothers and fathers were reported as providing any of the six types of this care to their children during this time period and so we excluded these parents from our analysis: non-coresident mothers - washing (n=2, 3%), feeding (n=5, 7%), playing with (n=2, 3%), supervising (n=4, 5%), co-sleeping (n=2, 3%) and caring for when sick (n=1, 10%); non-coresident fathers - washing (n=0), feeding (n=8, 3%), playing with (n=19, 8%), supervising (n=18, 8%), co-sleeping (n=11, 5%) and caring for when sick (n=7, 10%).

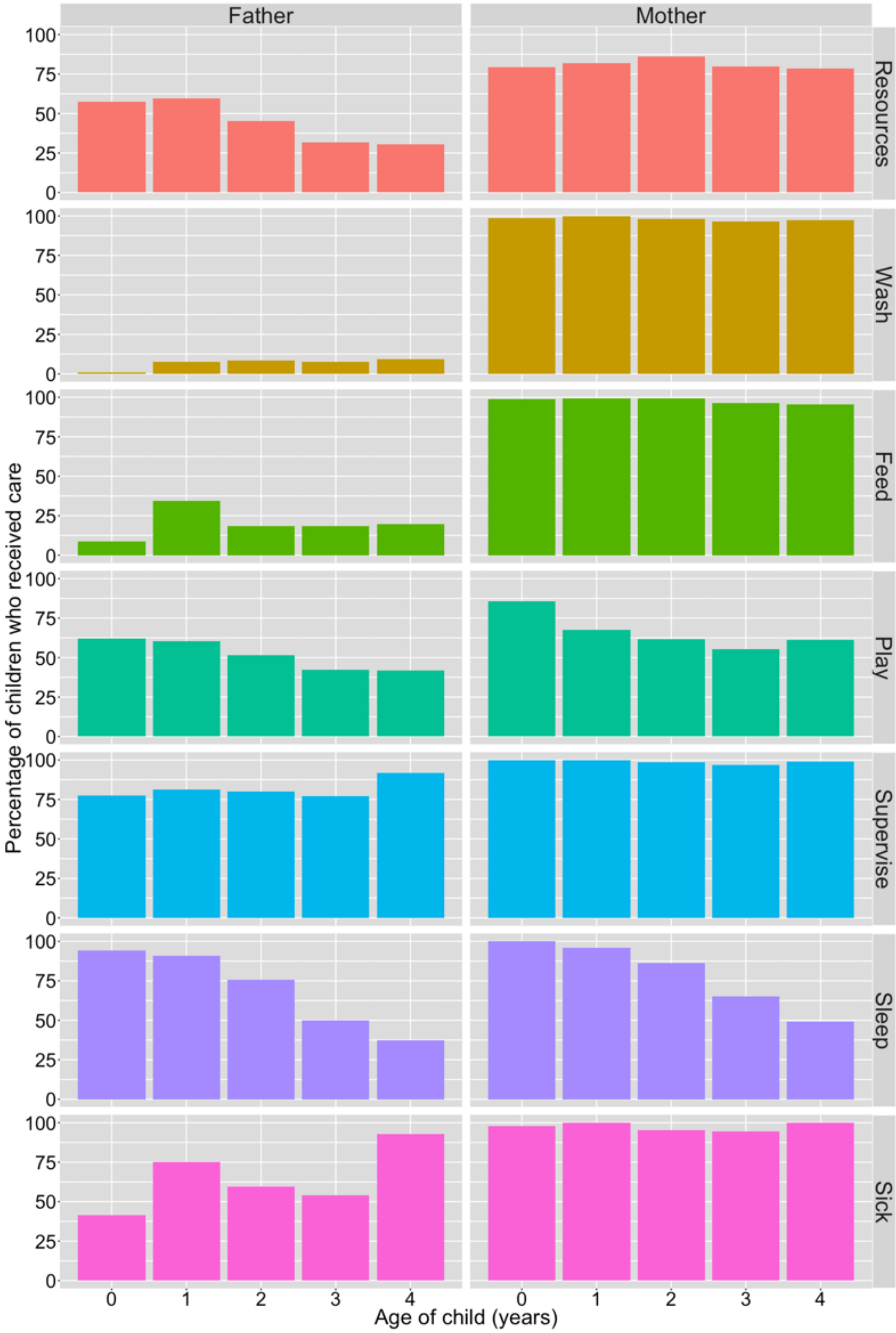

Figure 5.1 Percentage of children reported to receive material resources in past 3 months and direct/physical care in past two weeks from their biological fathers and mothers, by child's age (years)

Note: Resource provision is from alive mothers (n=801; excluded 'refusal' n=1) and non-coresident fathers (n=239; excluded 'don't know' n=1); direct care is from coresident parents only (Mothers: n=728; Fathers: n=547); caring for sick children limited to children who had been sick in past two weeks (n=215).

A greater percentage of boys than girls were reported to have received all types of direct/physical care from their coresident fathers; whereas, the results from coresident mothers were inconsistent, with little visible difference in care provision between sons and daughters (Figure 5.2). Logistic regression models showed no difference between boys and girls for any of the six types of direct/physical care provision from coresident mothers: confidence intervals for odds ratios crossed 1 and p-values were greater than 0.1 (Table 5.2; Supplementary Figure S5.1; Supplementary Tables S5.3.1-S5.3.6). Sons had higher odds of receiving all six types of direct/physical care from coresident fathers than daughters, with strong evidence of a difference in odds (at $p<0.05$) for washing, feeding and supervising the child (Table 5.2). For the other activities, effect sizes were comparable but in all cases 95% confidence intervals crossed 1 and p-values were greater than 0.1 (Table 5.2; Supplementary Figure S5.1; Supplementary Tables S5.4.1-S5.4.6).

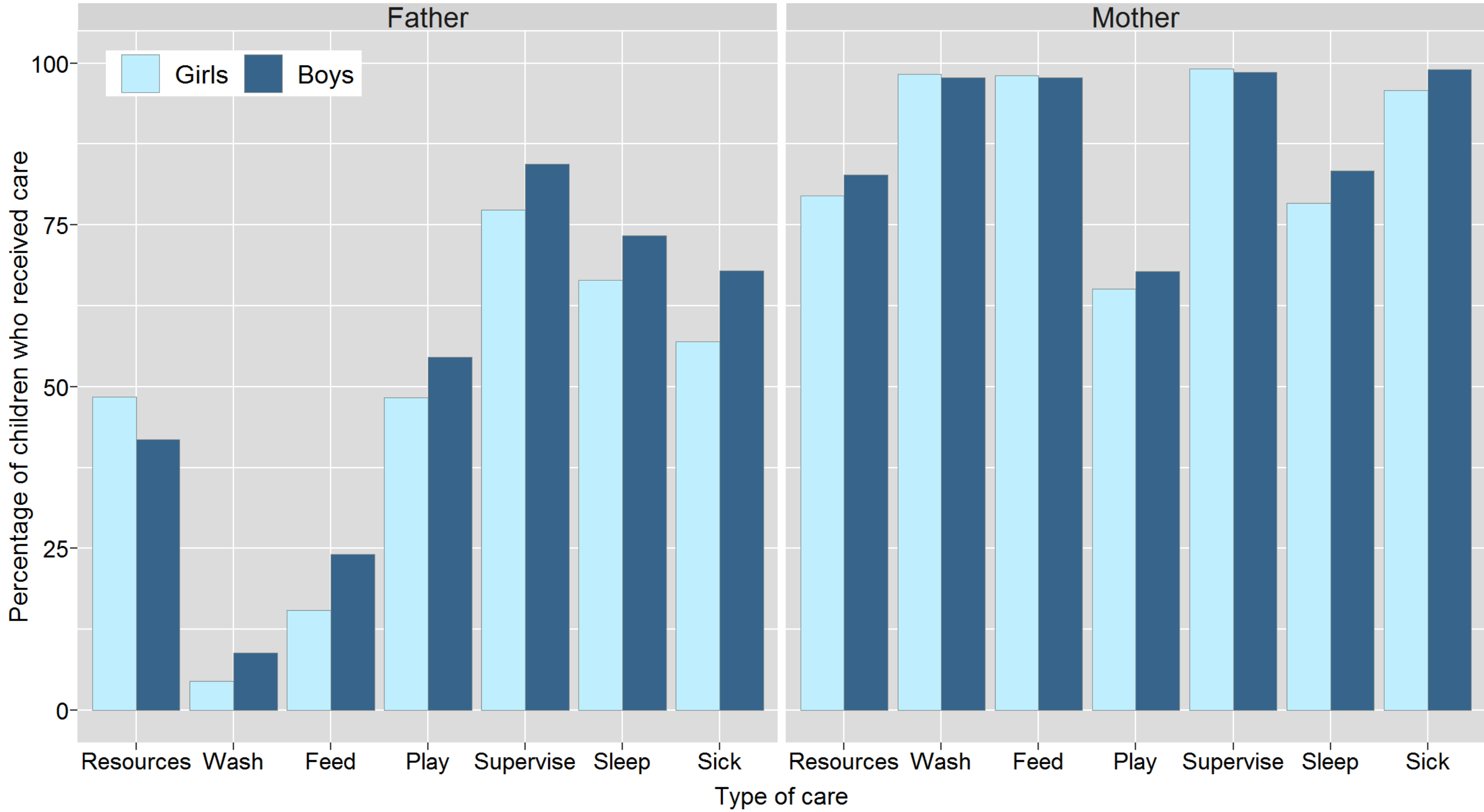

Figure 5.2 Percentage of children reported to receive material resources in past 3 months and direct/physical care in past two weeks from their biological fathers and mothers, by child's sex.

Note: Resource provision is from alive mothers (n=801; excluded 'refusal' n=1) and non-coresident fathers (n=239; excluded 'don't know' n=1); direct care is from coresident parents only (Mothers: n=728; Fathers: n=547); caring for sick children limited to children who had been sick in past two weeks (n=215).

Table 5.2 Logistic regression outputs showing associations between child's sex and each type of parental care provision.

	Odds Ratio (95% CI)							
Type of Care	Resource Allocation		Washing		Feeding		Playing	
	Mother	Father	Mother	Father	Mother	Father	Mother	Father
n	807	239	728	547	728	547	728	547
Child is Male	1.21 (0.84-1.73)	0.86 (0.51-1.46)	0.75 (0.26-2.19)	2.19* (1.07-4.47)	0.88 (0.31-2.46)	1.76** (1.14-2.71)	1.12 (0.81-1.53)	1.24 (0.88-1.74)
Type of Care	Supervising		Sleeping Next To		Caring when Sick		Exclusive Breastfeeding	
	Mother	Father	Mother	Father	Mother	Father	Mothers	
n	728	547	727	547	204	143	541	
Child is Male	0.59 (0.14-2.48)	1.63* (1.06-2.52)	1.45~ (0.95-2.20)	1.28 (0.84-1.93)	4.30 (0.47-39.47)	1.56 (0.78-3.1)	0.85 (0.60-1.20)	
Type of Care	Parents Married vs Divorced		Parents Married vs Divorced		Parents' Co-reside vs Live Apart		Parents' Co-reside vs Live Apart	
	Full Sample		First Child Only		Full Sample		First Child Only	
n	653		101		793		166	
Child is Male	1.00 (0.65-1.55)		1.13 (0.45-2.82)		1.12 (0.83-1.51)		1.42 (0.74-2.73)	

~p<0.10; *p<0.05; **p<0.01; ***p<0.001

Note: Effect sizes (Odds Ratios) adjusted for child's age (continuous) and age-squared. Full models for each type of care available in Supplementary Material Tables S5.2.1-S5.6.4. Resource allocation is from alive mothers (n=801) and non-resident fathers (n=239); all six forms of direct/physical care are from co-resident parents only (Mothers: n=728; Fathers: n=547); caring for sick children is limited to children who had been sick in past two weeks (n=215).

5.4.3 Breastfeeding Duration, Parental Marital Status and Co-Residence

There was almost universal coverage of breastfeeding among the children surveyed (99% of children experienced at least some breastfeeding), with 30% of children still breastfeeding during the survey period. Among weaned children (n=558), the median time to weaning was 17 months; this did not differ by child's sex. The majority of weaned children were breastfed exclusively for at least 6 months (62%). More girls were reported as being exclusively breastfed for at least 6 months (63%) than boys (60%), but this small difference was not statistically significant (Supplementary Table S5.1). A Kaplan-Meier survival curve showed no visible difference between duration of overall breastfeeding between sons and daughters and a log-rank test conducted to check equality of the survivor function across both sexes confirmed this (p=0.27). Discrete-time survival analysis showed no difference in age at weaning among sons and daughters (Figure 5.3; Supplementary Tables S5.2-S5.3; Supplementary Figure S5.2).

Neither parental marital status nor residential situation were related with children's sex (Table 5.2; Supplementary Tables S5.6.1-S5.6.4).

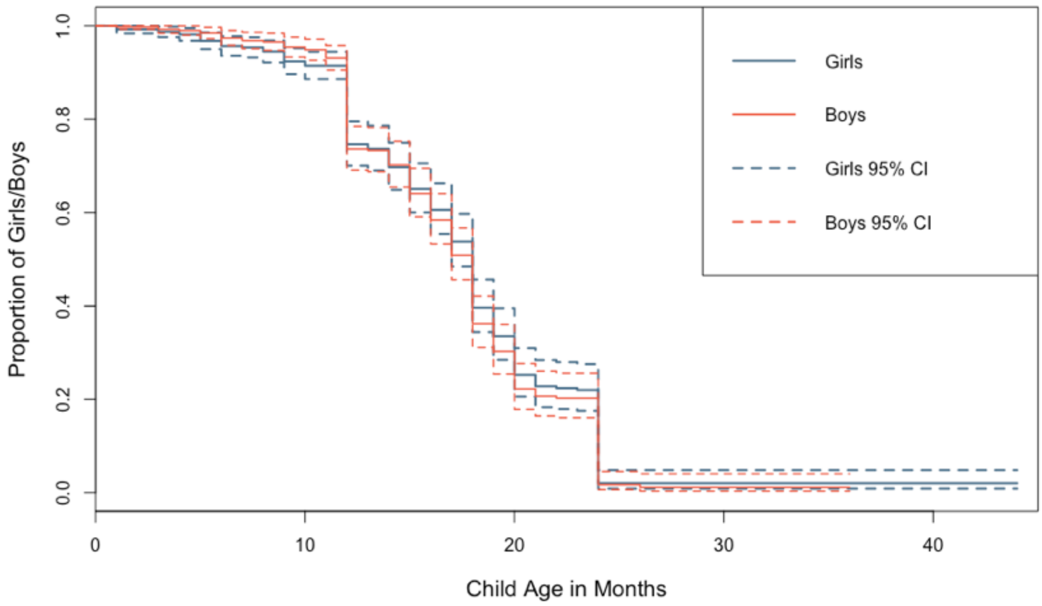

Figure 5.3 Kaplan Meier Survival Curves showing difference in overall breastfeeding duration between boys and girls with 95% CI

5.5 Discussion

Sex biased parental care is common throughout the world with parents expected to direct investment towards the sex with a higher fitness pay off. In this rural Tanzanian context, analysing reports of parental care behaviour from children's mothers or guardians, we find that fathers favour sons in several measures of direct/physical parental care; but mothers do not discriminate their care in any form – resource provisioning, direct/physical care, or breastfeeding duration – based on their child's sex.

We explored if mothers and fathers provided care differentially to children, without making a priori predictions about whether or how sex-bias would vary between them. Previous research suggests that mothers and fathers can differ in the care given to sons and daughters. For example, patterns similar to our finding that fathers favour sons (at least in some dimensions of care) but mothers don't discriminate have been seen in both contemporary high-income populations (Harris, Furstenberg, & Marmer, 1998) and in another Tanzanian population (among Hadza hunter-gatherers (Marlowe, 2003)). Other studies document a paternal bias towards sons without reporting on maternal biases. For example, researching men's preferences for their children's sex and resultant contraceptive behaviour, Mwageni et al. find men to have a strong inclination towards having sons over daughters (Mwageni, Ankomah, & Powell, 2001); and Nettle finds fathers invest more in sons vs daughters among a large British cohort (Nettle, 2008). Research also reports on maternal biases towards daughters without collecting data on fathers (Suitor & Pillemer, 2006). One particularly large-sample study of British families finds fathers spend more time engaging in childcare activities with sons while mothers favour daughters (Lawson & Mace, 2009). Analysing data from South Africa, Bangladesh, Indonesia and Ethiopia, a study finds substantial variation by country in parental investment in children's education by both child and parent's gender (Quisumbing & Maluccio, 2003). The authors highlight the need to consider context-specific factors that drive parental gender preferences. A recent study of parental time investment among East and South Asian families in the US (more than nine countries of origin included) suggests that norms of son preference persist post-migration but only for mothers (Kaushal & Muchomba, 2018). Here, mothers spend more time with young sons than daughters whereas fathers are gender neutral with this age-group (0-5 years); as children grow older, mothers spend more time with daughters and fathers with sons (6-17 years).

What lies behind such variation in the behaviour of mothers vs. fathers in relation to child sex is not immediately obvious, but may reflect contextual differences in sex-specific costs and benefits of care and/or related cultural variation in gendered division of parenting. One explanation for fathers caring more for boys than girls in the context of rural Tanzania could be that fitness interests of fathers and sons are more closely associated than those of fathers and daughters, resulting in greater investment from fathers in sons. For example, in patrilineal and patrilocal societal structures male relatives may cooperate more with each other as residential and descent patterns favour men, whereas women move away from their relatives and do not inherit either the family name or wealth (Gibson, 2008; Pashos & Mcburney, 2008). Mothers on the other hand may invest equally because they stand to receive equal returns from both sexes: as well as receiving the benefits sons are expected to bring in terms of reproductive and financial payoffs, they also benefit from the help daughters provide with housework and childcare later in life (which may have relatively little impact on fathers). It would be instructive to explore this possibility with data on the long-term consequences of parental investment in sons versus daughters.

It is also possible that the patterns we observe are not adaptive or meaningful from a fitness perspective but nevertheless in line with local cultural customs. On a proximate level, our findings are consistent with articulated gender norms relating to parental care in Kisesa. In exploratory focus group discussions with parents of children under 5-years of age (conducted alongside quantitative data collection), both mothers and fathers commented on gendered aspects of parenting. Several mothers indicated that direct physical care of daughters by fathers was taboo, with one stating *"he can help you wash and clothe the child, but it should not be a female child…it's normal for a man to wash a male child but not a female child"* and another corroborating this "*when a female child reaches two or three years old she shouldn't be washed by her father".* This sentiment was echoed by fathers, with one stating "*I think the girl child under the age of five, may be some are afraid of female gender… people here are sensitive with gender… the big percent is done by women"*. While not all parents shared these views (one parent countered that child sex was of little relevance "*the issue is not whether it is a male or a female child; he would have done the same because it is his child"),* the articulation of these norms by parents suggest that our quantitative findings regarding discriminatory paternal care reflect real behaviour.

In contrast to our finding that fathers bias some care towards sons, our previous research in this population indicates that among recent cohorts parents invest more in their daughters' education compared to their sons' (Hedges et al. 2018). This may be because, in the context of agropastoralist livelihoods, boys subsistence work (farm work, cattle herding) is relatively difficult to combine with school whereas girls' work (largely domestic tasks) can more easily be done outside of school hours (Hedges et al., 2018). Together, these studies highlight that sex-biases in parental care can vary across the child's life course and across the dimension of care considered.

Another tenet of evolutionary parental investment theory is the Trivers-Willard Hypothesis (TWH). This suggests parents in 'good condition' (e.g., resource-rich) will benefit more from investing in offspring of the sex that has greater variation in reproductive success (often males); and parents in 'poor condition' (e.g., resource-poor) will benefit more from investing in offspring of the other sex (often females) (Trivers & Willard, 1973; Veller et al., 2016). However, interpretations of tests of the TWH have been muddled by a widespread failure to first confirm whether the preconditions of the TWH (for details see Trivers & Willard, 1973: page 91) are met. In light of these problems (see Cronk, 2007 for review), and our lack of supporting data to establish these preconditions, we have opted to not test the TWH in this study.

We did however, in supplementary analyses, consider the possibility that sex-biases in care provision may vary by the child's age or birth order, and considered whether alloparenting may compensate for the lack of paternal care provision for girls. To explore child age and birth order we conducted two subsequent analyses. The original regression models for resource allocation, direct/physical care provision and parental marital status and co-habitation were re-run, including an interaction term for a continuous measure of child's age; and including an interaction term for whether the child was their father's first born or not, measured as a binary variable. There was no evidence of an interaction between child's sex and either child's age or child's birth order for any form of care provision (See Supplementary Tables S5.7.1-S5.7.17 and S5.8.1-S5.8.17). To examine alloparent compensation, we used data on resource allocation and all six forms of direct/physical care provision from five different alloparents (maternal grandparents, paternal grandparents, maternal aunts/uncles, paternal aunts/uncles and child's siblings) collected using the same methods as defined earlier for parents. Logistic regression models tested for associations between each measure of alloparental care and child's sex. We found no evidence of sex-biased care provision from any alloparent (See Supplementary Tables S5.9.1-S5.9.2).

5.5.1 Limitations and Future Work

Our analysis is limited by some weaknesses inherent in survey-data. For example, it is possible that social desirability bias may have impacted responses to our questions on care provision for children as respondents may be inclined to answer in ways they think others want to hear. However, as our participants were blind to our hypotheses (i.e., not informed that we would compare care of sons with daughters), we consider that this will not have impacted our findings substantially.

It is possible that the extra care sons receive from fathers is surplus and will not impact their survival and eventual reproductive success. If this is the case, then a functional/adaptationist perspective on sex-biased parental investment may be misguided. However, the under-5 year age group is a critical period for children and we would expect that even marginal amounts of care could have a potentially significant impact on their wellbeing. Thus, a logical follow-up to this study would be to investigate a link between parental care and children's health and survival.

5.5.2 Conclusion

We report novel evidence of sex-biased parental care in early childhood among a Sukuma community in north-western Tanzania. We also add to previous scholarship by providing detailed information on what both fathers and mothers do for their young children in this context. We find that mothers provide more direct/physical care to children, but also observe significant amounts of direct/physical care and resource provisioning from fathers. Furthermore, we find that fathers provide direct/physical care differentially by child's sex while mothers do not discriminate. Sex-biases in fathering appear limited to direct interactive forms of childcare, and are further reflected in local gender norms articulated by parents. An evolutionary perspective predicts that these patterns are ultimately accounted for by higher returns to paternal care in sons over daughters, as has been suggested in past research in other cultural settings (e.g. (Nettle, 2008)). Further research will be required to determine whether or not these patterns are generalizable to related low-income settings, and whether sons actually benefit from more care from their fathers during this vulnerable stage of child development.

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6. Childcare in transition: evidence that patterns of childcare differ by degree of market integration in north-western Tanzania

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Surname/Family Name	Hassan		
Thesis Title	Parental care, allomothering and child health in north-western Tanzania: Who cares for children and does it matter?		
Primary Supervisor	Rebecca Sear		

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For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I was responsible for the study design and the data analysis. I was primarily responsible for writing this paper. My co-authors supported this work in an advisory capacity and helped edit the writing.

SECTION E

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6.1 Abstract

Women around the world receive help with childrearing, much of which would have come from kin throughout most of human history. Market integration is known to be associated with less kin-dense social networks leading to the common expectation that it also transforms patterns of allomaternal care. Yet, few empirical studies have quantified the role of market integration in childcare patterns. We test the hypothesis that higher levels of market integration will be associated with (i) a lower probability of receiving allomaternal support from kin; and (ii) higher probability of receiving support from non-kin. Using a survey of 808 children under 5 years from Mwanza, Tanzania, we test for differences in childcare arrangements between a more market integrated town and less market integrated village. We consider two types of allomaternal care - low-intensity and high-intensity - from seven sources - fathers, siblings, maternal and paternal grandparents, maternal and paternal aunts/uncles and distant/non-kin. In the town, fathers, siblings and paternal kin had lower odds of providing care, whereas distant/non-kin had higher odds of doing so. Care from maternal kin was not associated with market integration. Market integration appears to disrupt paternal kin-orientated childcare arrangements, yet does not impact care from maternal kin, who may overcome greater physical distance to maintain contact. Distant/non-kin appear to substitute for the reduced support from kin in the town. We contribute data on an often assumed, but rarely tested, hypothesis: that market integration is associated with lower likelihood of help from kin, finding mixed support for this hypothesis.

6.2 Introduction

Increasing levels of market integration across the world are altering who people regularly interact with (Fischer, 1982; M. Murphy, 2008; Newson, Postmes, Lea, & Webley, 2005; Zelinsky, 1971). It is commonly presumed that due to differences in physical proximity to kin, individuals living rurally rely more on kin for support (Nelson, 2020), whereas individuals in urban communities are more likely to cooperate with non-kin (David-Barrett, 2019; M. Murphy, 2008, 2011; Sear & Coall, 2011). Dissolution of kin networks with market integration and urbanisation could result from declining dependence on agriculture leading to families living further apart in their search for work (Nelson, 2020). In support of this idea, between 1790 and 1940 in the US, living close to patrilineal kin declined from nearly 50% of households to 17% - a decline that is partially attributed to urbanisation (Nelson, 2020). Similarly, in Poland, rural economies are characterised by large kin-dense support networks (i.e., a high proportion of the support network is comprised of kin who are also connected to each other), while women living in households that are more market integrated tend to have less kin-dominated networks (Colleran, 2020b).

Declining kin availability, and this proposed erosion of kin networks in more market integrated communities, may well then have implications for who provides childcare support to mothers – or allomaternal support (G Bentley & Mace, 2009; Hrdy, 2005b; Sear & Coall, 2011; Sear & Mace, 2008). Evolutionary anthropologists have demonstrated that humans have adopted a system of cooperative reproduction, in which women require help to raise children (Hrdy, 2005b). While allomothering is documented in most societies around the world, there is large diversity in who helps and the type of help provided; as well as in the impact of this help on women's fertility and children's survival and health (Schaffnit & Sear, 2017; Sear & Coall, 2011; Sear & Mace, 2008). It therefore matters to understand how level of market integration correlates with types and sources of allomaternal support, as different patterns of support can drive real world differences in fertility and health between more and less market integrated populations. As such, in this study we compare patterns of allomaternal care between a town and a village in north-western Tanzania that vary in their level of market integration but are culturally and historically similar in other ways.

In this paper, we use the term market integration to refer to shifts in subsistence from economies largely reliant on farming and agriculture to those that are more dependent on wage-based labour and market work. The terms 'market integrated' and 'urban' are used interchangeably, with less market integrated communities referred to as 'rural' and more market integrated ones as 'urban'. Rural and urban populations (i.e., less and more market integrated) differ considerably in their demographic make-up, in ways that can determine people's social worlds. Whereas extended family co-residence and high fertility are common in rural populations (Bentley, Goldberg, & Jasienska, 1993; Hedges et al., 2018; R. S. Walker, 2014; R. S. Walker et al., 2013), urbanised market economies tend to feature less complex family systems, lower fertility, and higher investment in human capital (due to a shift from agriculture-based to wage-based labour and an emphasis on formal education) (Gurven, Jaeggi, Von Rueden, Hooper, & Kaplan, 2015; Hedges et al., 2018; H. Kaplan, 1996; Mattison & Neill, 2013; Mattison & Sear, 2016; Sear & Coall, 2011). Living in close proximity to family is correlated with more frequent and consistent childcare provision (Clark, Madhavan, Cotton, Beguy, & Kabiru, 2017); perhaps increasing the availability and readiness of kin to provide help in rural areas (Sear & Coall, 2011). If urban households are smaller and more nuclear, and extended families do not reside nearby, seeking help from them may not be as easy as in rural neighbourhoods. High fertility coupled with lower investment in formal education in less market integrated communities also enables older children to help mothers with domestic tasks including childcare. Contrastingly, lower fertility in urban communities can mean fewer siblings. Additionally, more investment in children's education means that the relatively fewer older siblings who are present are less able to provide allomaternal support due to the demands of schooling. Children living rurally may therefore receive more care from their kin, especially siblings, compared to children living in more urban communities.

However, a number of studies suggest the relationship between market integration and kin support may not be straightforward. In Zambia, it has been argued that socioeconomic instabilities resulting from urban living have led urban-dwellers to foster stronger connections with their village-based families (Cliggett, 2003); and kinship systems among an Igbo community in Nigeria have strengthened amidst contemporary political and economic instability as social ties are used to navigate structures of power (Smith, 2001). Urban settlements also have certain other distinct features that distinguish them from rural ones, for example, being more densely populated and having better transport links. These can diminish geographical barriers between families and may even facilitate the provision of allocare from non-resident kin. Women may also prefer to receive support from their kin, regardless of where they reside, as it is more dependable and of better quality compared to non-kin (Sear and Coall, 2011; Valeggia, 2009). Some kin members, especially women's own mothers, may be willing or urged to bear the costs of travelling to provide help. This is seen in other contexts, for example, in rural Ethiopia, maternal grandmothers not residing with their married daughters continue to provide physical support regardless of the distance between their households (Gibson & Mace, 2005); and in Indonesia, grandparents provide more household help to daughters who are working outside the home (Snopkowski & Sear, 2015). So, urban women may receive similar levels of care from their kin as rural women – highlighting the need for studies that explore rural-urban differences in support provision.

Depending on the context, women living in urban communities may also require more help with childcare if they participate in wage-labour outside the home, compared to rural women who engage primarily in domestic labour or farm work more readily compatible with childcare. While relatives are likely accessible and willing to provide help in urban locales, women's interactions with non-kin may still be still more frequent and regular simply because there are more of them around. Receiving allomaternal care from non-kin is not uncommon, even in the absence of market integration (Crittenden & Marlowe, 2008; Hrdy, 2011; Meehan, 2008, 2009; Meehan & Crittenden, 2016) and we expect social support to come from individuals who are around mothers more, such as friends and neighbours. An increased need for childcare together with higher availability of non-kin may lead to women living in urban neighbourhoods receiving more help from non-kin than women in rural areas.

It is more straightforward to envisage that because higher levels of market integration predict less kin dense networks, allomaternal support will be more likely to come from non-kin in market integrated settings than it would in less market integrated ones. However, there are reasons why this may not be the case; while market integration may result in increased distances from kin and reduced number of kin in a woman's social network, family members may still be motivated to overcome physical and social barriers to provide childcare support. While studies have demonstrated that kin density declines with market integration (Colleran, 2020b; Nelson, 2020) to our knowledge the hypothesis that level of market integration is predictive of patterns of allomaternal care provision has only been tested in one other study, where Schacht et al (2018) find that increased market access over a span of 20 years in a Mayan village co-occurred with changing patterns of paternal investment (Schacht, Davis, & Kramer, 2018). In this paper, we contribute towards filling this gap by providing a descriptive demographic perspective on childcare provision in two neighbouring communities in north-western Tanzania, a rural village and an urban town. While geographically close and culturally similar, previous research in the communities (see Hedges *et al,* 2018) and our observations during data collection suggest that the two vary in their levels of market integration. We first test this proposed variation in market integration between the two locations using our data, by identifying socio-economic and demographic markers of market integration and comparing these between the village and town. We then compare who provides allomaternal childcare in each community, with the level of market integration operationalised by whether children lived in the village or town. We make two predictions: (i) children in the village will have higher odds of receiving allomaternal care from kin than children in the town; and (ii) children in the town will have higher odds of receiving care from non-kin than children in the village. We utilise survey data on five measures of allomaternal care and seven categories of carers, from a relatively large sample compared to other anthropological studies on allomothering (n=808 children under 5-years). For the purpose of this study, we define childcare as 'direct' or 'physical' care provision that requires active involvement with the child.

6.3 Data and Methods

6.3.1 Data collection

We collected data from two neighbouring communities in north-western Tanzania, situated within the Magu Health and Demographic Surveillance System (HDSS). The Magu HDSS, 20km east of Mwanza city, is managed by the Tanzanian National Institute for Medical Research (NIMR), Mwanza Centre, and has a population of approximately 35,000 people (Kishamawe et al., 2015). Data were collected through cross-sectional surveys, from July through October 2017, for the requirements of a larger project studying marriage and the wellbeing of women and their children (Lawson et al., 2020; Schaffnit, Hassan, Urassa, & Lawson, 2019b).

Households were selected through simple random sampling using the 2016 HDSS census as a sampling frame and were eligible for inclusion in the study if they had resident at least one girl/woman aged 15 through 35-years. This age range was chosen for the requirements of the larger project; as was our sample goal of surveying 900 women (for details see Schaffnit *et al.*, 2019b; Lawson *et al.*, 2020). To reach our sample goal, we approached 1254 households; of these, 743 were surveyed leading to a total of 993 women. The gap between households approached and included was largely due to ineligibility of many of the households selected from the sampling frame (either because of the outmigration of the woman or of the entire household). Of the women who were successfully contacted, less than 1% refused participation. Once a household was included in the study based on the woman's participation, we asked if the household had a resident child under the age of 5 years. All children under 5-years of age were eligible for the child's survey. Data used in this paper come from surveys conducted in 506 of those households that had a resident child aged under 5 years (N=808).

Verbal consent for participating in the study was obtained from all adults before the interviews, as well as consent from parents/guardians to measure their children. An information and consent form describing the study's goals and any risks/benefits of participation was read out to participants, who were then given time to ask questions and/or accept/decline to take part. Each participant was given a hard copy of the informed consent form as well as contact details for NIMR representatives in case they had any concerns or questions in the future.

At each household, we first recorded household membership, size and composition, the demographic characteristics of all household members, and household socio-economic status through household surveys with household heads (n=743). Following this (and the interviews with the eligible resident women), we conducted interviews with the eligible children's biological mothers or primary guardians. These lasted up to 30 minutes. All indicators used in this paper that pertain to the child and the child's parents were measured through the children's surveys. Participating in the study was voluntary and survey respondents were not paid. All interviews were carried out in Swahili or Sukuma using Open Data Kit (ODK) Collect, an electronic data collection software (Brunette et al., 2013). Ethical approval was granted by the National Institute for Medical Research, Tanzania (MR/53/100/463), the Tanzanian National Ethical Review Committee (NIMR/HQ/R.8a/Vol.IX/3104), London School of Hygiene and Tropical Medicine (13809), and University of California Santa Barbara (1-17-0405).

6.3.2 Study population

The two communities selected for this project represent either extreme of a rural-urban gradient within the HDSS, and thus two levels of market integration. The village is less market integrated than the town. Previous work in these two communities shows that more village than town residents rely on subsistence farming (village: 38%, town: 10%); they farm and sell agricultural produce more (45% versus 4% in the town); and own and herd cattle more (44% versus 7% in the town) (Hedges et al., 2018). Children in the villages also regularly contribute to farm-work (Hedges et al., 2018). In contrast, the town has experienced substantial market integration over the past decade with an increase in owning or working in small businesses or partaking in petty trading, labouring or skilled work, for example, more households in the town have a busines or shop (33% versus 10% in the village), and more have salaried (13% versus 2% in the village) and skilled members (20% versus 3% in the village) (Hedges et al., 2018). The town bestrides the main road linking Mwanza to Kenya. It is relatively densely populated, has a regular and busy public transport system which connects it to Mwanza city, and its own thriving marketplace. Employment and business prospects in the town are more diverse and abundant than in the village. For example, large textile and Coca-Cola factories nearby are major sources of employment and can require secondary-level schooling for employment. The village is situated close to the town (about 10km away), yet it is more sparsely populated and is mostly removed from the main road. While the majority of children aged 7 to 19 years in both communities were enrolled in school (75% in the village and 85% in the town in 2016), there is more investment in children's education in the town, with progression to secondary school much higher here (73% of 14-19 year olds) than in the village (31% of 14-19 year olds) (Hedges et al., 2018). Further economic and demographic differences between the two sites, analysed using data collected for this thesis, are described below (see Table 6.1). The population is primarily Sukuma, an ethnic group that comprises approximately 17% of the national population (Malipula, 2016). Sukuma households tend to be larger than neighbouring ethnic groups (Lawson et al., 2015) and often contain affinal kin and/or fostered children (Hedges, Sear, et al., 2019; Urassa et al., 1997). Almost all individuals get married during their lifetime, however both divorce and re-marriage are commonly practiced (Boerma et al., 2002).

6.3.3 Variables used and data analysis

We measured seven sources of allomaternal care: the child's biological father, maternal grandparents, paternal grandparents, siblings, maternal aunts/uncles, paternal aunts/uncles, and distant/non-kin (usually comprising non-kin such as mother's friends or neighbours). Data were not collected separately for grandmothers and grandfathers, aunts and uncles, or brothers and sisters. For each category of allomother, the child's mother/guardian was asked if that allomother had provided different types of care to the child in the two weeks preceding the survey. This measure was irrespective of the allomother's presence/absence or residence in the household at the time.

Direct allomaternal care - activities that require physical contact or interaction with the child (Meehan, 2008) – was measured through five binary variables (our dependent variables). Each represented a different activity and indicated whether the child had received that particular care from each allomother in the two weeks preceding the survey. The five types of direct childcare were: supervising, playing with, washing, feeding or cooking for, and caring for the child if they had been sick in the 2 weeks preceding the survey (27% of children had been sick in this time period, n=215). The proportion of children who received each of these five types of care from each allomother, by village and town residence, is presented in Supplementary Material Figure S6.1. For this analysis, we categorised the 5 measures of care into two variables, high-intensity and low-intensity care as adapted by Meehan (2005, 2008) from Kleiman and Malcolm (1981) and Marlowe (1999, 2005). High-intensity care requires either intimate contact with the child, direct attention given to the child or actions that can interrupt the carers other activities; whereas low-intensity care requires relatively low-levels of energy expenditure on the part of the carer, e.g., being in close proximity to or watching the infant (Meehan, 2005, 2008). High-intensity care in our study comprised of four variables: washing, feeding/cooking, playing, and caring when sick (n=808 for all allomothers, except n=807 for playing with maternal aunts/uncles and paternal aunts/uncles); and low-intensity care comprised of one variable: supervising (n=808 for all allomothers, except n=807 for paternal aunts/uncles). If, in the 2 weeks preceding the survey, children received any of the four care-types categorised as high-intensity, they were analysed as having received high-intensity care from that allomother; similarly, if children had received supervision from a particular allomother, they were included in the analysis as having received low-intensity care from that allomother.

Our primary independent variable was level of market integration, operationalized by whether the child lives in the village or the town. To assess whether the town and village were indeed different in their extent of market integration, we examined the following demographic and socio-economic characteristics: extended family co-residence, measured by household size; investment in human capital, measured by the household head's educational attainment; and reliance on agriculture versus wage-based labour or market work as a form of livelihood, measured by the household head's occupation. To explore variation in market integration between the village and the town, we run bivariate associations between place of residence (village or town) and the socio-economic and demographic variables listed above, as well as a number of other child and household level characteristics, using Pearson chi-squared tests and t-tests.

We use logistic regression analyses to test both our predictions. An independent regression model was run to analyse the association between village/town residence and each type of care from each category of allomother, for example, the effect of living in the town on receiving low-intensity care from fathers was one regression model. Thus, a total of 14 regression models were run: 12 models to test our first prediction (2 types of care and 6 categories of kin members); and 2 models to test our second prediction (2 types of care and 1 category of distant/non-kin allomother). The first stage of our analysis (bivariate associations between town and village) also allowed us to narrow down which variables may be important in explaining differences between the town and village, information which was used while building our regression models. While we *a priori* retain child's age (measured continuously in years) as a confounder in all our models, child's sex and parity are not included based on results from bivariate analyses. While a number of socio-demographic characteristics are strongly associated with village/town residence, including household size and household head's education level and primary occupation, these are not adjusted for in the regression models as we suspect these indicators to be on the causal pathway between residence and caregiving. Analyses are restricted to children who co-resided with their biological mothers (n=728) so that provision of care reflects allomaternal support (i.e. care provided to help mothers).

6.4 Results

6.4.1 Variation in market-integration and household demographics between the village and town

Households in the town compared to the village were of smaller size (village: mean 8.5, SD 3.2; town: mean 7.1, SD 2.9; t-test=5.22; $p<0.001$) and had fewer resident children under the age of 5-years (village: mean 2.0, SD 1.1; town: mean 1.6, SD 0.9; t-test=4.9; $p<0.001$; see Table 6.1). Most household-heads in both the town (63.2%) and the village (68.4%) had achieved primary level education. However, substantially fewer had progressed further than primary level in the village (1.9% versus 17.7% in the town); and more had no education in the village (33.5% versus 12.9% in the town). Pearson chi-squared tests indicated a strong difference in household head's education level between the village and town (χ^2 (3)=52.63; $p<0.001$). The household head's primary occupation varied largely between the town and village with the starkest difference seen for farming: while the majority of households in the village farmed to earn their livelihoods (84.9%), only one-third of households in the town did so. In contrast many more households in the town relied on trading or market-based work to earn wages (30.1%) compared to the village (7.6%). Pearson chi-squared tests indicated a strong difference in household head's mode of livelihood between the village and town (χ^2 (3)=130.5; $p<0.001$). Difference in level of market-integration between the village and town was also reflected in land and livestock ownership with substantially more households in the village owning land (52.4% versus 30.9% in the town; χ^2 (3)=94.6; $p<0.001$) and livestock (81.1% versus 38.8% in the town; χ^2 (1)=89.9; $p<0.001$).

There were more female-headed households in the town (22.1% versus 13.7% in the village; χ^2 (1)=5.8; $p=0.02$), possibly due to more household heads being widowed and/or divorced than in the village. Almost all households in the village identified as Sukuma (99.1%); but there was more variation in ethnicity in the town where 83.7% identified as Sukuma (χ^2 (1)=32.7; $p<0.001$). Almost half of the village-residents prescribed to traditional religious beliefs or 'no religion' and half to Christianity, whereas majority of the town residents identified as Christian (88.1%; χ^2 (2)=101.5; p<0.001).

6.4.2 Variation in children's characteristics by village and town residence

There was no difference in the proportion of boys and girls, or children's mean age between the two sites (Table 6.1). Children's parental residence patterns varied in two main ways. More children in the village co-resided with both parents (71% versus 62% in the town), and fewer children in the village lived in father non-resident households (19% versus 29% in the town). There was a small number of foster children (i.e., residing without both alive biological parents) captured in our sample and this did not vary between the village and town (village: 8.4%; town: 8%). Pearson chi-squared tests indicated a strong difference in children's parental residence patterns between the village and town (χ^2 (3)=13.1; p<0.001), likely pointing to the differences seen in father's residence. The majority of children's parents were stated as married to each other, i.e., married and either living together or apart, or living together as married. However, fewer parents were recorded as married to each other in the town (65.3%) than in the village (75.1%); and a higher percentage of parents in the town were either divorced (13.7% versus 10.4% in the village) or unmarried and living apart (19% versus 13% in the village). Pearson chi-squared tests indicated there was a difference in children's parental residence patterns between the village and town (χ^2 (4)=10.5; p=0.03). Fewer fathers were in a polygynous union in the town (8.4% versus 18.2% in the village; χ^2 (3)=11.3; p<0.001).

These findings indicate that parental relationships differ between the town and village. Parental relationships are likely to influence patterns of allocare: substitution effects have been observed between fathers and maternal kin, in that maternal kin are more likely to provide more support when fathers provide less support (Meehan, 2005), and children with less close relationships with fathers (after divorce, for example) are likely to have less close relationships with their paternal kin too. Studies on kin support also highlight that it is common for kin, especially grandparents, to help mothers who are most in need (Brewster & Padavic, 2002; Snopkowski & Sear, 2015) and this may apply in circumstances children do not co-reside with their fathers. Given the importance of parental relationships for allocare, we further explore whether results are different between households where fathers co-reside with children and those where fathers are non-resident.

Table 6.1 Bivariate analyses showing correlation between child's residence (village or town) and selected child, parent and household-level socio-demographic characteristics (n=808 children for child-level variables and n=506 households for household-head variables).

	Village	Town	test-statistic	p-value
INDICATORS OF MARKET-INTEGRATION (HOUSEHOLD-LEVEL)				
Households with children 0-5 years	212	294		
Household size – mean (SD)	8.50 (3.24)	7.08 (2.86)	t-test=5.22	<0.001
Number of 0-5s in household – mean (SD)	1.99 (1.05)	1.57 (0.88)	t-test=4.90	<0.001
Primary occupation of head – n (%)			χ^2 (3) = 130.5	<0.001
Farmer	180 (84.91)	100 (34.01)		
Trader	16 (7.55)	89 (30.27)		
Other	10 (4.72)	85 (28.91)		
None	6 (2.83)	20 (6.80)		
Education level of head – n (%)			χ^2 (3) = 52.63	<0.001
Primary	134 (63.21)	201 (68.37)		
More than Primary	4 (1.89)	52 (17.69)		
None	71 (33.49)	38 (12.93)		
Don't Know	3 (1.42)	3 (1.02)		
Land ownership – n (%)			χ^2 (3) = 94.59	<0.001
Owns land	111 (52.36)	90 (30.93)		
Owns and rents land	59 (27.83)	30 (10.31)		
Rents land	28 (13.21)	46 (15.81)		
Neither owns nor rents land	14 (6.60)	125 (42.96)		
Livestock ownership – n (%)			χ^2 (1) = 89.93	<0.001
Yes	172 (81.13)	114 (38.78)		
No	40 (18.87)	180 (61.22)		

HOUSEHOLD HEAD CHARACTERISTICS				
Age – mean (min, max)	46.15 (13.35)	45.61 (12.65)	t-test=0.4635	0.64
Sex – n (%)			χ^2 (1) = 5.79	0.016
Female	29 (13.68)	65 (22.11)		
Male	183 (86.32)	229 (77.89)		
Marital status – n (%)			χ^2 (4) = 9.48	0.05
Married (monogamous)	153 (72.17)	204 (69.39)		
Married (polygynous)	32 (15.09)	28 (9.52)		
Divorced / separated	9 (4.25)	18 (6.12)		
Widowed	18 (8.49)	41 (13.95)		
Never married (Not engaged)	0 (0.00)	3 (1.02)		
Religion – n (%)			χ^2 (2) = 101.49	<0.001
Roman Catholic	42 (19.81)	138 (46.94)		
Other established Christian	59 (27.83)	121 (41.16)		
Other	111 (52.36)	35 (11.90)		
Ethnicity – n (%)			χ^2 (1) = 32.73	<0.001
Sukuma	210 (99.06)	246 (83.67)		
Other	2 (0.94)	48 (16.33)		
CHILD CHARACTERISTICS				
Total number of children 0-5 years	393	415		
Sex – n (%)			χ^2 (1) = 0.00	0.99
Girl	193 (49.11)	204 (49.16)		
Boy	200 (50.89)	211 (50.84)		

Father's first child – n (%)*			χ^2 (1) = 3.78	0.05
Yes	305 (81.33)	300 (75.57)		
No	70 (18.67)	97 (24.43)		
Age in years – mean (SD)	2.39 (1.36)	2.48 (1.42)	t-test=-1.01	0.31
Parental residence – n (%)			χ^2 (3) = 13.09	<0.001
Lives with both parents	278 (70.74)	255 (61.74)		
Lives with mother, but not father	73 (18.58)	120 (29.06)		
Lives with father, but not mother	9 (2.29)	5 (1.21)		
Lives apart from both parents (fostered)	33 (8.4)	33 (7.99)		
Parents' marital status – n (%)			χ^2 (4) = 10.47	0.03
Officially married	291 (74.05)	264 (63.61)		
Live together as married	4 (1.02)	7 (1.69)		
Divorced	41 (10.43)	57 (13.73)		
Mother and/or father dead	6 (1.53)	8 (1.93)		
Unmarried and live apart	51 (12.98)	79 (19.04)		
Father in polygynous union – n (%)**			χ^2 (1) = 11.33	<0.001
Yes	53 (18.21)	22 (8.40)		
No	238 (81.79)	240 (91.60)		

* Excludes missing data (n=36).
** Restricted to children with married parents, excludes Don't Know/Refusal responses (n=533).

6.4.3 Variation in allomaternal care provision

Provision of allomaternal care varied by village/town residence, by who the allomother was, and by whether the care was low- or high-intensity. In both the village and the town, children received most low-intensity care from their fathers, followed by siblings; and most high-intensity care from siblings, followed by distant/non-kin (Figure 6.1). In the town, children had lower odds of receiving low- (OR: 0.52, 95% CI: 0.38-0.70) and high-intensity (OR: 0.74, 95% CI: 0.55-0.99) care from fathers, low- (OR: 0.34, 95% CI: 0.21-0.56) and high-intensity (OR: 0.38, 95% CI: 0.24-0.60) care from paternal grandparents, and low- (OR: 0.44, 95% CI: 0.22-0.86) and high-intensity (OR: 0.54, 95% CI: 0.32-0.91) care from paternal aunts/uncles. Children also had lower odds of receiving low- (OR: 0.85, 95% CI: 0.63-1.15) and high-intensity (OR: 0.48, 95% CI: 0.33-0.70) care from their siblings in the town, but 95% confidence intervals crossed 1 for low-intensity care.

In contrast, children had much higher odds of receiving both low-intensity care (OR: 1.97, 95% CI: 1.32-2.94) and high-intensity care (OR: 1.43, 95% CI: 1.04-1.96) from distant/non-kin in the town. While maternal grandparents (low-intensity OR: 1.21, 95% CI: 0.84-1.73; high-intensity OR: 1.08, 95% CI: 0.77-1.53) and maternal aunts/uncles (low-intensity OR: 1.52, 95% CI: 1.00-2.32; high-intensity OR: 1.43, 95% CI: 0.98-2.08) also had higher odds of providing both types of care in the town, 95% confidence intervals crossed 1 for all estimates indicating no difference between the two communities regarding care from maternal kin. Full results for each allomother and each type of care are provided in Table 6.2, and regression models in **Supplementary Material Tables S6.1.1-S6.1.14.**

Figure 6.1 Percentage of children who received low-intensity (supervising) and high-intensity care (washing, feeding, playing, caring when sick) from each allomother in the village and town. Restricted to children with co-resident mothers (n=728).

Table 6.2 Logistic regression models showing associations between town residence (reference: village) and receiving low- and high-intensity care from each allomother. Analyses restricted to children with co-resident mothers (n=728)

	Father - low intensity				Father - high intensity				Maternal GP - low intensity			
	n=728				n=728				n=728			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.52	0.38	0.70	0.00	0.74	0.55	0.99	0.04	1.21	0.84	1.73	0.30
Child's age	1.17	1.05	1.31	0.01	0.89	0.80	0.99	0.03	0.91	0.80	1.03	0.15
Intercept	1.57	1.13	2.18	0.01	1.32	0.96	1.82	0.09	0.30	0.20	0.44	0.00

	Maternal GP - high intensity				Paternal GP - low intensity				Paternal GP - high intensity			
	n=728				n=728				n=728			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	1.08	0.77	1.53	0.65	0.34	0.21	0.56	0.00	0.38	0.24	0.60	0.00
Child's age	0.86	0.75	0.97	0.02	0.78	0.66	0.93	0.01	0.83	0.70	0.97	0.02
Intercept	0.42	0.29	0.60	0.00	0.35	0.23	0.55	0.00	0.36	0.24	0.56	0.00

	Sibling - low intensity				Sibling - high intensity				Maternal Aunt/Uncle - low intensity			
	n=728				n=728				n=728			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.85	0.63	1.15	0.29	0.48	0.33	0.70	0.00	1.52	1.00	2.32	0.05
Child's age	1.18	1.05	1.31	0.00	1.53	1.33	1.76	0.00	0.93	0.80	1.08	0.32
Intercept	0.44	0.32	0.62	0.00	2.28	1.56	3.36	0.00	0.16	0.10	0.25	0.00

	Maternal Aunt/Uncle - high intensity				Paternal Aunt/Uncle - low intensity				Paternal Aunt/Uncle - high intensity			
	n=728				n=727				n=728			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	1.43	0.98	2.08	0.06	0.44	0.22	0.86	0.02	0.54	0.32	0.91	0.02
Child's age	0.92	0.81	1.06	0.24	0.91	0.72	1.16	0.45	0.75	0.62	0.90	0.00
Intercept	0.23	0.15	0.35	0.00	0.10	0.05	0.19	0.00	0.26	0.16	0.41	0.00

	Distant kin/Non-kin - low intensity				Distant kin/Non-kin - high intensity			
	n=728				n=728			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	1.97	1.32	2.94	0.00	1.43	1.04	1.96	0.03
Child's age	1.13	0.98	1.30	0.09	1.49	1.32	1.67	0.00
Intercept	0.11	0.07	0.17	0.00	0.68	0.48	0.94	0.02

6.4.4 Are results similar in households with and without paternal residence?

We investigate whether paternal co-residence is causing the differences in allocare seen between the town and village. We use a 2-category variable for child's paternal residence, indicating whether the child lived with both biological parents (n=533) or co-resided with their mother in a household where the father was non-resident (n=193). Few children lived solely with their fathers (n=14) or were fostered/lived with neither parent (n=66); these children are excluded from analysis to avoid issues of data sparsity. Two further children are excluded due to 'Don't Know' and 'Refuse' responses. Our total sample size for this analysis is 726 children. We use a Pearson chi-squared test to analyse the correlation between the 2-category variable for paternal residence and village/town residence. Fewer children co-resided with both parents in the town (67.6%) than in the village (79.2%); and more town-based children lived in father non-resident households (32.4%) compared to the village (20.8%; chi-squared test-statistic=12.4, $p<0.001$). We use logistic regression analyses to test if allomaternal care in the town differs to the village for children who (a) reside with both parents; and (b) reside with their mothers only. Two sets of models were run: 14 models (7 carers and 2 care-types) for children with co-resident parents (results in Table 6.3); and 14 models (7 carers and 2 care-types) for children living with mothers in father non-resident households (results in Table 6.4).

Our results show that children with co-resident fathers had lower odds of receiving low-intensity care from fathers (OR: 0.63, 95% CI: 0.40-0.97), both types of care from paternal grandparents (low-intensity OR: 0.30, 95% CI: 0.17-0.53; high-intensity OR: 0.36, 95% CI: 0.21-0.61), and high-intensity care from siblings (OR: 0.44, 95% CI: 0.26-0.73) in the town versus the village (Table 6.3). As before, there appeared to be no difference in care from maternal kin between the two communities, with 95% CI crossing 1 for all point estimates. For children with non-resident fathers, there appeared to be no difference in allomaternal care provision between the town and village for any category of kin (see results in Table 6.4). This indicates that while fathers, paternal kin and siblings are less likely to provide care in the town, this is limited to children with co-resident fathers; for children with non-resident fathers, care from kin is the same across the village and town. In other words, the results seen in Table 6.2 for the full sample were similar when the analysis was restricted only to children whose fathers were co-resident. This means that the differing patterns of kin allocare between town and village are not driven by differences in paternal residence between the two locations (full models for this analysis are provided in Supplementary Material Tables S6.2.1-S6.2.14 and S6.3.1-S6.3.14). In line with this, children with both parents co-resident had higher odds of receiving low-intensity care from distant/non-kin in the town (OR: 2.42, 95% CI: 1.52-3.87). However, it was children residing in father non-resident households who had higher odds of receiving high-intensity care from distant/non-kin in the town (OR: 2.59, 95% CI: 1.38-4.86), suggesting differences in paternal residence between the town and village may be influencing care received from distant/non-kin. In Supplementary Material we also show results of models exploring if allomaternal care differs for children with and without co-resident fathers. These show that while allomaternal care varies substantially by paternal residence, these patterns are similar across both the town and village; see Tables S6.4).

Table 6.3 Logistic Regression outputs showing associations between town residence (reference: village) and receiving low- and high-intensity care from each allomother. Analyses restricted to children residing with both parents (n=533).

Both parents resident

	Father - low intensity				Father - high intensity				Maternal GP - low intensity			
	n=533				n=533				n=533			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.63	0.40	0.97	0.04	0.84	0.59	1.19	0.33	0.61	0.25	1.49	0.28
Child's age	1.13	0.96	1.32	0.15	0.80	0.70	0.91	0.00	0.98	0.71	1.35	0.90
Intercept	4.08	2.53	6.56	0.00	2.65	1.78	3.93	0.00	0.06	0.02	0.14	0.00

	Maternal GP - high intensity				Paternal GP - low intensity				Paternal GP - high intensity			
	n=533				n=533				n=533			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.53	0.27	1.05	0.07	0.30	0.17	0.53	0.00	0.36	0.21	0.61	0.00
Child's age	0.91	0.71	1.16	0.44	0.74	0.61	0.90	0.00	0.74	0.61	0.88	0.00
Intercept	0.13	0.07	0.25	0.00	0.48	0.29	0.79	0.00	0.55	0.34	0.88	0.01

	Sibling - low intensity				Sibling - high intensity				Maternal Aunt/Uncle - low intensity			
	n=533				n=533				n=533			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.93	0.66	1.31	0.67	0.44	0.26	0.73	0.00	1.37	0.63	3.00	0.43
Child's age	1.10	0.97	1.25	0.14	1.32	1.10	1.59	0.00	1.05	0.79	1.40	0.73
Intercept	0.65	0.45	0.95	0.03	5.11	2.98	8.75	0.00	0.04	0.02	0.10	0.00

	Maternal Aunt/Uncle - high intensity				Paternal Aunt/Uncle - low intensity				Paternal Aunt/Uncle - high intensity			
	n=533				n=533				n=533			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.88	0.48	1.60	0.67	0.64	0.31	1.30	0.22	0.61	0.34	1.10	0.10
Child's age	0.95	0.76	1.19	0.66	0.85	0.66	1.10	0.23	0.71	0.57	0.89	0.00
Intercept	0.12	0.06	0.22	0.00	0.12	0.06	0.24	0.00	0.29	0.17	0.51	0.00

	Distant kin/Non-kin - low intensity				Distant kin/Non-kin - high intensity			
	n=533				n=533			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	2.42	1.52	3.87	0.00	1.21	0.83	1.76	0.32
Child's age	1.13	0.96	1.34	0.14	1.44	1.25	1.66	0.00
Intercept	0.10	0.06	0.17	0.00	0.84	0.57	1.25	0.40

Table 6.4 Logistic Regression outputs showing associations between town residence (reference: village) and receiving low- and high-intensity care from each allomother. Analyses restricted to children residing with mothers in father non-resident households (n=193)

Mothers resident, fathers non-resident

	Father - low intensity				Father - high intensity				Maternal GP - low intensity			
	n=193				n=193				n=193			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.50	0.17	1.45	0.20	1.62	0.63	4.15	0.31	0.56	0.29	1.06	0.07
Child's age	1.01	0.69	1.46	0.97	0.80	0.58	1.10	0.17	1.09	0.88	1.35	0.43
Intercept	0.12	0.04	0.35	0.00	0.16	0.06	0.41	0.00	2.40	1.23	4.67	0.01
	Maternal GP - high intensity				Paternal GP - low intensity				Paternal GP - high intensity			
	n=193				n=193				n=193			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	0.59	0.31	1.12	0.11	0.81	0.27	2.45	0.71	0.65	0.23	1.89	0.43
Child's age	0.94	0.76	1.17	0.60	0.89	0.60	1.32	0.56	1.17	0.81	1.70	0.41
Intercept	3.19	1.61	6.31	0.00	0.11	0.04	0.34	0.00	0.08	0.02	0.24	0.00
	Sibling - low intensity				Sibling - high intensity				Maternal Aunt/Uncle - low intensity			
	n=193				n=193				n=193			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	1.21	0.56	2.62	0.63	0.80	0.42	1.52	0.50	0.96	0.53	1.73	0.89
Child's age	1.35	1.04	1.75	0.02	1.79	1.41	2.26	0.00	0.99	0.81	1.21	0.90
Intercept	0.10	0.04	0.25	0.00	0.54	0.29	1.04	0.07	0.72	0.39	1.33	0.29

	Maternal Aunt/Uncle - high intensity				Paternal Aunt/Uncle - low intensity				Paternal Aunt/Uncle - high intensity			
	n=193				n=73				n=193			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	1.31	0.73	2.35	0.37	1				0.44	0.15	1.33	0.15
Child's age	1.02	0.84	1.25	0.82	1.18	0.62	2.26	0.62	0.81	0.54	1.22	0.32
Intercept	0.70	0.38	1.30	0.26	0.05	0.01	0.29	0.00	0.18	0.07	0.50	0.00

	Distant kin/Non-kin - low intensity				Distant kin/Non-kin - high intensity			
	n=193				n=193			
	Odds Ratio	95% CI		p-value	Odds Ratio	95% CI		p-value
Town residence	1.12	0.52	2.44	0.77	2.59	1.38	4.86	0.00
Child's age	1.10	0.85	1.43	0.48	1.56	1.24	1.96	0.00
Intercept	0.16	0.07	0.37	0.00	0.36	0.18	0.70	0.00

6.5 Discussion

Children were provided care by a number of allomothers in both the town and village. Concurrent with other literature, care was commonly received from kin members, particularly fathers (Boyette et al., 2018; BS Hewlett, 1992; Hill & Hurtado, 2009; Opondo, Redshaw, Savage-McGlynn, & Quigley, 2016), siblings (Kramer, 2002, 2005; R. D. Lee & Kramer, 2002; Meehan, 2008; Mulder & Milton, 1985; Sear & Mace, 2008) and maternal kin (Isiugo-Abanihe, 1985; Pollet et al., 2009; Sear & Mace, 2008). Importantly, many children also received care from distant/non-kin, especially high-intensity care (low-intensity: 13% in the village and 25% in the town; high-intensity: 63% in the village and 70% in the town). Consistent with our overall hypothesis, living in the town versus the village appears to alter the childcare picture. There is partial support for our first prediction, that mothers would be less likely to receive help from their kin in the town. Children were less likely to receive both low- and high-intensity care from their fathers and paternal kin, and low-intensity care from their siblings, in the town compared to the village. However, maternal kin (aunts/uncles and grandparents) had the same odds of providing support to mothers in both communities (see Table 6.2). Second, we predicted that mothers would be more likely to receive support from non-kin in the town, and this is supported by our findings for both types of care.

As expected, we find the town was more market integrated than the village, approximated by levels of investment in human capital (i.e., the household head's education level) and engagement in farming versus market-based work (85% of households farmed for their livelihoods in the village versus 34% in the town; and 8% of households in the village engaged in wage-labour versus 30% in the town). Households in the town on average also had fewer residents than households in the village (mean of 9 members per household in the village versus 7 members in town), usually characteristic of urban neighbourhoods (Bentley et al., 1993; Hedges et al., 2018; Walker, 2014; Walker et al., 2013). Town-living was also associated with more variation in children's parental residence; lower likelihood of parents being married; fewer polygynous unions; and more female-headed households (see Table 6.1 for results). There were also clear differences between the two communities in regard to religion and ethnicity (Table 6.1).

Some of these individual socio-economic and demographic factors, particularly household size, may be determining the different patterns of childcare we see between the town and village. However, the purpose of this paper was to provide a descriptive demographic perspective on variation in allomaternal care between a rural and urban community in Tanzania, and not explore which particular characteristics of the town were driving variation in care. A next step in this research is to explore these individual and potentially causal features as modifiers of the relationship between urban living and allomaternal care.

The lower likelihood of fathers providing childcare in the town could have been reflective of the lower levels of father-child co-residence documented here compared to the village. However, results from our post-hoc analysis indicate differently. Fathers are, unsurprisingly, much more likely to provide care to children they co-reside with; however, even among households where fathers are co-resident with their children, they still have a lower likelihood of providing care in the town than in the village. This indicates that other factors are driving the variation in paternal care between the two communities. For instance, the higher likelihood of father care in the village may be attributed to the different demands of agropastoral work in the village versus wage-based labour in the town. While the majority of village-based households listed farming as their primary occupation, most town-based household heads were either traders or involved in other non-farming employment. Farming in the village is primarily subsistence farming on family land surrounding a complex of houses and outbuildings. As such, fathers are likely spending a larger portion of their time in or near their household. In contrast, fathers in the town are labourers, traders, own or work at market shops, or have migrated away from home for employment. This may help explain the distinction seen between fathers' provision of low- and high-intensity care. Overall, a higher proportion of children received low-intensity care from their fathers than high-intensity care, indicating fathers are perhaps more inclined towards providing childcare that is not disruptive of their other activities. Further, although fathers were more likely to provide both types of care in the village than the town, this difference was greater for low-intensity care (i.e., supervision). This suggests that fathers may be less able to passively supervise children in the town – perhaps due to being away from the house for market-based work.

Schacht et al (2018) find that Mayan fathers spent more time with their families after their community had become more market integrated, as they were able to repurpose time gained due to efficient agricultural production strategies (e.g., technology) towards family investment. However, these changes coincided with reduced opportunities of wage labour and higher returns for investing in children that accompany market integration (e.g., increase value of education); and were facilitated by the fathers being in monogamous unions (Schacht et al., 2018). Wage-based labour may have a reverse effect, increasing the demands on men's time and pulling them away from the family. However, while fathers may engage in less direct care in the town, this does not mean they invest less overall; and may instead be shifting the form of their investment into other forms of care such as provisioning via work. Scholars have argued that shifts in human subsistence strategies in the past have coincided with shifts in family structure (H. S. Kaplan & Lancaster, 2003). While this is usually discussed in regard to shifts from foraging to farming, and a concurrent reduction in paternal care (Draper & Harpending, 1987; H. S. Kaplan & Lancaster, 2003), it is possible that paternal care also differs systematically between farming and market integrated communities.

We examined care from matrilineal and patrilineal relatives separately because a large body of research indicates that maternal and paternal relatives have different roles and impacts in regards to childcare (King & Elder, 1995; King et al., 2003; Pashos & Mcburney, 2008; Perry & Daly, 2017; Pollet et al., 2009; Sear & Mace, 2008; Sear et al., 2000; Voland & Beise, 2002). Women's natal kin have largely been documented to provide more help than affinal kin. The proximate mechanisms which drive this greater helpfulness from maternal kin might involve greater emotional closeness between women and their maternal, compared with paternal, kin. Evolutionary researchers have also commonly attributed this to 'paternity uncertainty' (i.e., the probability that a man's child was not actually sired by him); but paternity uncertainty tends to be very low in human populations (Anderson, 2006), and a matrilineal bias can also be explained without the need to invoke paternity uncertainty (Perry & Daly, 2017). Differences seen between patrilineal caregiving in the two locations may be partially explained by higher levels of patrilocal residence in the village and shifts towards neolocality in the town. While we did not collect data on whether the focal child resided with their maternal or paternal family, we do find that paternal relatives had a higher likelihood of providing care in the village, and this was limited to father-resident households, which may be indicative of patrilocal residence. Further, our results show that children's mothers in the town were more likely to be divorced or living apart from the children's fathers, than in the village. In these cases, mothers may seek help from non-kin, or may even be residing with their natal kin (i.e., children's maternal kin) and receiving support from them. This is supported by research among the Aka foragers in the Central African Republic (Meehan, 2005). Here, Meehan (2005) finds that infants who live with their mother's kin receive most allocare from these kin, especially from women, and very little investment from fathers; whereas, infants who reside with their fathers' lineage are provided high levels of paternal investment but very little care from other women. The authors suggest this could potentially be explained by female alloparents relieving fathers from their duties in matrilocal residences; substituting for a lack of paternal care in these camps; or it could be due to female alloparents being surer of genetic relatedness with infants who reside matrilocally. However, it is also of note that women's own parents (i.e., the focal child's maternal grandparents) and their siblings (i.e., the child's maternal aunts/uncles) are equally likely to help them in the town and the village. This suggests that maternal kin provide care equally whether the child and mother reside patrilocally, matrilocally or neolocally (presumably in the town). Dense housing and accessible transport links in towns also makes within-town mobility a lot easier. This may allow maternal relatives to travel more conveniently and provide support to mothers even if they reside far away or patrilocally. Such investment from maternal kin has been seen in Ethiopia, where grandmothers continue to provide allocare to their daughters even if they reside patrilocally post-marriage (Gibson & Mace, 2005).

Siblings had lower odds of providing high-intensity allocare in the town, but no difference was seen between the two sites for low-intensity care. This could be attributed to the difference in educational attainment between the two communities. Previous research in these two communities shows higher odds of school enrolment and progression to secondary school in the town compared to the village (Hedges et al., 2018). This may decrease older children's availability to provide high-intensity allocare to younger siblings. Hedges et al. (2018) also show that among those not attending school, children in the village (and girls in particular) participated in more productive work, including household chores, than children in the town. This is potentially reflected in our study as household chores can consist of high-intensity childcare tasks, e.g., washing, feeding etc. The difference seen between low- and high-intensity care could also be driven by the inclusion of 'playing' in the high-intensity care category. Children may be more likely to play with their siblings in the village perhaps because there are more co-resident children here (average of 2 under-5 children per household) whereas in the town there are slightly fewer co-resident children (average of 1.5 under-5 children per household) and children have more access to non-kin playmates such as neighbours. Playgroups consisting of neighbouring pre-school aged children were very commonly observed in the town, with ages appearing to range between one and seven years old. We also note here that the children sampled in our study are not of school-going age and thus will not have been interacting with other children through school in either the village or town.

Lastly, we find that distant/non-kin were more likely to provide care to children in the town than in the village. Scholars have emphasised the covariance between relatedness and living close-by (Crittenden & Marlowe, 2008; Gurven, 2004; Koster & Leckie, 2014), attributing cooperation between kin to the reduced geographic distances between them that help lower costs of providing support (Clutton-Brock, 2002; Nolin, 2010; Page, Thomas, et al., 2019). If residential proximity spurs cooperation, and children are living closer to more unrelated individuals in the town than in the village *as well as* closer to more unrelated individuals than related individuals, then it is unsurprising that we find non-kin to play a larger role in childcare in the town than in the village. While non-kin were also more likely to provide both low- and high-intensity care in the town than in the village, similar to fathers, the odds ratios were greater for low- intensity care. This could imply that women's friends or neighbours help with child supervision, especially if the likelihood of fathers doing so is lower, and has important implications for female friendships, which are an understudied source of support for women. Future research could explore in detail exactly who these distant and non-kin are and what motivates them to provide substantial amounts of support to mothers. Another category of non-kin allomothers can include other children – for example, children's own friends, friends of older siblings, other children living in the neighbourhood (Blurton Jones et al., 2005; Emmott & Page, 2019; Meehan et al., 2013). The higher odds of receiving care from – or at least, playing with or being supervised by – unrelated children in the town could also explain the reduced odds of siblings providing care in the town. Recent work among the Agta foragers in the Philippines posits children's playgroups as another type of allocare (Page et al., 2020). This is perhaps more probable in urban neighbourhoods with greater housing density as more children are likely to live close by. This can generate increased opportunities for children to spend time in larger playgroups compared to the village where houses are more dispersed. Our post-hoc analysis also implies that it is children living in father non-resident households who have a higher likelihood of receiving high-intensity care from non-kin in the town. This may be a particular circumstance where friends and community members are stepping in to provide support.

6.5.1 Limitations

All measures of care we have used are binary, measuring if each allomother provided care in the two weeks preceding the survey or not. Thus, we do not know the frequency of care provision, only whether it was provided at least once or not at all. This limits us from estimating a real quantification of the level of care provided and how this varies between the village and town, and between allomothers. Second, we describe childcare patterns for very young children, and it is possible that results would vary for children above the age of 5 years. Third, we use the village and town as proxies for market integration – it is therefore in reality a tale of two communities, and not of one village urbanising over time. It remains possible that the differences we observe reflect some unmeasured characteristic of each location, or perhaps a peculiarity of our sampled locations. That said, the two locations benefit from being geographically close and largely culturally/historically similar thus limiting the scope for this. Nevertheless, this research question has not been tested as yet and these comparisons provide useful case studies. Other studies have also used comparisons between different neighbourhoods as representative of changing socio-ecology (Hedges et al., 2018; Nettle, 2012). An ideal follow-up from this work would be to test these questions using longitudinal data that allow for observation of changes in allomaternal networks as a community urbanises.

6.5.2 Conclusion

We tested the predictions that allomaternal care would be less likely from kin, and more likely from distant/non-kin, in a town compared to a village in Tanzania. Our predictions were partially supported, in that paternal kin and siblings were less likely to provide allocare, and non-kin more likely, in the town. However, there were no differences in care from maternal kin. This may reflect differences in the consistency of support from maternal kin across contexts, and the more facultative nature of support from paternal kin. It may also be related to matrilocal/patrilocal differences in residence; or driven by any of the features of market integration (i.e., smaller household size, higher education level, increase in wage-based labour or trade) or children's socio-demography (e.g., parents' marital or residence status) that we find associated with town residence. While it was within the scope of this paper to explore one of these factors (paternal residence) it may be illustrative to investigate others in future research.

Market integration and its impact on kin networks holds potential future implications for a population's demography and its health. Changing trends in allomothering occurring alongside urbanisation are known to cause shifts in the demographic structures of societies (David-Barrett, 2019; Notestein, 1953). Both the availability of allomaternal support and market integration are linked to fertility outcomes; generally, high levels of allomaternal support are linked to higher fertility (Hrdy, 2005a, 2011; Kramer, 2010, 2014) while shifts from subsistence to wage-based economies – and associated transitions in wealth and status – are linked to lower fertility (Colleran, Jasienska, Nenko, Galbarczyk, & Mace, 2015; Sear & Coall, 2011; Skirbekk, 2008). It is thus often assumed that the breakdown of kin networks with market integration would limit the help available to women, which may in turn impact their reproductive decisions leading to declining family size. In fact, the influence of kin on women's fertility has been noted in a number of studies, although the relationship between two is multifaceted and context-specific (Sear, 2018; Snopkowski & Sear, 2013).

Here, we show that while patterns of allomaternal support vary by level of market integration, women are not less likely to receive support in the more market integrated community; this may be an interesting avenue for future research on fertility. Further, as allomaternal support can improve children's survival and health, this work may have important implications for child wellbeing across different contexts, particularly if care from different allomothers is associated with differentials in child outcomes. Future research on children's wellbeing in societies undergoing demographic transitions could benefit from exploring whether variation in who children receive support from impacts their health.

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7. Which kin matter? The impact of allomaternal care on children's health in north-western Tanzania

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7.1 Abstract

Allomaternal care (non-maternal care) impacts children's health variably across societies. However, existing studies in low-income settings largely use proxy measures for caregiving behaviours (e.g., absence/presence of kin in household) that may mask variation in care and its impact on children's health. To overcome this, we measure two types of childcare (low- and high-intensity) from seven categories of allomothers (fathers, maternal grandparents, paternal grandparents, siblings, maternal aunts/uncles, paternal aunts/uncles and distant/non-kin) for 808 children under 5-years in rural Tanzania; and child health is assessed using height-for-age and weight-for-height z-scores (HAZ and WHZ). We test the predictions that receiving care will be beneficial for children's health; that children residing without their mothers will have poorer health compared to children with co-resident mothers; and that allomaternal care will be especially important for child health in mother non-resident households. We find little support for our predictions. For children with co-resident mothers, there is no association between care and HAZ; and few associations with WHZ. There is no evidence that children's HAZ or WHZ vary between mother resident and non-resident households. For children not co-residing with mothers, evidence is mixed: paternal care is associated with better HAZ and care from siblings with better WHZ; however, care from paternal grandparents is associated with better WHZ but poorer HAZ; and care from maternal aunts/uncles with poorer HAZ. In sum, our findings are inconclusive, illustrating either that allomaternal care is not a key determinant of children's health in this population, or that our measures of care - while more nuanced than proxy indicators used in previous research - still do not fully capture the complexity of children's caregiving environments. Future research may benefit from identifying pathways between childcare and health, utilising more comprehensive measures of care.

7.2 Introduction

It is a truth almost universally acknowledged that the care provided to young children is a key determinant of their health (Britto et al., 2017; Christiaensen & Alderman, 2004; Engle et al., 2000; Hughes et al., 2021; Krueger, 2014; Love et al., 2003; Reher & González-Quinones, 2003; Sear & Coall, 2011). What happens in the first few years of a child's life can have lasting impacts for the rest of their life (Arregoces et al., 2019). Research shows that early hardship can lead to long-term adverse effects (Black et al., 2017), and equally, that effective interventions in early life can have lifelong benefits (Richter et al., 2017; S. Walker, Chang, Powell, & Grantham-McGregor, 2005). More and more, interventions with narrow focus on improving children's nutrition or reducing child stunting are leading to mixed findings. For example, studies have found child malnutrition prevalent in households that are food secure and have good access to health care (Arimond & Ruel, 2003; Deutsch et al., 1993; Engle et al., 2000); and these interventions are not showing as clear positive effects on children's cognitive development as expected (Prado et al., 2019). As such, early childhood development (including factors like children's caregiving environment, healthcare and food security) is gaining more attention from global programmes and policies aiming to improve child wellbeing, for example by the Human Capital Initiative and the Sustainable Development Goals (UNDESA, 2021; World Bank, 2021). In line with this, the 2018 Nurturing Care Framework provides guidance on what is considered a healthy life for a child (Britto et al., 2017; WHO et al., 2018). In this paper, I focus on one component of this framework: 'responsive caregiving'.

For infants and younger children, care is most often expected to be provided by the mother, with studies in a variety of populations finding high correlation between maternal survival or investment and healthy child outcomes (Panter-Brick et al., 2014; Sear & Mace, 2008; Sear et al., 2002). However, especially as they age, children's caregivers extend far beyond their mothers, encompassing a number of allomaternal carers (carers other than the mother) including kin and non-kin, who can have real impacts on children's health and survival (Aubel, 2010, 2012; G Bentley & Mace, 2009; Hrdy, 2009b; Kramer, 2010; Kramer &

Veile, 2018; Meehan & Crittenden, 2016; Meehan & Hawks, 2014; Meehan, Helfrecht, et al., 2016; Sear & Coall, 2011; Sear & Mace, 2008, 2009). While studies in anthropology have often studied the role of a wide range of allomothers in influencing children's health, global health research has had a more limited focus. This paper responds to recent calls by child health researchers to 'determine what policies, programmes and interventions can best support babies and toddlers and those who care for them' (Hughes et al., 2021, page 2). A first step in this direction then is to ascertain who provides care to children, and which carers matter for children's health.

Importantly, research also shows that context matters in how allomothering impacts child health. In a review of 45 studies, Sear & Mace (2008) find that kin members are not consistent in their impact on children's survival and conclude that the relationship between kin presence and child survival is influenced by local ecology. While, in many studies, grandmothers are emphasized as essential allomothers because they provide large amounts of care (Aubel, 2010, 2012; Hrdy, 2005a; Kramer, 2010) and can benefit their grandchildren's survival and cognitive and nutritional outcomes (Al Awad & Sonuga-Barke, 1992; Aubel, 2010, 2012; Fox et al., 2010; Pope et al., 1993; Sear & Mace, 2008; Sear et al., 2000), in other cases the findings are mixed. For instance, in a recent review, Sadruddin et al (2019) find considerable variation in the relationship between grandparental involvement with their grandchildren and ensuing child outcomes (Sadruddin et al., 2019). Grandparental care also varies by lineage. For example, Sear and Mace (2008) find more variation in the influence of paternal grandmothers than maternal ones, with the latter having a more dependable role across contexts. This is echoed in studies in evolutionary anthropology, which repeatedly show a matrilineal bias in allomaternal investment, even in patrilocal societies. In this literature, maternal grandparents are commonly associated with better child health, and paternal grandparents with having very little, none, or even a negative impact on children (Perry & Daly, 2017). This pattern has been seen in different ecological contexts including historical Germany (Voland & Beise, 2002); rural Gambia (Sear & Mace, 2008; Sear et al., 2000); and contemporary UK (Pollet et al., 2009). There is also uncertainty regarding the role of fathers as allomothers and their correlation to child health and survival, with evolutionary anthropologists even questioning their importance in some subsistence economies and natural fertility[1] populations (Hawkes et al., 1997; Sear et al., 2002). However, fathers play a key role in determining offspring outcomes in hunter-gatherer populations, due to the importance of male hunting and provisioning (Hill & Hurtado, 2009; H. Kaplan, 1996); and in other societies, they can be crucial in ensuring their children's health (see Boyette, Lew-Levy, & Gettler, 2018; Dearden et al., 2013; Edelblute & Altman, 2018; Hewlett & MacFarlan, 2010; Sarkadi, Kristiansson, Oberklaid, & Bremberg, 2008; Sigle-Rushton & McLanahan, 2004, among others). A previous study in Tanzania suggests that both paternal death as well as having an alive but absent father are associated with worse child anthropometric outcomes and lower household food security (Lawson et al., 2017).

The relationship between care and health can be unclear due to a number of factors. A study in Guatemala shows that results vary by both who provides care and the type of care provided: contact with maternal grandmothers is correlated with advantages in children's height (especially infants), having a living paternal grandmother is associated with a negative impact, contact with grandfathers has no effect, and financial help from grandfathers is beneficial for babies but adversely affects older children (Sheppard & Sear, 2016). Similarly, among the Kipsigis in Kenya, the relationship between paternal kin and reduction in child mortality is seen in wealthier households but not poorer ones, attributed by the author to higher cooperation between Kipsigis brothers in richer patrilineages resulting from specific local socio-ecological characteristics (Borgerhoff Mulder, 2007). Allomothers are also somewhat reactive to the needs of the household. For example, grandmothers in Ethiopia provide support to their daughters when needed even when they reside patrilocally after marriage (Gibson & Mace, 2005). In Guatemala, Sheppard and Sear (2016) consider financial support from grandfathers to be provided when the household is in need. Grandparents in Indonesia are also documented to

[1] Populations making no conscious effort to limit their fertility / number of children.

provide more support to needier grandchildren and adult children (Snopkowski & Sear, 2015); and in a study in the UK, women with lower socio-economic position received more financial support and help with childcare from their parents (Schaffnit & Sear, 2017). Thus, in cases when care is provided due to poorer child health, or when the mother/child's needs are greater, children's health outcomes may not reflect the benefits of care provision, at least in cross-sectional studies.

The nature of allocare provided may differ even in the presence of mothers. Some allomothers might provide childcare in addition to maternal investment, such that it does not reduce the amount of care provided by mothers, i.e., 'additive' care; and some may replace care otherwise provided by mothers, allowing mothers to redirect their energy towards other activities, i.e., 'substitutive' care (Emmott & Page, 2019; Kushnick, 2012). In the case of receiving additive care, children are expected to gain a 'net benefit' which leads to better child health than they would have had otherwise (Emmott & Page, 2019). Whereas, substitutive care may lead to null effects, and depending on the carer and the type of care provided, it can potentially even be detrimental for children's health (Emmott & Mace, 2015; Emmott & Page, 2019; Kramer & Veile, 2018). Thus, we can expect the relationship between care and child outcomes to be positive, negative or even neutral.

In this paper, we investigate whether receiving care from alternative allomothers impacts the health of children under 5 years of age, measured by children's anthropometrics, i.e., standardized height-for-age (HAZ) and weight-for-height (WHZ). Our data come from two communities in Mwanza Region, north-western Tanzania. We have two broad aims. First, to overcome previous limitations associated with using proxy indicators to measure childcare (such as the absence/presence or co-residence of kin in a household, or the geographic proximity of kin) as opposed to measuring the provision of care itself, (Schaffnit & Sear, 2014; Sear & Coall, 2011; Sear & Mace, 2008; Thomese & Liefbroer, 2013). We do this by using detailed measures of caregiving from a large sample of children (n=808) in an urbanising context. In doing so, we realise our second aim of combining the advances of studies in small-scale populations which focus on measuring detailed forms of childcare alongside the advances of studies in industrialised or historical settings in terms of larger sample sizes. We note here that our measure of childcare is in a way a proxy measure too, as we did not actually observe caregiving behaviour, but collected data through surveys with children's mothers/guardians. Our study is grounded in the overarching hypothesis that, all else equal, care from any allomother will be associated with relatively good child anthropometric outcomes. This hypothesis is operationalized through a prediction of greater HAZ and WHZ scores for children who receive care from each allomother, net of potential confounds (including care from other allomothers) and tested separately for both low- and high-intensity care types. Given that allomaternal care may be especially important in cases were mothers themselves are absent, we also explore associations between allomaternal care and child health in households where children have co-resident mothers versus households where children do not reside with their mothers.

7.3 Study Context

Our study was undertaken in Kisesa ward of Mwanza Region, Tanzania, within the bounds of the Magu Health and Demographic Surveillance System (HDSS). Operated by the National Institute for Medical Research (NIMR), the Magu HDSS has been active and collecting longitudinal demographic and health data on the local population since 1994 (Kishamawe et al., 2015). Our data were collected in two of seven villages in the HDSS catchment area, that lie on either end of a rural-urban extreme in the region. One is primarily reliant on subsistence-farming and the other undergoing several aspects of industrialisation (Hedges *et al.*, 2018; also see Chapter 6). Mortality and fertility rates in the Magu HDSS area are high, although under-5 mortality has declined substantially over the past decade (Kishamawe et al., 2015; MoHCDGEC et al., 2016). HIV/AIDS and malaria are the leading causes of death in the area, with HIV-related mortality being a major cause of orphanhood (and thus child fostering) in recent years (Kishamawe et al., 2015). Child malnutrition continues to be a significant issue in the country, including in Mwanza Region where 39% of children under 5-years are considered stunted and 4% wasted in the most recent Tanzanian

Demographic and Health Survey (2015-16) (MoHCDGEC et al., 2016). Poverty levels are high, with half of the total households sampled for this study classifying as severely food insecure at the time of survey (Hassan et al., 2019).

The majority of residents in both communities are Sukuma, an ethnic group that makes up roughly 17% of the national Tanzanian population (Malipula, 2014). Sukuma populations historically resided in large, scattered homes and kept sizeable numbers of cattle; now, land holdings have reduced in size and consumer goods are more commonly used as wealth, consequently leading to a decline in herd-keeping (Wijsen & Tanner, 2002). Relative to other ethnic groups, Sukuma households are larger and tend to contain both affinal kin and fostered (living without both biological parents) children (Lawson et al., 2015; Urassa et al., 1997; Varkevisser, 1973). A recent study in northern and central Tanzania showed that of 809 Sukuma children under 5-years, 5% were fostered and 16% had a living but not co-resident father (Lawson et al., 2017); and previous research among the two communities surveyed for this paper found that 26% of children over 7 years were fostered, and another quarter resided solely with their mothers (Hedges, Sear, et al., 2019). Sukuma children are most often fostered by their grandparents, and maternal kin are more likely to foster children than paternal kin (Urassa et al., 1997). Moreover, while marriage is universally practiced, it is not uncommon to get divorced or remarried (Boerma et al., 2002). These are common reasons for fostering, although children occasionally also live with stepparents (Urassa et al., 1997). Households can thus have diverse family structures and demographic compositions which may shape children's caregiving environments. Children under 5-years in this population receive substantial care (transfer of resources and direct caregiving) from both their parents (Hassan et al., 2019; Chapter 5 of this thesis) as well as a number of other individuals.

7.4 Data and Methods

7.4.1 Sample

This study was undertaken as part of a larger project that explored marital practices and the wellbeing of women and their young children (for details see

Schaffnit *et al.*, 2019a; Lawson *et al.*, 2020). Households were eligible to be included in the study if they had a woman aged 15-35 years resident. Household and women's surveys were carried out in 728 households; and child surveys were administered in the 506 households that had a resident child under 5-years of age, all of whom were eligible for inclusion in the study, leading to a total sample of 808 children. The child survey was administered to either the child's biological mother, or primary guardian in the few cases when the mother was not available. In the majority of cases the children included in the sample were offspring of the women who responded to the women's survey (76%). So as to not exclude from analysis the 24% of children for whom maternal data were missing, in this paper we primarily use data from the household and children's survey; with supplementary analyses conducted using maternal data from the women's survey. The household survey recorded information on the village of residence, household composition, size and demographic characteristics of all residents. The women's survey provided health and demographic indicators for the child's mother; and the child survey measured all child characteristics used in this paper. Interviews were carried out in Swahili or Sukuma by enumerators from the Tanzanian National Institute for Medical Research (NIMR) using Open Data Kit (ODK) Collect software on tablets (C. Hartung et al., 2010). Ethical approval was obtained from the National Institute for Medical Research Mwanza Lake Zone Institutional Review Board (MR/53/100/463), the Tanzanian National Ethical Review Committee (NIMR/HQ/R.8a/Vol.IX/3104), the University of California Santa Barbara Human Subjects Committee (1-17-0405), and the London School of Hygiene and Tropical Medicine Research Ethics Committee (13809).

All participants over 18 years of age provided informed consent verbally; for unmarried minors, consent was first obtained verbally from parents and then from the unmarried minor.

7.4.2 Variables

As per WHO guidelines, children's anthropometrics (age, height and weight) were collected as an indicator of their health. The WHO recommends child anthropometry as a measure of growth status for young children and as a validated indicator of malnutrition (de Onis, 2006; de Onis et al., 2012; World Health Organisation, 2014). Child's age was provided by the survey respondent for all 808 children. Height/length and weight measurements were recorded for the majority of children (n=757 for height/length; n=769 for weight). All children were measured with minimal clothing and no shoes. Child height was measured to the nearest millimetre using a stadiometer for those children who were able to stand on their own; a measuring mat was used to measure the length of infants who could not stand. Henceforth, both length and height are referred to as 'height'. Child weight was measured to the nearest 100 grams using an electronic weighing scale on solid ground. For babies and infants who could not stand on their own we first measured the weight of their mother/guardian, and then of the mother/guardian holding the child and subtracted one from the other to attain the child's weight. To account for observer error, all measurements were made twice and entered into ODK Collect. If there was a discrepancy of 5cm or more between the two heights entered, the program automatically requested a third measurement. Similarly, if there was a discrepancy of 2kg or more between the two weights entered, the program requested a third measurement. Once the final data were uploaded, we corrected for any odd or extreme entries, and a mean height and weight was calculated for each child. Children were measured by one of five different enumerators, who were rotated between both villages and assigned households randomly.

Height-for-age z-scores (HAZ), and Weight-for-height z-scores (WHZ) were derived using the World Health Organisation age- and sex-specific growth standards (de Onis et al., 2012; WHO, 1983). A low HAZ refers to "stunting" or "failing to grow" among children below 3 years and "being stunted" or "having failed to grow" among children above 3 years (de Onis & Blössner, 2003). This can be a result of long-term malnutrition or inappropriate feeding practices as well as early exposure to poor environmental conditions and recurrent illnesses. HAZ, therefore, describes chronic malnutrition by analysing body length or height in relation to age. A child with a HAZ of less than -2 SD is considered stunted or chronically malnourished, and a child with a HAZ of less than -3 SD is considered severely stunted. A low WHZ refers to wasting or thinness and indicates current or recent extreme weight loss/malnutrition. This can be due to acute starvation and/or severe illness. Usually, low WHZ peaks in the second year of life (de Onis & Blössner, 2003). WHZ are used to describe current nutritional status by analysing body weight in relation to body length or height. A child with a WHZ of less than -2 standard deviations (-2SD) from the median of the WHO reference population is considered thin or "wasted" or acutely malnourished, and a child with a WHZ of less than -3 standard deviations (-3 SD) is considered severely wasted. Children with WHZ scores of more than +2 SD from the median of the WHO reference population are considered overweight. Anthropometrics were calculated using macros in Stata 15 provided by the World Health Organisation (WHO and UNICEF, 2019). The software automatically flags improbable Z-scores in the data following WHO guidelines, and these were removed for analysis. Following exclusion of extreme scores, we had HAZ data for 741 children and WHZ data for 738 children.

Our dependent variable, care provision, was measured from seven categories of allomothers: the child's biological father, maternal grandparents, paternal grandparents, siblings (brothers or sisters), maternal aunts/uncles, paternal aunts/uncles, and distant kin/non-kin. The distant kin/non-kin category does not include stepparents, but could theoretically include distant kin not covered by the other categories, e.g., cousins. However, most respondents specified that 'others' were unrelated friends or neighbours. Respondents were asked if a child had received five types of caregiving, from each allomother independently, in the preceding two weeks: washing, feeding, supervising, playing with, and providing care to the child if they had been sick (215 children [27%] had been sick in this time period). Each type of care was measured as a binary variable, coded 'yes' if the child had received that particular care from an allomother (in the two weeks preceding the survey) and 'no' if they had not. Thus, the variables indicate whether each allomother had provided each type of care at least once, or not at all, in the specified time period. The five measures of direct care were categorised into two variables, those requiring relatively low-levels of energy expenditure on the part of the carer (low-intensity care) and care requiring high-levels of energy expenditure on the part of the carer (high-intensity care) (Meehan, 2005, 2008). As such, low-intensity care consisted of one variable: supervising (n=808 for all allomothers, except n=807 for paternal aunts/uncles); and high-intensity care consisted of four variables: washing, feeding/cooking for, playing, and caring when sick (n=808 for all allomothers, except n=807 for playing with maternal aunts/uncles and paternal aunts/uncles).

Children's parents' vital status and residence were measured in the survey by asking if each parent was alive, and if so, did they co-reside with the child at that time. These data were used to construct a binary variable that indicates whether the child's biological mother co-resided with the child (n=728) or was alive but did not co-reside with the child (n=74). Six children's mothers were not alive, and these were excluded from analysis as children with dead mothers may have had very different caregiving environments and health outcomes compared with children whose mothers were alive (co-resident or not), and the group was too small to be analysed on its own (n=6).

We consider a number of child, maternal and household-level variables as potential confounders: child's age (continuous in years), child's sex, if the child was their father's first child as a proxy for birth order, child's mother's age in years, child's mother's height, rural/urban residence operationalised through whether the child lived in the town or the village, and food insecurity as a proxy for household socio-economic status. Food insecurity was measured using the Household Food Insecurity (Access) Scale (Coates et al. 2007), which records whether the household experienced problems with accessing food in the past month.

7.4.3 Analysis

Due to the diversity in allomothering observed in other studies, we first describe variation in who provides allomaternal care to children in this population. A correlation matrix is used to test correlation between receiving care from different allomothers and identifying major categories of care arrangements. Multivariate linear regression models were built to test associations between maternal residence and children's HAZ and WHZ. These models compare the effect of a child not co-residing with an alive mother with the baseline of having a co-resident mother. Each of these controlled for child's age, sex and birth order, urban/rural residence, and household food insecurity levels.

Finally, multivariate linear regression models were run to examine the effect of receiving each type of care (low-intensity and high-intensity) from the seven allomother categories on children's HAZ and WHZ. To explore associations between allomaternal care and child health in households where mothers are resident versus non-resident, models were run separately for those children who lived with their mothers, and separately for those children whose mothers were not co-resident (as such, our analyses were stratified by child's mother's residence). We thus run eight models: four exploring the effects of receiving each of low- and high-intensity care on each of the two outcomes (HAZ and WHZ) for children with co-resident mothers; and four exploring the effects of receiving each of low- and high-intensity care on each of the two outcomes (HAZ and WHZ) for children with non-resident mothers. These models controlled for child's age, sex and birth order, urban/rural residence, and household food insecurity levels. Additionally, to control for the effect of receiving care from one allomother on the effect of receiving care from another, we include care from all allomothers in the same model (and thus do not have to run a separate model for each allomother category). Of the 728 children who co-resided with their mothers, we have HAZ data for 665 children, and WHZ data for 662 children. For the 74 children whose mothers are not resident in the household, we have HAZ and WHZ data for 70 children.

Data were missing for 24% (n=195) of children's mothers, for reasons including the mother did not live with the child, was dead, or was not a woman who completed the woman's survey. Thus, maternal age was only available for 76% of children (n=613) and maternal height for 75% (n=609). As such, these two variables were not included in the main models. However, for the sub-sample of children with data on maternal age and height we ran all models with these characteristics as controls (see Supplementary Material Tables S7.3 and S7.4). These models will be able to help identify if/how the main models were biased by not including maternal characteristics.

7.5 Results

7.5.1 Descriptive Statistics

Across the sample, children's height ranged from 35cm to 112cm (mean: 82.75cm, SD: 13.92); and their weight ranged from 1.9kg to 20.8kg (mean: 11.38kg, SD: 3.34). Children had a mean HAZ of -1.64 (SD: 1.58) and mean WHZ of 0.28 (SD: 1.42). According to the WHO categorisation of 'stunting' and 'wasting', 40% (SD: 1.8, 95% CI: 36.2-43.3) of children in our sample were stunted or chronically malnourished (low HAZ), and 5% (SD: 0.79, 95% CI: 3.54-6.69) could be categorised as 'wasted' or as having acute malnourishment (low WHZ). These statistics correspond to the Tanzania Demographic and Health Survey (TDHS) averages for these measurements in Mwanza Region in 2015-2016. The TDHS 2016 records 39% of children in Mwanza Region as stunted, and 4% as wasted in 2015-2016 (MoHCDGEC et al., 2016). Figure 7.1 shows the range of height-for-age and weight-for-height z-scores in our sample along with sample mean and the WHO cut-offs for 'stunting' and 'wasting'.

Boys had a mean HAZ of -1.73 (SD: 1.71) and mean WHZ of 0.26 (SD: 1.49); both of which were slightly lower than the girls' HAZ (mean: -1.56, SD: 1.43) and WHZ (mean: 0.30, SD: 1.35). Children aged between 1 and 3 years had the lowest HAZ compared to children in other age-groups; however, children's WHZ appeared to worsen with age, indicating older children suffered more from acute malnourishment than younger ones (see Table 7.1 for details). First-born children had worse HAZ (mean: -1.89, SD: 1.66) than later-born children (mean: -1.58, SD: 1.56); but later-born children had worse WHZ (mean: 0.23. SD: 1.44) compared to first-borns (mean: 0.50, SD: 1.31). Children living away from their mothers appeared to do worse in both health outcomes compared to children living with their mothers.

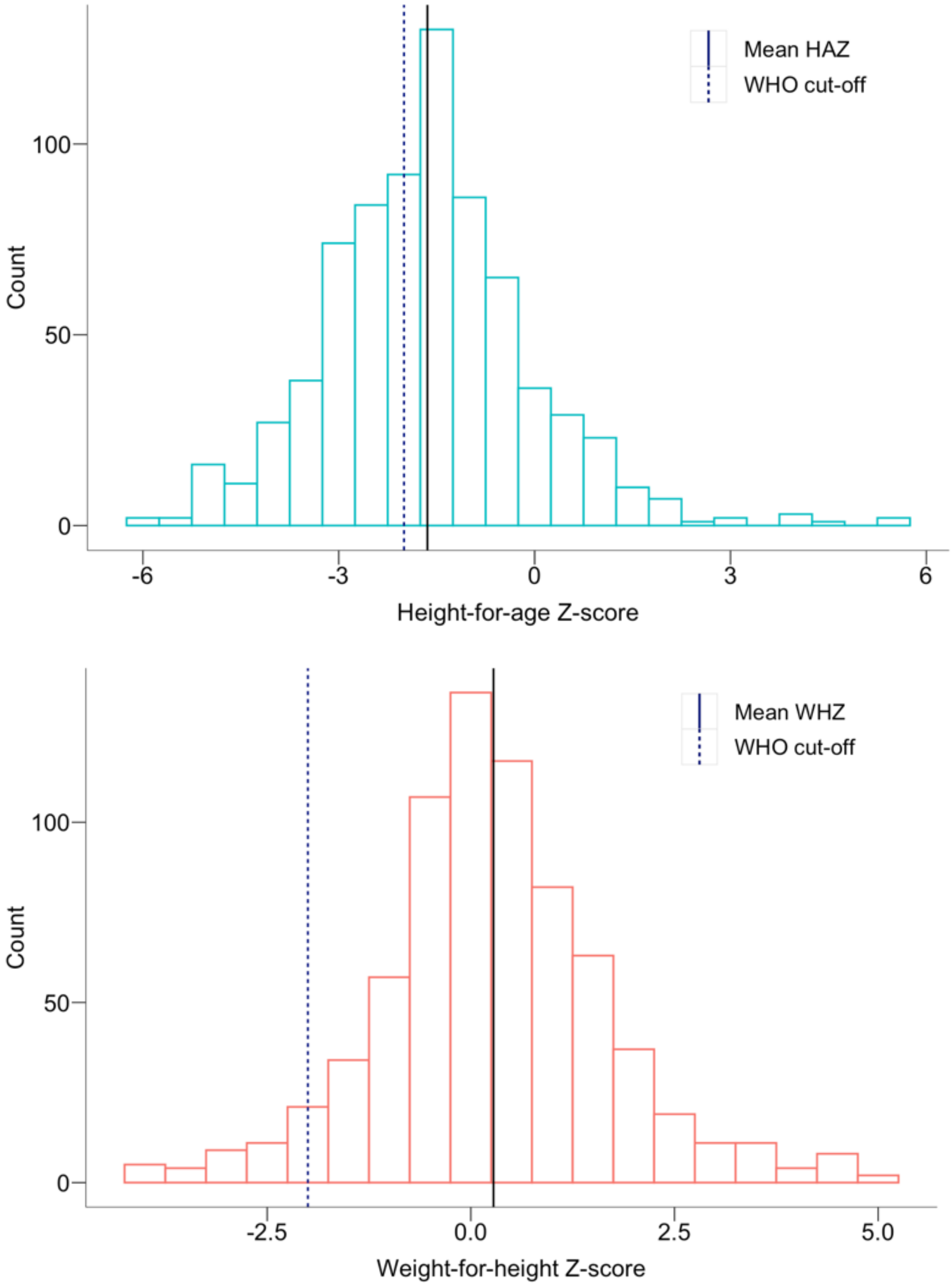

Figure 7.1 Histograms of children's height-for-age z-scores (HAZ) and weight-for-height z-scores (WHZ)

Table 7.1 Characteristics of surveyed households and children and breakdown of children's mean HAZ and WHZ by sociodemographic indicators

		HAZ	WHZ
		mean (SD)	*mean (SD)*
Total households surveyed - *n*	506		
Total children 0-5 years - *n*	808	-1.64 (1.58)	0.28 (1.42)
Characteristics of children			
Child's sex - *n (%)*			
Girl	397 (49.13)	-1.56 (1.43)	0.30 (1.35)
Boy	411 (50.87)	-1.73 (1.71)	0.26 (1.49)
Child's age - *n (%)*			
0-1 years	165 (20.42)	-1.04 (2.12)	0.49 (2.08)
1-2 years	156 (19.31)	-2.07 (1.35)	0.42 (1.42)
2-3 years	165 (20.42)	-1.82 (1.65)	0.32 (1.13)
3-4 years	177 (21.91)	-1.57 (1.28)	0.18 (1.29)
4-5 years	145 (17.95)	-1.70 (1.22)	-0.01 (0.98)
Father's first child - *n (%)*			
Yes	167 (21.63)	-1.89 (1.66)	0.50 (1.31)
No	605 (78.37)	-1.58 (1.56)	0.23 (1.44)
Characteristics of mothers			
Residence - *n (%)*			
Mother co-resident	728 (90.1)	-1.62 (1.58)	0.31 (1.46)
Mother not co-resident	80 (9.90)	-1.85 (1.60)	0.01 (0.98)
Age - *n (%)*			
15-19y	41 (6.69)	-1.56 (1.71)	0.94 (1.37)
20-24y	170 (27.73)	-1.91 (1.65)	0.39 (1.58)
25-29y	186 (30.34)	-1.59 (1.60)	0.38 (1.33)
30-35y	216 (35.24)	-1.46 (1.51)	0.06 (1.40)
BMI - *n (%)*			
Underweight (BMI<18.5)	50 (9.43)	-2.00 (1.13)	-0.25 (1.55)
Normal weight (BMI 18.5-24.9)	383 (72.26)	-1.59 (1.67)	0.30 (1.47)
Overweight (BMI 25-30)	72 (13.58)	-1.27 (1.68)	0.57 (1.38)
Obese (BMI>30)	25 (4.72)	-1.62 (1.40)	0.15 (1.08)
Height - *mean (SD; min, max)*	1.59 (0.06; 1.44, 2.07)		
Characteristics of households			
Residence – *n (%)*			
Town	294 (58.10)	-1.59 (1.58)	0.27 (1.50)
Village	212 (41.90)	-1.70 (1.58)	0.28 (1.35)
Food insecurity - *mean (SD; min, max)*	10.26 (7.6, 0, 27)		
Household size - *mean (SD; min, max)*	7.67 (3.10; 3, 25)		
Under-5s in HH - *mean (SD; min, max)*	1.75 (0.98; 1, 7)		

Children received care most commonly from fathers, siblings and distant kin/non-kin; followed by maternal grandparents (Figure 7.2). All allomothers, except fathers, provided more high-intensity care (washing, feeding, playing, and caring when sick) than low-intensity care (supervision); and fathers provided more low-intensity care than any other allomother. More than half of the children received high-intensity care from siblings and distant kin/non-kin, but much fewer received low-intensity care from either of these allomothers. The correlation matrix (Supplementary Table S7.1) indicates correlation between receiving care from fathers, siblings and paternal kin; between care from maternal kin; and negative correlation between care from fathers and maternal relatives.

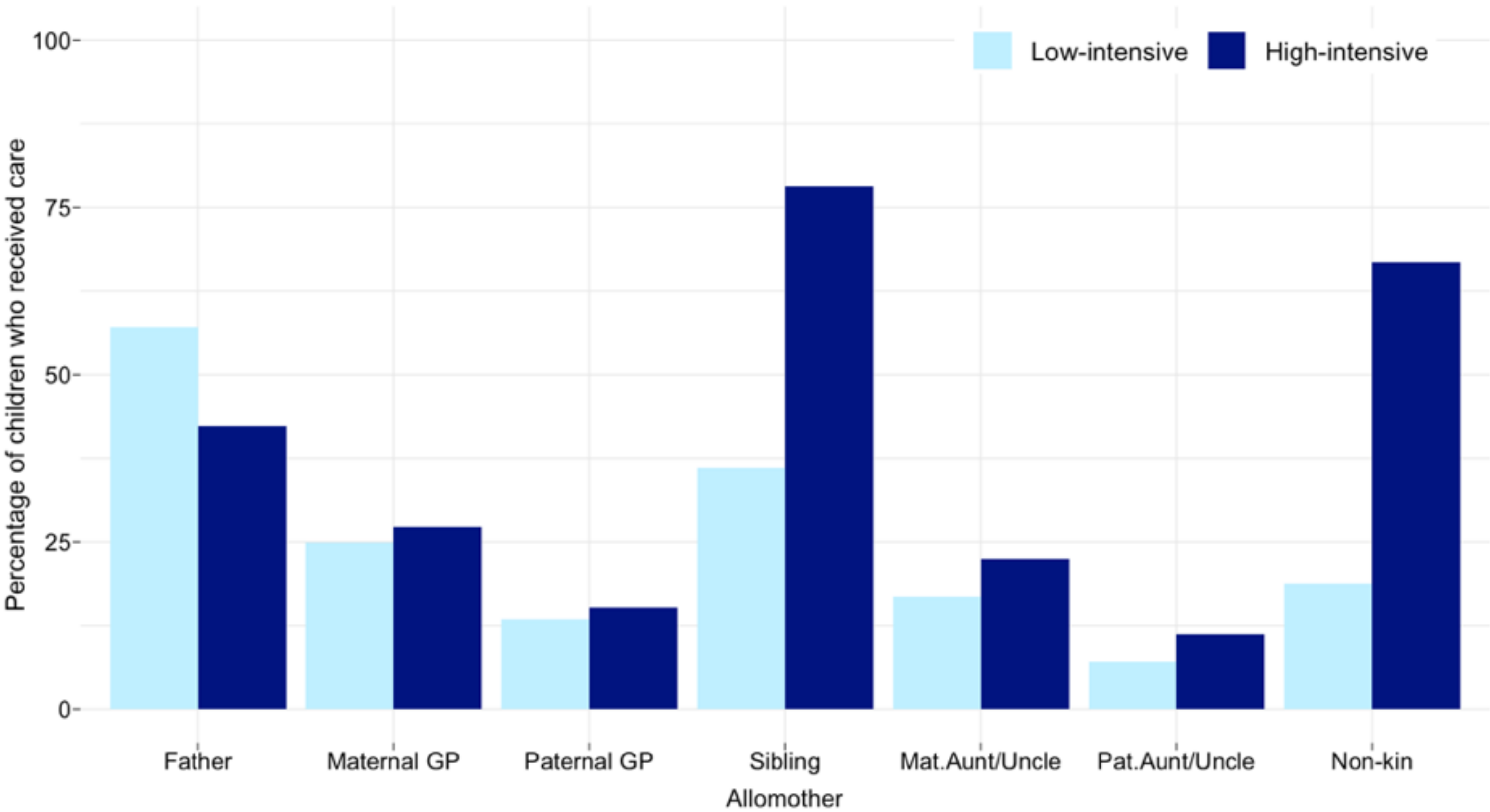

Figure 7.2 Percentage of total children (n=808) receiving low- and high-intensity care from each allomother in the last two weeks

Care provision differed by children's maternal residence (Figure 7.3); for reference, we also show variation in low- and high-intensity care provision from alive mothers (n=802). The majority of children residing with their mothers (n=728) received care from them; but very few alive but non-resident mothers (n=74) provided care (Figure 7.3). Fathers and siblings appeared to provide more care in households where the mother was co-resident compared to mother non-resident households. Conversely, all other allomothers (maternal and paternal grandparents, maternal and paternal aunts/uncles, and others/non-kin) provided more care to children who lived without their mothers compared to children with co-resident mothers. Patterns were similar for both low- and high-intensity care.

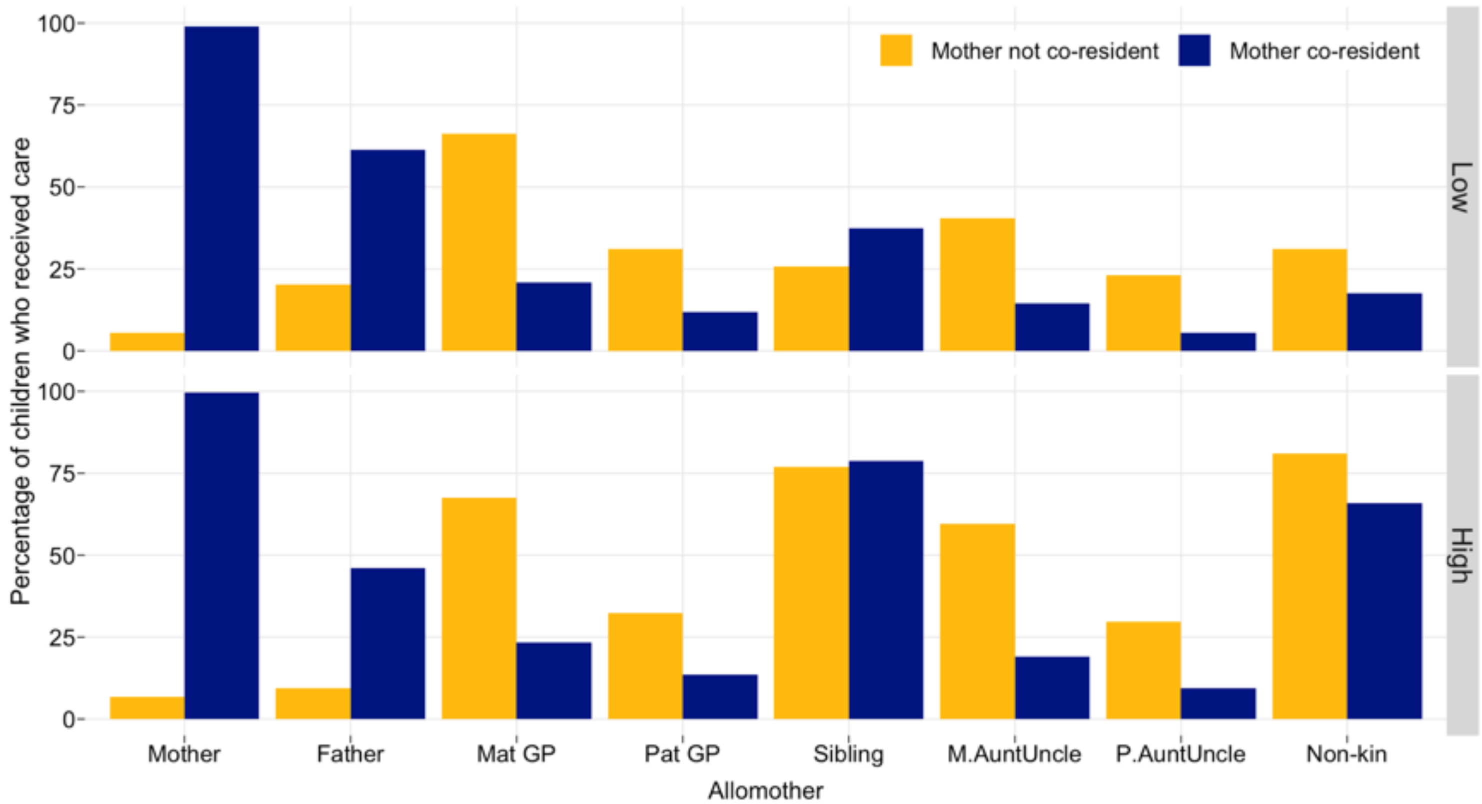

Figure 7.3 Care provided by alive mothers and seven allomother categories to children who resided without their biological mothers (n=74) compared to children residing with their biological mothers (n=728).

Note: Sample size is 74 children for all mother non-resident categories (first bar of each pair, coloured yellow); and 728 children for all mother co-resident categories (second bar of each pair, coloured blue), except for low-intensity care from paternal aunts/uncles, for which the sample was 727 children.

7.5.2 Linear regression results

Tables 7.2 and 7.3 show results from linear regression models testing the association between care provision and children's HAZ and WHZ for two groups of children: those who resided with their mothers, and those who did not co-reside with their mothers. The coefficients indicate changes in children's height-for-age and weight-for-height z-scores that are associated with receiving care from a particular allomother. A positive coefficient value implies care from that particular allomother is associated with an increase in z-scores, while a negative value indicates care from that allomother is associated with a decrease in z-scores.

Children whose mothers were co-resident

We find very little support for our prediction that children who received care would have better HAZ and WHZ than children who did not receive care. We find that receiving either low- or high-intensity care was not associated with better height-for-age z-scores for any allomother (Table 7.2). Results for children's weight-for-height z-scores are somewhat in line with our expectations. These indicate that receiving high-intensity care from fathers (versus not receiving it) was associated with having a higher WHZ; however, receiving low-intensity care from non-kin was associated with lower WHZ.

The supplementary analysis conducted on the sub-sample of children with co-resident mothers, for whom we had data on maternal age and height, produced results that were largely similar to those from the analysis using the full sample seen in Table 7.2. Two differences were detected in the models using the sub-sample of children: (a) we did not see an association between low-intensity care from non-kin and children's WHZ, both in the models that adjusted for and did not adjust for maternal age and height; (b) only in the models that adjusted for maternal age and height we see a strong positive association between low-intensity care from siblings and children's WHZ (see Supplementary Results, Tables S7.3 and S7.4 for details). These scattered findings imply weak evidence for our overall hypothesis that receiving allomaternal care would be positively associated with children's health outcomes, and are potentially a result of sample size effects.

Children whose mothers were not co-resident

We expected children who did not co-reside with their alive biological mothers to have worse anthropometric outcomes than children who co-resided with their mothers. While descriptive results indicate that children residing without their mothers had lower mean HAZ and WHZ than children residing with their mothers (Table 7.1), multivariate linear regression analyses indicate no evidence of a difference in HAZ or WHZ between children residing with and without their mothers (Supplementary Material Table S7.2). Further, we find mixed support for the prediction that allomaternal care provision would be especially important for children residing without their mothers. High-intensity care from fathers is positively associated with children's HAZ; and high-intensity care from paternal grandparents and both types of care from siblings with better WHZ. However, we find high-intensity care from paternal grandparents and maternal aunts/uncles to be associated with poorer HAZ (Table 7.3).

Table 7.2 Summary of linear regression analyses showing effects of receiving low- and high-intensity care (reference: not receiving care) from each of seven allomother categories on children's HAZ and WHZ outcomes. Analyses restricted to children with co-resident mothers (n=728)

	HAZ								WHZ							
	Low intensity care Model 1 n=651				High intensity care Model 2 n=652				Low intensity care Model 3 n=648				High intensity care Model 4 n=649			
	coef.	95% CI		p-val	coef.	95% CI		p-val	coef.	95% CI		p-val	coef.	95% CI		p-val
Father	-0.13	-0.43	0.17	0.40	-0.14	-0.39	0.12	0.30	0.07	-0.21	0.34	0.63	**0.31**	**0.08**	**0.55**	**0.01**
Maternal GP	-0.35	-0.72	0.03	0.07	-0.25	-0.60	0.09	0.15	-0.14	-0.48	0.20	0.43	-0.08	-0.40	0.24	0.62
Paternal GP	-0.03	-0.45	0.39	0.89	0.08	-0.32	0.48	0.70	0.19	-0.19	0.57	0.32	-0.16	-0.53	0.20	0.38
Sibling	-0.03	-0.30	0.24	0.83	0.17	-0.17	0.51	0.33	0.22	-0.03	0.46	0.08	-0.28	-0.59	0.04	0.09
Mat Aunt/Uncle	-0.14	-0.54	0.26	0.51	-0.02	-0.37	0.34	0.92	0.33	-0.03	0.69	0.08	0.18	-0.15	0.51	0.28
Pat Aunt/Uncle	-0.44	-1.02	0.14	0.14	-0.21	-0.68	0.26	0.38	0.44	-0.09	0.97	0.10	0.15	-0.27	0.57	0.48
Distant/Non-kin	0.21	-0.13	0.56	0.23	-0.26	-0.54	0.01	0.06	**-0.39**	**-0.71**	**-0.08**	**0.02**	-0.15	-0.40	0.10	0.24
Child's Age (cont.)	-0.10	-0.19	-0.01	0.03	-0.09	-0.19	0.00	0.06	-0.10	-0.18	-0.01	0.02	-0.07	-0.16	0.02	0.12
Child is Male	-0.14	-0.39	0.11	0.27	-0.16	-0.41	0.08	0.19	-0.05	-0.27	0.18	0.67	-0.06	-0.28	0.17	0.63
Child is First Child	-0.20	-0.54	0.15	0.26	-0.17	-0.53	0.18	0.34	0.30	-0.01	0.61	0.06	0.18	-0.15	0.50	0.28
Town Residence	0.05	-0.21	0.31	0.73	0.13	-0.13	0.38	0.33	0.08	-0.16	0.32	0.51	0.00	-0.24	0.23	0.99
Food Insecurity	-0.01	-0.03	0.00	0.09	-0.02	-0.03	0.00	0.07	0.00	-0.02	0.01	0.68	0.00	-0.01	0.02	0.91

* All models control for: care provision from all other allomothers, child's age, sex, birth order, rural/urban residence & food insecurity levels.
* Models with co-resident mothers: HAZ: low-intensity, n=651; high-intensity, n=652; WHZ: low-intensity, n=648; high-intensity, n=649.

Table 7.3 Summary of linear regression analyses showing effects of receiving low- and high-intensity care (reference: not receiving care) from each of seven allomother categories on children's HAZ and WHZ outcomes. Analyses restricted to children with alive but not co-resident mothers (n=74)

	HAZ								WHZ							
	Low intensity care Model 5 n=53				High intensity care Model 6 n=53				Low intensity care Model 7 n=53				High intensity care Model 8 n=53			
	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value
Father	0.17	-1.31	1.65	0.82	**2.75**	**1.37**	**4.13**	**0.00**	0.39	-0.26	1.05	0.23	0.14	-0.69	0.97	0.74
Maternal GP	-0.76	-2.48	0.96	0.38	-0.99	-2.53	0.55	0.20	-0.17	-0.93	0.60	0.66	0.84	-0.09	1.76	0.08
Paternal GP	-0.74	-2.51	1.04	0.41	**-1.81**	**-3.56**	**-0.06**	**0.04**	-0.13	-0.91	0.66	0.75	**1.20**	**0.15**	**2.25**	**0.03**
Sibling	0.01	-1.27	1.30	0.99	0.27	-0.64	1.17	0.55	**1.09**	**0.52**	**1.66**	**0.00**	**0.74**	**0.20**	**1.28**	**0.01**
Mat Aunt/Uncle	-0.76	-1.99	0.47	0.22	**-1.06**	**-2.05**	**-0.08**	**0.04**	-0.07	-0.62	0.48	0.80	0.10	-0.49	0.70	0.72
Pat Aunt/Uncle	-0.56	-1.89	0.77	0.40	-0.56	-1.77	0.65	0.36	-0.08	-0.67	0.50	0.77	-0.24	-0.97	0.49	0.51
Distant/Non-kin	-0.48	-1.63	0.67	0.40	0.52	-0.36	1.41	0.24	0.35	-0.16	0.86	0.17	0.06	-0.47	0.60	0.81
Child's Age (cont.)	-0.36	-0.85	0.12	0.14	-0.22	-0.61	0.17	0.26	-0.12	-0.33	0.10	0.28	-0.21	-0.45	0.02	0.07
Child is Male	-0.50	-1.45	0.45	0.30	-0.78	-1.56	0.00	0.05	0.19	-0.23	0.61	0.37	-0.09	-0.56	0.38	0.71
Child is First Child	-0.36	-1.32	0.61	0.46	0.06	-0.71	0.84	0.87	-0.28	-0.71	0.15	0.20	0.09	-0.38	0.55	0.71
Town Residence	1.06	0.05	2.06	0.04	0.67	-0.15	1.48	0.11	-0.34	-0.79	0.10	0.13	-0.46	-0.96	0.03	0.06
Food Insecurity	-0.01	-0.07	0.06	0.83	0.01	-0.05	0.06	0.76	0.01	-0.01	0.04	0.31	0.01	-0.02	0.04	0.54

* All models control for: care provision from all other allomothers, child's age, sex, birth order, rural/urban residence, and food insecurity levels.
* All four models with non-resident mothers, n=53.

7.6 Discussion

We find little support for our predictions that allomothering would be beneficial for children's health, that children in mother co-resident households would fare better than children living without their mothers, and that allomaternal care would be particularly important in mother non-resident households. Results are not consistent across category of allomother, the type of care provided (low- and high-intensity) or children's outcomes (HAZ and WHZ). This suggests either that, at least for children with co-resident mothers, allomaternal care is not contributing any additional health benefits for children on top of maternal care; or that our measures of care are not capturing the complex realities of children's caregiving environments. Below I discuss some potential explanations for the individual correlations found in our results, and make some suggestions for future research.

For children with co-resident mothers, high-intensity care from fathers was correlated with better WHZ, but this was not the case for children with non-resident mothers. As all co-resident mothers had provided care to children at least once in the two weeks preceding the survey, this could potentially mean that paternal care was more beneficial for children's acute nutritional status (as represented by their weight-for-height z-scores) when it was provided in addition to maternal care. On the other hand, paternal care in the absence of mothers was positively associated with children's HAZ. This could reflect a couple of circumstances, e.g., that paternal care in the absence of mothers is beneficial for children's long-term nutrition; or that in the event of maternal non-residence, fathers choose to take care of children with better health. The latter suggestion may be supported by the finding that in the absence of mothers, care from paternal grandparents and maternal aunts/uncles had a negative association with children's HAZ. It is perhaps unlikely (and inconsistent with the rest of the results) that this indicates that receiving care from these particular allomothers was detrimental for children. Children with worse long-term health outcomes may come from households that require extra help, and close kin members step in to provide this care. Grandmothers have elsewhere also been noted to provide care when it is needed (Schaffnit & Sear, 2017; Snopkowski & Sear, 2015) as well as provide more specialised and high-quality care than any other caregiver (Scelza, 2009). Thus, these findings could signify reverse causality: if in the absence of mothers, fathers choose to take care of healthier children (i.e., with better HAZ) other close kin allomothers may be assigned responsibility of children who already suffer from poorer health. Regardless of the mechanism, a positive association between fathers and child anthropometrics has been documented in previous studies, including in Tanzania (Lawson et al 2016). Further, in the Republic of the Congo, Bondongo fathers have been noted to perceive higher-quality direct paternal care as more beneficial for child health and growth than indirect care (Boyette et al., 2018).

Results also indicate that for children with co-resident mothers, low-intensity care (i.e., supervision) from distant kin/non-kin is associated with worse WHZ. This could either indicate that distant/non-kin were providing 'bad' care which resulted in poorer health, or as above with grandparents, seeking care from distant/non-kin is representative of a wider socio-economic environment i.e., the circumstances that lead to mothers having children with poorer health are the same that lead to them seeking care from distant/non-kin. The former could be possible if the care (i.e., supervision) was coming from other children. Among the Agta, children were documented to receive care from peer playgroups, aside from non-kin adults and adolescents (Page et al., 2020) and this was observed in the study population during fieldwork as well. Supervision from peer playgroups could be associated with poorer outcomes if this signified continuous unavailability of adult carers or mothers. However, we do not know from our data who comprised the distant kin/non-kin category of allomother and so cannot but speculate on this.

We also find that children living without their mothers did not suffer worse health compared to children living with their mothers. This was not in line with our prediction, or previous research elsewhere in Tanzania which showed that children living without either or both parents have a higher risk of death than children in a 'nuclear family' (Gaydosh, 2019). Children living without one or both parents having worse anthropometric outcomes, compared with children living with both parents, has been previously documented (Lawson et al., 2017; Prall & Scelza, 2017). However, at least one past study has found similar results as ours. Research among the Kipsigis in Kenya finds that maternal absence did not diminish the quality of care provided to infants, nor contribute to the infant's distress; further, allomothers were found to provide care that equalled quality of maternal care (Mulder & Milton, 1985).

Lastly, we see that in the absence of mothers, care from siblings and paternal grandparents is positively associated with children's acute nutrition (weight-for-height). Our findings about sibling allocare complement previous studies that suggest siblings to be important caregivers (Kramer & Veile, 2018), including for high-intensity tasks such as carrying and feeding (Barry Hewlett et al., 1996) as well as for their economic contributions (Cain, 1977; Kramer, 2002; R. D. Lee & Kramer, 2002). Further, most literature on sibling presence or allocare indicates a positive relationship between siblings and maternal and child outcomes, including children's survival and anthropometric status (Bove et al., 2002; Crittenden & Zes, 2015; Kramer, 2005; Sear & Mace, 2009). The findings regarding paternal grandparents are interesting and possibly reflective of child fostering.

However, it cannot be denied that when examined as a whole, our results largely suggest a null relationship between allomaternal care and children's health. This is also not novel. Previous studies have found various allomothers, including paternal grandmothers and male kin, including fathers, to have negligible impacts on the nutritional status and survival of children (Sear et al., 2000). A recent study in Mexico finds similar results. Examining support to first-time mothers and their children from children's maternal grandmothers, the authors find no differences, in either perceived stress/temperament or anthropometry of either the mother or child, between mother-infant dyads who received support from maternal grandmothers and those who did not (Vázquez-Vázquez et al., 2021). So, it is possible that the associations seen in this chapter are spurious, resulting from multiple hypothesis testing using the same dataset and from some inherent limitations in our data. The null relationships seen between kin care and child health may suggest that despite the diversity of childcare arrangements seen in this population, children don't seem to suffer, or benefit, from any particular arrangements – families may be ensuring that all children are cared for similarly, though who provides care may differ somewhat between families. That is, the system of cooperative breeding may be working to flatten HAZ and WHZ differences among children appropriately.

7.6.1 Limitations, reflections and future research

Our data indicate whether an allomother had provided each type of care at least once in the 2 weeks preceding the survey, and thus we do not know the frequency of care provision. The latter would be very useful as receiving care only once may have no impact on health outcomes whereas receiving a high frequency of care may be associated with better health. In some cases, we may be comparing children who had received care only once versus those who hadn't received it at all – and as such may not see any real differences in health outcomes. Collecting data on frequency of care provision may help illustrate our findings.

Another useful indicator to measure in future research would be whether the care provided was in addition to maternal care or substitutive of it. Previous research has tended to assume that kin care is provided in addition to maternal care, so that care will improve child outcomes. But neutral relationships between care provision and health outcomes may arise when allomaternal care is provided as a substitute for maternal care (Emmott & Page, 2019; Page et al., 2020). For example, a child not receiving care from an allomother has a certain baseline level of health because they are receiving that care from their mother. A child receiving care from an allomother could have that same baseline level of health because the care was provided to substitute for the mother. Unfortunately, this is difficult to test using these data because we do not have information on either frequency of care provision or on the mother's activities at the time the care was provided to the child.

As a post-hoc analysis, and to check for a potential effect of household composition on the relationship between care provision and child health, we also ran two sensitivity analyses, once running all eight models but additionally including a control for the number of under-5 children in the household (as a proxy for sibship size), and once including an additional control for overall household size. The results from these models were the same as for the models that did not include either of these co-variates and we have chosen to retain the simpler models in this paper.

One reason we see differences between the impact of care on HAZ and WHZ may be because they represent different aspects of a child's nutritional status. While WHZ measures short-term malnourishment, HAZ is representative of longer-term chronic conditions. It perhaps then follows that instances of direct care provision in a short-term period (two weeks before the survey and anthropometric measurements) would be more highly correlated with children's WHZ as they both reflect a similar timeframe in the child's life.

7.6.2 Conclusion

We draw on the strengths of a large sample of children from an industrialising context to explore the effect of allomaternal care on children's anthropometric outcomes using two types of direct caregiving: low-intensity care and high-intensity care. While our results demonstrate minor variations in the relationship between carer, type of care, and children's HAZ and WHZ, we largely see a neutral association between care and child health. What is perhaps important to note is that the majority of children in this sample had received care at least once from at least one carer, even if in many instances this was from the mother. As such, future research could benefit from exploring frequency of the care provided to children as variation in health outcomes may be more susceptible to the degree of care being provided to the child as opposed to whether or not it had been provided. While this research extends beyond the use of proxy measures of care as seen in many previous large-scale studies on childcare and health, we find that measuring children's caregiving environments is not straightforward. More in-depth data could help clarify the results seen in this study and support some of the assumptions considered above.

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8. Discussion

In this final chapter, I summarise my research findings, linking these to my thesis aims and objectives; reflect on my results, addressing some issues that arose during the course of this research; make suggestions for future work; and then conclude with the contributions of this thesis.

8.1 Summary of findings

I had three broad aims for this PhD: (a) to draw on the methodological strengths of both anthropological and demographic research on childcare to collect data that overcame some of the limitations of previous studies; (b) to contribute to a more thorough and interdisciplinary understanding of the patterns and predictors of childcare; and (c) to shed light on potential demographic and health implications of childcare for children and women. These aims were realised through four objectives (Table 8.1):

1. Collect novel data on detailed measures of childcare for a large sample of children in two north-western Tanzanian communities that are undergoing the demographic transition
2. Describe the patterning of parental and alloparental childcare in these two communities
3. Explore child-level, parental, and ecological determinants of the care provided to children e.g., child's sex, parental co-residence with child, and market integration
4. Quantitatively investigate the relationship between parental and alloparental care provision and children's health

I found that while mothers were more commonly cited as children's caregivers, fathers did a substantial amount of parenting too. As expected, non-parents were also common providers of care; for example, children received care from their siblings, maternal and paternal grandparents, maternal and paternal aunts and uncles as well as distant kin and non-kin. However, even with allomaternal support very common, several factors were predictive of different patterns of support. For instance, fathers appeared to favour sons over daughters in three types of direct care (washing, feeding, and supervising), while there was no sign of sex-biased care from mothers or any alloparent (Chapter 5). Further, I found that children who lived in the more urban town experienced care less commonly from their fathers, siblings and paternal relatives compared to children in the rural village; however, they had a higher likelihood of receiving care from distant kin and/or unrelated individuals (Chapter 6). Interestingly, unlike other allomothers, maternal kin were equally likely to provide support in the town and the village. While the different patterns of allocare seen between the two communities were not driven by differences in paternal residence, who children received care from overall varied by whether or not their fathers were co-resident. I found little evidence that allomaternal support was associated with children's health (either positively or negatively), particularly for children who co-resided with their mothers (Chapter 7). While there were some significant associations between allomaternal care and health for children with non-resident mothers, these were not consistent in either source or type of care or by the health outcome examined. Moreover, children residing without their mothers appeared to have the same health outcomes as children with co-resident mothers.

Collectively, these results demonstrate that human behaviour can vary considerably even within the same population, and is responsive to a number of different social, demographic and ecological factors. There is substantial variation in who children receive care from and in the types of care they receive in these two communities in north-western Tanzania. Children's caregiving environments are partly associated with factors including the child's sex, parental residential status, and the community's level of market integration. However, unexpectedly, this research also suggests that this variation in care is not quite associated with children's health. I expand on some of the implications of these findings in the next section.

Table 8.1 The aims and objectives of this research, and the thesis chapters in which these were addressed

Aim		Objective		Chapter
1	To draw on the methodological strengths of anthropological and demographic research on childcare to collect data that overcomes some limitations of previous studies	1	Collect novel data on detailed measures of childcare for a large sample of children in two north-western Tanzanian communities that are undergoing the demographic transition	4
2	To contribute to a more thorough and interdisciplinary understanding of the patterns and predictors of childcare	2	Describe the patterning of parental and alloparental childcare in these two communities	5 & 6
		3	Explore child-level, parental, and ecological determinants of the care provided to children e.g., child's sex, parental co-residence with child, and market integration	5, 6 & 7
3	To shed light on potential demographic and health implications of childcare for children and women	2	Describe the patterning of parental and alloparental childcare in these two communities	5 & 6
		3	Explore child-level, parental, and ecological determinants of the care provided to children e.g., child's sex, parental co-residence with child, and market integration	5, 6 & 7
		4	Quantitatively investigate the relationship between parental and alloparental care provision and children's health	7

Table 8.2 A summary of the predictions tested in this thesis, the exposure and outcome variables analysed, and results

Chapter		Prediction	Exposure variable	Outcome variable	Result & Notes
5	1	Boys will more commonly receive care from both mothers and fathers than girls	Child was male or female	Resource provision	Mothers and fathers: no difference between daughters and sons
				Washing, feeding, playing, supervising, co-sleeping, caring when sick	Mothers: no difference between daughters and sons Fathers: biased towards sons in feeding, washing and supervising
				Parents' relationship	No difference between daughters and sons
				Breastfeeding	No difference between daughters and sons
6	2	Allomaternal care from kin will be more common in the village	Town or village residence	Low- and high-intensity direct care from various allomothers	Allomaternal care from fathers, siblings, paternal grandparents & aunts/uncles more common in the village. Allomaternal care from maternal kin same across the town and village
	3	Allomaternal care from distant kin/non-kin will be more common in the town			Allomaternal care from distant/non-kin more common in the town

	4	Rural-urban differences seen in children's caregiving will be driven by differences in father-child co-residence between the two locations	Town or village residence stratified by child's father's residence	Low- and high-intensity direct care from various allomothers	No evidence that differences in allomaternal care seen between town and village were driven by differences in child's father's residence
7	5	Receiving allomaternal care will be beneficial for children's health	Low- and high-intensity direct care from various allomothers stratified by child's mother's residence	Height-for-age (HAZ) and weight-for-height (WHZ) z-scores	Mothers: resident **HAZ** - No association **WHZ** - Fathers high-intensity: +ve Non-kin low-intensity: -ve Mothers: non-resident **HAZ** - Fathers high-intensity: +ve PGP high-intensity: -ve Maternal aunts/uncles: -ve **WHZ** - PGP high-intensity: +ve Siblings low-intensity: +ve Siblings high-intensity: +ve
	6	Children in mother non-resident households will have worse health than children in mother co-resident households	Maternal residence		No difference in HAZ or WHZ between children who co-resided with their mothers and children with non-resident mothers

Key: +ve = positive association; -ve = negative association; PGP = paternal grandparents; MGP = maternal grandparents

8.2 Reflections and implications

8.2.1 Children in transitioning settings

Studying childcare in transitioning contexts is not very common. However, as communities undergo the demographic transition, young children's environments change substantially too. While there is much work on how the demographic and urban transitions impact older children, especially due to the focus of research and development policy on children's education (Bank, 2011; Peet, Fink, & Fawzi, 2015), and how improvements in child health and reductions in infant mortality propel demographic transitions (discussed in Chapter 2), research has not fully explored the changing social environments of very young children. Results from this thesis suggest that there may be value in understanding how the lives of pre-school aged children vary between different ecological settings. I find that different levels of market integration are associated with variation in allomaternal caregiving behaviour by both who provides support to mothers and children and the type of support provided. This is important because different patterns of support may be driving real world differences in fertility and children's health between more and less market integrated populations.

A large body of research shows that shifts in subsistence strategies due to urbanisation or market integration, and ensuing transitions in wealth and status, are linked to higher proportions of women in the labour force (Klasen, Pieters, Santos Silva, & Ngoc Tu, 2019; Zhang, Gao, & Li, 2013), increasing importance of education, rising costs of children, and ultimately declines in fertility (Becker, 1960; Colleran et al., 2015; H. Kaplan, 1996; Lawson & Mulder, 2016; Sear & Coall, 2011; Skirbekk, 2008). These changes are often also correlated with cooperative childrearing, with research indeed showing that high levels of support provided to women are associated with higher levels of reproductive success, including fertility (Gibson & Mace, 2005; Hrdy, 2005a, 2011; Kramer, 2010, 2014; Sear et al., 2003; Voland & Beise, 2002). However, in this thesis, I do not necessarily find that women are less likely to receive support in the town than in the village; but instead that they are likely to receive care from different individuals in both communities.

Research shows that community-level indicators such as the socio-demographic characteristics of a woman's social network (e.g., community-level education), may be stronger drivers of fertility than individual-level characteristics (e.g., a woman's own education level) (Colleran et al., 2014). This suggests that who women regularly interact with may play an important role in their decision-making and behaviour. My findings indicate that women are more likely to interact with non-kin and have wider social networks in urban compared to rural communities; and studies have previously indicated that people take reproductive cues from other individuals' behaviours (Coale & Watkins, 1986; Knodel & van de Walle, 1979). If women's allomaternal support networks are a source of cultural transmission, then perhaps differences in who supports women in different ecological contexts (as shown in Chapter 6) are also an important driver of demographic change. This may be particularly relevant if women's support networks in different contexts are comprised of people with different socio-economic and demographic characteristics and/or cultural norms, which signal wider shifts in women's social environments. This raises the question: while the occurrence of fertility decline alongside increasing urbanisation and market integration is often attributed to the reduced support available to women – especially from kin – could it be that the driving force is not the lack of availability of childcare support, but rather who provides it? In particular, what are the wider socio-demographic implications of a higher likelihood of receiving support from non-kin in the town? These are questions that may be useful to explore in future research.

Relatedly, this idea may also apply to the differences seen in support from children's patrilineal kin members between the town and village. Research shows that lineage-based differences in who provides support to mothers (or who they reside with, depending on the measurement used) can impact their fertility. For example, residence with patrilineal kin has been associated with women having higher fertility (Sear et al., 2003; Snopkowski & Sear, 2013) as paternal relatives may be more inclined towards increasing their reproductive success by investing in their son's fertility rather than grandchildren's health. I find that fathers and paternal kin are more likely to provide support in the village than in the town, while maternal kin are equally likely to provide in both communities, and non-kin more likely to support mothers in the town. In future research, I would like to explore whether declines in patrilineal allomaternal support provision in transitioning contexts play a role in fertility decline.

These questions are especially relevant to the Tanzanian context. While the majority of the population currently resides rurally, the country is in the midst of a demographic transition and is experiencing rapid urbanisation in some areas. Communities are, or will soon be, undergoing significant socio-economic and demographic changes; and these transitions will be reflected in the caregiving environments of very young children. More women entering paid employment outside the home may mean reduced availability of maternal care; fathers engaging in wage-based labour instead of farmwork may also require them to be away from their households; and an increasing number of children enrolled in school may mean fewer older siblings around, and a possible transition from sibling care to non-kin peer group care. There are also considerable changes taking place across sub-Saharan Africa in regard to shifts in marital norms, e.g., more choice over who to marry, prominence placed on the nuclear as opposed to extended family (Clark, Kabiru, & Mathur, 2010; Madhavan, Beguy, & Clark, 2018; Madhavan, Clark, Beguy, Kabiru, & Gross, 2017). And marriage dissolution, staying unmarried, or living without spouses or partners is common (Clark et al., 2017); as is labour migration (Beguy, Bocquier, & Zulu, 2010; Therborn, 2006). These factors significantly impact children's family and household structures. Some of these socio-demographic differences were recorded in Welamasonga and Kisesa villages (Chapter 6; Table 6.1); and children's peer groups were mostly observed in urban Kisesa during fieldwork.

I am thus also interested in gaining a more comprehensive understanding of the contexts in which help is requested from different individuals, for example, which characteristics of market integration in transitioning populations are associated with who provides support to women and children; and further exploring how young children's lives vary between rural farming contexts and urbanising market integrated ones. Understanding how these changes affect not only maternal energy loads and allomaternal support networks, but also children's lived experiences of 'childhood', may benefit future studies on child development. Collecting data on women's work and maternal activities in conjunction with data on allomaternal support, especially the frequency of care provided will further aid in these analyses. A better understanding of who provides support to mothers in transitioning contexts may also allow policymakers and development workers to better target interventions aimed at improving children's wellbeing, e.g., infant feeding programmes that involve training of children's key caregivers, as research repeatedly shows the positive impact of contributions from different allomothers on children's nutrition (Asiodu, Waters, Dailey, & Lyndon, 2017; Aubel, 2012; Dinga, Kiage, & Kyallo, 2018; Scelza & Hinde, 2019; Shroff et al., 2011).

8.2.2 Non-kin as alloparents

While the role of kin members in providing support to mothers has been studied extensively, distant kin and non-kin have been underplayed in much of the literature on childcare (Chapter 2). My findings show that children do receive allomaternal support from non-kin in both the town and village, although it is much more likely in the town (Chapter 6; Figure 6.1, Table 6.2). This is interesting because availability of allomaternal support may in fact be more important in urban communities compared to rural ones. Women living in more urban or market-integrated areas are more likely to participate in wage-based employment, possibly a consequence of increased household and family financial needs (Klasen et al., 2019; Zhang et al., 2013). Mothers employed outside their homes will also have increased pressure to find external help for childcare, especially if they cannot access support from their relatives. My results suggest that in urban communities non-kin may step in to provide this support to women; and further, that they may even be substituting for care from paternal relatives.

Not only does this emphasise the flexibility of women in who they receive support from, but also the importance of non-kin care in transitioning contexts.

However, if non-kin are important support providers in these circumstances, what role do they play in influencing women's fertility decisions and determining children's wellbeing? The lack of research on the role of non-kin, especially in low-income transitioning settings, makes it difficult to predict what implications care from non-kin would have for children and women's outcomes, and if/how this differs from the impact of different kin members. Although I attempted to examine this topic in Chapter 7 my findings are inconclusive and require further investigation. This is a particularly rich area for research in communities undergoing demographic and/or urban transitions as women and children in these contexts may be experiencing shifts in their support environments, as well as multiple influences and pressures – socio-economic, cultural and political – on both their reproductive decision-making processes (e.g., rising costs of childrearing, policies promoting smaller family sizes), as well as appropriate childrearing practices (e.g., enormous global movements to improve children's health and nutrition).

If kin and non-kin have different motivations to provide care, i.e., the mechanisms of kin selection/inclusive fitness and reciprocity/direct returns discussed in Chapter 2, then this also leads to some theoretical considerations. It may perhaps be reasonable to conjecture that kin members provide better quality care – or rather, are more invested in improving children's outcomes – as their fitness returns are reliant on that child's wellbeing, compared to non-kin who are expected to care for reciprocal benefits. However, there is no clear evidence that this may be the case. The variation in the relationships seen between care from different kin and child outcomes (Sadruddin et al., 2019; Sear & Mace, 2008) also suggests that relationships between different non-kin and child health may also be variable. Further, while non-kin are expected to care for reciprocal returns or direct benefits, research indicates that often kin members are incentivised by the same reasons and that reciprocity and kin selection are not mutually exclusive (Allen-Arave et al., 2008; Jaeggi & Gurven, 2013; Nolin, 2010), generating an avenue for future research to consider what motivates different non-kin to provide allomaternal support.

8.2.3 Benefits of interdisciplinary research

This thesis benefited from taking an interdisciplinary mixed-methods approach. I drew on the strengths of both demographic and anthropological methods to design a study that measured childcare behaviour for a relatively large sample of children. Such detailed data on childcare have previously been collected by anthropologists using observational methods, which restricts sample sizes (usually to between 10-30 children). Conducting this study in affiliation with the Magu Health and Demographic Surveillance System (HDSS) was also beneficial. This facilitated and streamlined a large part of the fieldwork experience including local ethics applications, hiring of trained interviewers, provision of an office space to work at, collaboration with local researchers who provided valuable guidance through the duration of fieldwork, and good relations between the HDSS and the study participants as well as village leaders. This enabled me to collect my PhD data in a relatively short period of time (4 months), and was an incredibly pleasant experience, with all study participants welcoming us into their homes and amiably responding to our questions. While this study design allowed me to overcome some limitations of previous research as this thesis had aimed to do, and has helped moved research forward from studies that used proxy measures for care provision, there are some important lessons learnt that I would incorporate in future work, for example incorporating detailed questions in surveys that allow measurements of real behaviour as would have been observed by researchers undertaking focal follows (e.g., frequency of care provision, maternal activities while the child was taken care of, whether the care being provided was in fact of low- or high-intensity, and as such, if it was disruptive of the carers other activities or not); using time allocation surveys; or even supplementing surveys with some observational methods.

I also undertook training in qualitative research methods and conducted focus group discussions, an anthropological method of data collection, which is now regularly utilised in mixed-methods studies (Randall & Koppenhaver, 2004). These allowed extremely valuable insights into local cultures and perceptions, especially those regarding parental and alloparental care.

The theoretical framework of this research also drew on multiple disciplines, as discussed in Chapter 2. These combined methodologies and concepts allowed me to create a holistic picture of children's caregiving environments. From an evolutionary perspective I drew on an understanding of what motivates people to behave in certain ways, and from HBE, why people behave variably in different contexts; from demography, not only did I adapt my methods, but also accessed a vast body of knowledge on the impact of demographic changes in different populations and how demographic phenomena impact human behaviour; and finally from population health sciences, the importance of understanding why and how variation in behaviour can be crucial for children's wellbeing. Thus, I drew on evolutionary theory to generate testable hypotheses about human behaviour and health which were tested in a socio-demographically transitioning context. Conducting interdisciplinary research is also one way to respond to requests for international organisations to take into account ecological differences in childcare practices when planning interventions (Gladstone et al., 2018; Lingam et al., 2014). For example, researchers have recently called for more holistic measurements of children's caregiving environments (Sadruddin et al., 2019). Sadruddin et al (2019) present a conceptual framework to address different features of children's grandparental caregiving environments (however this can be applied to other caregivers). The features of this framework address many different dimensions of care: how care is measured (e.g., co-residence, behaviours, financial support); the context that it is provided in (e.g., numerous child-level and structural determinants); and a variety of child outcomes (including physical health, socioemotional health and cognitive development). Finally, they emphasize situating these factors in robust research methods and theory, and the design of studies that can inform or guide policy. This framework is derived from a systematic review of studies spanning multiple disciplines; it then follows that future studies, drawing on this framework to guide their research, must engage with theory, evidence and methods from these different disciplines.

Reflecting on the role of culture

Conducting interdisciplinary research also allows for, and promotes, a balance between different perspectives and theoretical frameworks. Recently, the field of human behavioural ecology – and evolutionary demography in specific – has met critique for its dismissal of cultural mechanisms as drivers of human behaviour. While I took an interdisciplinary approach in this thesis, my predictions were almost wholly derived from evolutionary demography and HBE, and thus my results interpreted from that perspective. However, spending time with the local communities where this study was undertaken, and considering the study participants' own perceptions and explanations of parental behaviour (e.g., as discussed in the focus group discussions), has made me much more cognizant of the value of incorporating cultural explanations in my research. This is especially true for my findings in Chapter 5, where I grappled to find an adaptive explanation for the result that paternal care was son-biased while mothers provided equally to girls and boys. However, reading through the focus group discussions made evident that there was a fairly simple explanation for this behaviour: cultural taboos prevented men from providing certain types of care to their daughters. This, for me, then begs the question – are the two explanations mutually exclusive? And is one more relevant than the other? If I was simply interested in using data collected in rural Tanzania to test a prediction derived from evolutionary parental investment theory (i.e., parents will favour children who have higher chances of reproductive success), then I had succeeded. Yet, my results were not in line with my prediction and there was a gap in my understanding of this behaviour. What provided important context and nuance to these findings (i.e., specific reasons for why son-biased care existed in this community) were the interactions with community members and listening to their explanations and beliefs – which I admit had not been the prime focus of my research. This has made me really appreciate the fundamental role of mixed-methods research when studying human behaviour.

There have been multiple calls for developing integrative frameworks that incorporate concepts of culture into evolutionary and demographic approaches, and that give due credence to cultural mechanisms in driving specific human behaviours (Colleran, 2020a; Cronk, 1995; Roth, 2004). Anthropological demographers have perhaps been most successful at doing this, and Laura Bernardi clearly demonstrates its value in her introduction to the discipline (Bernardi, 2007). While my thesis did not set out to respond to these calls, I believe that my findings do echo them. As Colleran puts it, there is perhaps 'a need to relax the often sharp distinction made by behavioural ecologists between proximate and ultimate (i.e., functional) explanations' (Colleran, 2020a).

8.2.4 Reflections on methodology

Longer pilot & pre-survey qualitative research

In retrospect, a longer pilot and qualitative research to inform the survey design would have helped guide my understanding of the concepts I was measuring in the local context. One example is the timeframes I used for my measures of care. Respondents were asked to state if they had received support for the focal child at least once from different individuals, either within the two weeks before the survey (for measures of direct care, e.g., washing, feeding etc.) or in the three months preceding the survey (for resource provision). These two timeframes were chosen for two reasons: accuracy of recall and the feasibility, or realistic probability, of that care having been provided in the specified time period. On the other hand, choosing wider time periods without capturing frequency of care provision means that the data may have captured care from individuals who were not regular carers but had just happened to provide care once in the specified time period (e.g., visitors or guests). Pilot-work, or qualitative research, focused on a deeper understanding of the meaning of different types of care provision may have better informed these measures.

Using surveys instead of observational data

I chose to collect data that measured caregiving because past studies have often used indicators such as the absence/presence or co-residence of a caregiver as proxies for behaviour; while studies that collected data on caregiving behaviour have been observational in nature and thus restricted to very small sample sizes. When designing this study, I did consider taking an observational approach in line with previous work on allocare, as this methodology has its strengths (e.g., does not suffer from reporting biases, and allows for a completer and more in-depth picture of a child's environment). However, I opted for self-reported measures of care collected through quantitative surveys as this allowed for the selection of a relatively large sample of children in my study, facilitated by the HDSS sampling frame, knowledge of the study area and trained interviewers amongst other benefits, as discussed earlier. Moreover, HDSS connections and existing relationships with the communities meant high response rates and respondents who were generally happy to participate in the study. Collecting observational data on such a large sample would have had high financial and time costs and been practically infeasible. I thus supplemented these surveys with a small qualitative component which enabled formal in-depth discourse on children's care and wellbeing with the study participants. I was also able to informally observe study participants when visiting households for interviews which added to my knowledge of the local environment, cultures and norms. Moving forward, I would also supplement self-report surveys with some observational methods, such as focal follows, to ascertain accuracy of self-reported data.

<u>Measuring co-residence of allomothers</u>

I did not specifically ask about the co-residence of the allomothers who were providing care (except for fathers). The household roster measures the relationship of the child to the household head, but it does not state the relationship between each member of a household. The reason to not collect these data were simply because the care data being measured in this study was collected to *overcome* proxy measures such as co-residence. However, in retrospect it would have been valuable to cross-reference co-residence with care provision to see how well the two correlated and if co-residence really was a good proxy for care provision. While I do not have these data on all allomothers, I do know about paternal co-residence. For fathers, mapping co-residence onto care shows that in fact non-residential fathers provided resources to their children, while quite a few resident fathers did not provide direct care. Further, while all mothers provided direct care, there was more variation in maternal provision of resources, and few non-resident mothers provided care. This emphasises the important of different measures of care and shows that co-residence does not always indicate care provision.

The allomother category of 'distant/non-kin'

The category for 'non-kin' was merged with 'other' during fieldwork to shorten the length of the questionnaire. However, as the individuals we did ask about include mothers, fathers, stepparents, siblings, grandparents, and aunts/uncles, it is likely that the 'other' category consists of either distant kin such as cousins, or non-kin. Conversations with participants and interviewers also suggested that the 'other' category was often used to refer to friends or neighbours, and a few times the church. Another point of consideration regarding the categories of carers is that we did measure care from stepparents however very few children had stepparents and so this group was dropped from analyses.

8.3 Issues arising and future directions

The limitations of individual studies were discussed in Chapters 5 to 7. In this section I reflect on some of the overall issues that arose during this project.

8.3.1 Sampling restrictions

Our sample was obtained using Round 31 of the Magu HDSS. While we conducted a simple random sample from the sampling frame that we did have, this frame itself did not contain households that may have moved into the HDSS area during the one-year interim period between the HDSS Round 31 and our data collection (Round 31 of the HDSS was undertaken in 2016, and our data collection took place from July through October of 2017). This is probably especially likely in Kisesa where levels of mobility were significantly high. As described in Chapter 4, there were numerous households in the sampling frame for Kisesa that we were unable to locate during fieldwork. This may have led to our sample not accurately representing more mobile households, where patterns of allomaternal support could have varied considerably from households that were more settled. However, the overall refusal rate from households that were successfully located was very low and probably did not bias the sample.

The sample was also biased towards younger mothers as we only interviewed households that had a resident woman aged 15-35 years. I thus may have excluded from my sample children who would have been living in households with older women, e.g., higher birth order children (i.e., children with more older siblings) or children who were perhaps being raised by grandparents (fostered children) or were not living with their mothers. This could mask results of grandparental care in the event of fostering, and care provision from older siblings. While I do capture a small percentage of fostered children in this study this sample was too small to test for variation in childcare. Future research could benefit from including a larger proportion of fostered children in the sample. Fostered children likely vary considerably from children living with one or both parents, in who they receive care from. Further, previous findings are mixed regarding the health outcomes of fostered children, with a study in Tanzania showing that fostered children have similar anthropometric outcomes as children residing with both parents (Lawson et al., 2017); while a study among Namibian pastoralists finds fostered boys and girls to fare worse than non-fostered children (Prall & Scelza, 2017). It may be insightful to explore whether variation in allomothering impacts the health of fostered children differently to non-fostered children.

8.3.2 Using self-report data

All data were self-reported by the survey respondents and thus could be biased. All responses about childcare (i.e., whether or not an individual had provided care to the child) were from the point of view of the mother or guardian of the child (as opposed to caregiving behaviour being observed by myself or interviewers). I constructed the survey in this way for two reasons: mothers/guardians were most likely to be aware of who was providing help to them; and relatedly, this measurement was more likely to reflect the support being provided to the mother (i.e., allomaternal support). However, responses could have been biased if, for example, a mother was partial towards or against a particular relative, they may have been more inclined to respond positively or negatively about this individual's provision of support. Social desirability biases can also arise if participants are hesitant to report negative behaviour (i.e., lack of care provision for children). Future work on whether and how self-reported data are biased would be an interesting addition to this research and could be carried out using observational methods like focal follows or analysed through qualitative discussions around norms or stigmas related to childcare provision.

Another drawback of self-report data which may have affected this survey is acquiescence bias. Respondents were asked to answer a series of very similar questions about childcare in a row. For example, "Did the child's father wash the child in the previous two weeks?", followed by "did the child's maternal grandmother wash the child in the previous two weeks?" and so on for each allomother; followed by the same list of questions for the next type of care. Further, if a mother had more than one child under the age of 5 years, she had to answer the survey multiple times. This creates a risk of questions becoming monotonous and leading to respondents losing interest or focus. However, I am confident that our interviewers were well experienced to identify and handle such occasions.

My categorisation of low- and high-intensity care was based on how care has been categorised in past observational studies (Meehan, 2005, 2008; Page et al., 2020). However, these measures are not an actual reflection of the level of intensity experienced by an allomother when providing that care, which is in fact measured in observational studies. Low-intensity care pertains to low-energy tasks that can be carried out without the carers other activities being disrupted, while these activities are disrupted when the carer engages in high-intensity tasks – as such, this behaviour is observable. Moving forward, collecting such data through surveys may benefit from asking more detailed questions about the nature of care provision and its impact on the caregivers.

8.3.3 How care was measured

The data do not measure frequency of care. For each child they indicate whether the allomother or parent had provided that care at least once in the 2 weeks (for direct care provision) or 3 months (for resource provision) preceding the survey. I may have uncovered more variation in care had I known how often a mother and allomother had provided each type of care in the specified time period. This would have added more nuance in our understanding of children's caregiving environments, for example, whether boys had actually received more care than girls, or if non-kin in the town were actually substituting for the care provided by paternal kin in the village. A measure of frequency of care would also have allowed me to explore with more certainty to what degree health outcomes were correlated with frequency of care.

Ideally, a measure of maternal activity at the time when allocare was provided to the child would have been valuable in ascertaining whether the care being provided to the child was in addition to maternal effort (additive care) or provided to substitute for maternal effort (substitutive care) (Emmott & Page, 2019; Kushnick, 2012). Whether care is additive or substitutive in nature has previously been documented as impacting children's health outcomes differentially, with substitutive care even associated with worse child outcomes (Emmott & Mace, 2015; Emmott & Page, 2019; Kramer & Veile, 2018).

Ideally, future research will be able to collect longitudinal data that measures frequency of care. This may allow more appropriate tests of some evolutionary concepts, by measuring long term consequences of parental investment (e.g., in sons versus daughters), urbanising of the same community over time, or the impact of caregiving environments in childhood on future health.

8.3.4 Chances of Type 1 error

An issue that can arise when using the same dataset to conduct multiple analyses is an increased chance of erroneously finding significant results, or false positives (i.e., Type 1 error). While there is strong evidence against the null hypothesis for some of the results in my research (e.g., the difference in source of allomaternal carer – kin versus non-kin – between the town and village seen in Chapter 6), others are weaker and form no patterns (e.g., the relationship between care provision and health outcomes in Chapter 7). It is possible that some of the latter findings may therefore have simply been due to chance. While some relationships are identified between caregiving and health in Chapter 7, these are not suggestive of any patterns, and I suspect may have arisen from multiple hypothesis testing using the same dataset. There are methodologies available to correct for multiple hypothesis testing or the generation of multiple models using the same data, however, there is also debate that this might not be the best approach as it may increase the chance of Type 2 errors for findings that were true positives (Rothman, 1990). As such, I did not correct for multiple hypothesis testing in this thesis.

8.3.5 Future research and plans

Previous studies have relied on proxies for care provision in exploring the relationship between 'care' and children's health. Recently there have been calls for more nuanced research that examines children's caregiving environments more holistically. While my research responds to these calls, I find that the relationship between childcare and health remains unclear. Caregiving patterns are quite diverse, and yet not predictive of children's health. One reason for this could be how care was measured in this study. Moving forward, I would like to collect data that measure frequency of care, as well as maternal activities at time of allomaternal care provision, and women's participation in the workforce. This may allow a deeper understanding of the pathways between care provision and children's health, while taking into account the impact of different socio-ecological contexts (e.g., maternal unavailability due to paid labour outside the home).

There also remain a number of research questions that I plan to address in the future from the data collected for this thesis. One of these is investigating how non-resident fathers participate (or do not participate) in childcare. In Chapter 5, I found that while non-resident fathers were not contributing to direct caregiving, almost half of them had provided resources to their children in the three months before the survey, and I aim to explore this further using these data. I would also like to examine children's birth order as another child-level determinant of parental and alloparental care. As mentioned in Chapter 4, I collected data on children's general health (as reported by their mothers or guardians) and on the foods they had consumed in the day prior to the survey; I would like to explore in the future whether these outcomes vary or not by type and source of allomaternal support. I finally plan to formally analyse my FGD data to write a qualitative research paper on parents' perceptions of childcare.

8.3.6 Dissemination

The research in this thesis has been presented at a number of conferences in the past three years, including the IUSSP International Population Conference (IPC) in 2017, the Human Behaviour and Evolution Society (HBES) Conference in 2018, the European Human Behaviour and Evolution Association (EHBEA) Conference in 2019, PopFest 2019, as well as at an invited talk at the University of Roehampton in 2018. I have not as yet disseminated the findings of this research in Tanzania but plan to do this in the future. I would like to go back to Kisesa and Welamasonga to discuss these findings with the local researchers, interviewers, village chairpeople and study participants. Not only do I think that it is important for research participants to have access to the findings of studies they participated in, but this will also be really valuable for my understanding of my research, and aid my interpretation of results. In a way my research has raised as many questions as it has answered, and it will be a useful addition to this research to discuss these questions with the local community.

8.4 Conclusions

Mothers and children in transitioning contexts undergo significant changes in their social lives. In this thesis I contribute novel data on childcare that demonstrates the diverse nature of children's caregiving environments, and the flexibility of mothers in who they receive support from. This work confirms that various kin members support women and children across different levels of market integration, including the child's father, maternal and paternal grandparents and aunts/uncles, and the child's siblings. However, it also clearly demonstrates that demographic and urban changes are increasing the role played by non-kin. Distinguishing between different predictors of care, e.g., the child's sex (Chapter 5), village or town residence (Chapter 6), and parental residence (Chapters 6 and 7); as well as the null results for the relationship between childcare and health seen in Chapter 7, prove to be valuable in demonstrating that the reality of childcare is complicated, and not easy to measure. These three main takeaways, that children's social environments are changing, that non-kin are important allocarers, and that childcare is multidimensional, have important implications for future research and policy: not taking into account ecological context may mask significant changes occurring in young children's lived experiences of childhood; excluding non-kin from research on childcare as well as from policies targeting children's caregiver behaviour may paint an incomplete picture of children's caregiving environments, and hinder progress in health improvements; and lastly, that future research should avoid collecting proxy measures for childcare. Policymakers, development workers and population health researchers are increasingly giving weight to children's caregiving behaviour as a determinant of their wellbeing. I believe this thesis contributes to this body of research, and highlights the need for future work that investigates more deeply the pathways between caregiving practices and health outcomes.

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10. Appendices

10.1 Ethics approval

10.1.1 Ethics approval for fieldwork from LSHTM

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
United Kingdom
Switchboard: +44 (0)20 7636 8636

www.lshtm.ac.uk

LONDON SCHOOL *of* HYGIENE &TROPICAL MEDICINE

Observational / Interventions Research Ethics Committee

Ms. Anushe Hassan
LSHTM

14 July 2017

Dear Anushe,

Study Title: How much do fathers matter? Paternal investment and child health in rural Tanzania

LSHTM Ethics Ref: 13809

Thank you for responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Protocol / Proposal	AHassan_Questionnaires_forEthics_2017-04-10	10/04/2017	1
Information Sheet	AHassan_Consent Form_Under 18	24/04/2017	1
Information Sheet	AHassan_InformationSheets	24/04/2017	1
Investigator CV	CV_SusanSchaffnit	25/04/2017	1
Investigator CV	CV_DavidLawson	25/04/2017	1
Investigator CV	CV_AnushéHassan	25/04/2017	1
Protocol / Proposal	AHassan_DataCollectionFormODK_ChildSurvey_2017-04-26	26/04/2017	1
Protocol / Proposal	AHassan_StudyProtocol_2017.04.25	26/04/2017	1
Investigator CV	SearCV LSHTM_newformat2	27/04/2017	1
Local Approval	LZIRB CERTIFICATE	29/06/2017	1
Local Approval	UCSB Ethics - Human Subjects Approval for 1170405	29/06/2017	1
Information Sheet	Consent & Info for Participation in FGD_REVISED_2017.06.28	29/06/2017	2
Covering Letter	Hassan_LSHTMethics_CoverLetter	29/06/2017	1
Protocol / Proposal	AHassan_StudyProtocol_REVISED_2017.06.28	29/06/2017	2

After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

Page 1 of 2

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: http://leo.lshtm.ac.uk

Additional information is available at: www.lshtm.ac.uk/ethics

Yours sincerely,

[redacted]

Professor John DH Porter
Chair

ethics@lshtm.ac.uk
http://www.lshtm.ac.uk/ethics/

10.1.2 Ethics approval for fieldwork from Lake Zone IRB, National Institute for Medical Research, Mwanza, Tanzania

LAKE ZONE INSTITUTIONAL REVIEW BOARD (LZIRB)

National Institute for Medical Research
Mwanza Medical Research Centre
P.O. Box 1462, Mwanza
Tel: +255 28 2541935
Fax: +255 28 2500654
e-mail: mwanza@nimr.or.tz

MR/53/100/463

Mark Urassa
NIMR-Mwanza
P.O. Box 1462
Mwanza -Tanzania

30th May 2016

CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH

This is to certify that the research titled: **"Family structure and well-being of women of reproductive age and their under-five children in Kisesa ward, Magu district Tanzania (Urassa M et al)"** has been granted ethics clearance by LZIRB.

The Principal Investigator (PI) of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health and Mwanza Medical Research Centre, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from NIMR Headquarters.
3. Copies of final publications are made available to the Ministry of Health & Social Welfare Mwanza Medical Research Centre and the National Institute for Medical Research Headquarters.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine. NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Approval is for this study, any other changes should be communicated to the Board for approval.
6. Study site: Kisesa ward, Magu District, Mwanza Tanzania

Approval is for one year: 30th May 2017 to 29th May 2018.

Name: Dr Sophia Kalokola
Signature: [redacted]
Chairperson

Name: Mr Mansuet Temu
Signature [redacted]
Secretary

CC: Regional Medical Officer
District Medical Officer

10.2 Informed consent forms

10.2.1 English version of information sheet

Kisesa Family Structure and Wellbeing Project

Information for Survey Participants

Hello, we are researchers working with Tazama, and we are here to learn about the lives of people in this community. The research focuses on family structure, including marriage practices, and the welfare of women and children.
The information we collect will help us to better understand family life and why the wellbeing of some women and children is better than others in this area.

Your household was selected to be interviewed because you have resident woman between the ages of 15 and 35 years. The questions usually take about 30 minutes. After we have spoken to you, we would like to briefly interview the women in this household about their activities, and any guardians of children under 5 years old too. Each of those surveys will take about one hour. You can decide whether you are happy for us to do so after the first part of the interview. Your name will not be used in my report, so we can describe what you think without anyone knowing that it is you. This means that what you say will be shared with other members of the research team, but I am not going to tell your family, or anybody in the community, what you tell me.

Your participation in this study is entirely voluntary. By that we mean that you may refuse or agree to participate and your decision will not benefit or harm you in any way. You don't have to be in the study, but we hope you will agree to answer the questions since your views are important. If I ask you any questions you don't want to answer, just let me know and I will go on to the next question, or you can stop the interview at any time.

You are welcome to ask questions now or at any time during or after the survey. If you have any questions regarding this survey you can contact Mr Mark Urassa who oversees this research (during the week in working house) a [redacted] This research has been approved by the Lake Zone Research Ethics Board which gives permission to conduct research after confirming that the relevant research has no effect on participants. You can contact Mr Mansuet Temu at the Research Ethics Board which approved this research at this phone number: [redacted]

10.2.2 Swahili versions of consent form and information sheet

National Institute for Medical Research (NIMR), Mwanza Centre

TAZAMA Project

Fomu ya ridhaa

Jina langu naitwa ………… na ninafanya kazi katika mradi wa TAZAMA ulio chini ya Taasisi ya Taifa ya Utafiti wa Magonjwa ya Binadamu, Kituo cha Mwanza. Mradi wa TAZAMA umekuwa unafanya kazi za utafiti na za kupambana na maambukizi ya Virusi Vya UKIMWI katika Kijiji hiki kwa takribani miaka 22 sasa. Sasa hivi tupo katika kutekeleza shughuli ya utafiti itakayotuwezesha kufahamu zaidi juu ya maisha ya wakazi wa Kijiji hiki yakiwemo maswala ya ndoa pamoja na ustawi wa wanawake na watoto. Taarifa tutakazozipata zitatuwezesha kuelewa zaidi maisha ya familia katika kijiji hiki na pia kujua kwa nini ustawi wa wanawake na watoto unatofautiana kutoka kaya moja hadi nyingine.

Kaya yako imechaguliwa kushiriki katika kazi hii kwa kuwa ina wakazi wa kike wenye umri wa miaka 15-35. Sasa nitakuuliza maswali machache ambayo yatachukua kama dakika 30 hivi. Baada ya kuzungumza na wewe, nitaomba kuongea pia na wanawake kwenye kaya hii (wenye miaka 15-35) na kuzungumza nao juu ya shughuli zao za kila siku. Vilevile na wale wanaowaangalia watoto walio chini ya miaka mitano tungependa kuongea nao pia. Mazungumzo yote yatakayofanyika hapa katika kaya hii hayatahusisha uchukuaji wa majina ya washiriki na hivyo hakuna yeyote katika kijiji au nje ya kijiji atakayejua yale uliyoyazungumza nasi. Watafiti wa shughuli hii wataweza kuona yale uliyazungumza lakini hata hivyo hawatajua nani ameyasema hayo.

Ushiriki wako ni wa hiari kabisa. Hii ina maana kwamba unaweza kukubali kushiriki au kukataa na uamuzi wako utaheshimiwa. Uamuzi wowote hautakuadhiri kwa namna yoyote ile. Hata hivyo tunategemea utaamua kushiriki ili uweze kutupatia taarifa muhimu za kuifanikisha shughuli hii. Kama kuna swali ambalo usingependa kulijibu, tafadhali nijulishe ili niweze kuendelea na maswali mengine au pia unaweza kusitisha mazungumzo yetu wakati wowote.

Unakaribishwa kuuliza maswali sasa au wakati wowote wa utekelezaji wa shughuli hii. Au kama una maswali baada ya kukamilika kwa shughuli hii, unaweza kuwauliza waandaji wa shughuli hii mfano Mratibu wa Mradi wa TAZAMA au Bodi ya maadili ya utafiti ya Kanda ya Ziwa. Mawasiliano yao yapo katika fomu ya taarifa ambayo utapatiwa.

Baada ya maelezo hayp, sasa ningependa nikuulize kama unakubali kushiriki katika shughuli hii?

National Institute for Medical Research (NIMR), Mwanza Centre

TAZAMA Project

Fomu ya Taarifa kwa Mshiriki

Jina langu naitwa …… na ninafanya kazi katika mradi wa TAZAMA ulio chini ya Taasisi ya Taifa ya Utafiti wa Magonjwa ya Binadamu, Kituo cha Mwanza. Mradi wa TAZAMA umekuwa unafanya kazi za utafiti na za kupambana na maambukizi ya Virusi Vya UKIMWI katika Kijiji hiki kwa takribani miaka 22 sasa. Sasa hivi tupo katika kutekeleza shughuli ya utafiti itakayotuwezesha kufahamu zaidi juu ya maisha ya wakazi wa Kijiji hiki yakiwemo maswala ya ndoa pamoja na ustawi wa wanawake na watoto. Taarifa tutakazozipata zitatuwezesha kuelewa zaidi maisha ya familia katika kijiji hiki na pia kujua kwa nini kuna tofauti katika ustawi wa wanawake na watoto hapa kijijini.

Kaya yako imechaguliwa kushiriki katika kazi hii kwa kuwa ina wakazi wa kike wenye umri wa miaka 15-35. Sasa nitakuuliza maswali machache ambayo yatachukua kama dakika 30 hivi. Baada ya kuzungumza na wewe, nitaomba kuongea pia na wanawake kwenye kaya hii (wenye miaka 15-35) na kuzungumza nao juu ya shughuli zao za kila siku. Vilevile na wale wanaowaangalia watoto walio chini ya miaka mitano tungependa kuongea nao pia. Mazungumzo yote yatakayofanyika hapa katika kaya hii hayatahusisha uchukuaji wa majina ya washiriki na hivyo hakuna yeyote katika kijiji au nje ya kijiji atakayejua yale uliyoyazungumza nasi. Watafiti wa shughuli hii wataweza kuona yale uliyazungumza lakini hata hivyo hawatajua nani ameyasema hayo.

Ushiriki wako ni wa hiari kabisa. Hii ina maana kwamba unaweza kukubali kushiriki au kukataa na uamuzi wako utaheshimiwa. Uamuzi wowote hautakuadhiri kwa namna yoyote ile. Hata hivyo tunategemea utaamua kushiriki ili uweze kutupatia taarifa muhimu za kuifanikisha shughuli hii. Kama kuna swali ambalo usingependa kulijibu, tafadhali nijulishe ili niweze kuendelea na maswali mengine au pia unaweza kusitisha mazungumzo yetu wakati wowote.

Unakaribishwa kuuliza maswali sasa au wakati wowote wa utekelezaji wa shughuli hii. Au kama una maswali baada ya kukamilika kwa shughuli hii, unaweza kuwauliza waandaji wa shughuli hii mfano Mratibu wa Mradi wa TAZAMA au Bodi ya maadili ya utafiti ya Kanda ya Ziwa. Mawasiliano yao yapo katika fomu ya taarifa ambayo utapatiwa.

Kama una swali lolote kuhusiana na shughuli hii unaweza kuwasiliana na Bw. Mark Urassa ambaye anasimamia shughuli hii. Unaweza kupiga simu namba (siku na saa za kazi)[redacted] Shughuli hii imeidhinishwa na Bodi ya maadili ya utafiti ambayo hutoa ruhusa ya kufanya utafiti baada ya kujiridhisha kwamba utafiti husika hauna madhara yoyote kwa washiriki. Kama una swala lolote ambalo ungependa kuwasiliana na bodi iliyoidhinisha shughuli hii unaweza kuwasiliana na Bw. Mansuet Temu kupitia simu: [redacted]

10.3 Survey tools

10.3.1 Household survey

Welcome to the household survey.	
Enter today's date	
Village	[ ] Kisesa [ ] Welamasonga
Subvillage	
Balozi	
Household	
Who is present for this interview? List all interviewers or researchers present.	
We are researchers working with TAZAMA, and we are here to learn about the lives of people in this community. This research focuses on family structures and roles, children health and marriage practices. The information we collect will help us to better understand how families operate in this area. Your household was selected to be interviewed because you have resident a woman between the ages of 15 and 35 years. The questions usually take about 30 minutes. After we have spoken to you, we would like to briefly interview the women in this household about their activities and any guardians of children under 5 years old too. Each of those surveys will take about one hour. You can decide whether you are happy for us to do so after the first part of the interview. Your name will not be used in my report, so we can describe what you think without anyone knowing that it is you. This means that what you say will be shared with other members of the research team, but I am not going to tell your family, or anybody in the community, what you tell me. Your participation in this study is entirely voluntary. By that we mean that you may refuse or agree to participate and your decision will not benefit or harm you in any way. You don't have to be in the study, but we hope you will agree to answer the questions since your views are important. If I ask you any questions you don't want to answer, just let me know and I will go on to the next question, or you can stop the interview at any time. Do you have any questions?	
Would you like to take part in this study?	[ ] Yes [ ] No
Your (the interviewer's) signature	
Now we will list all the people in this household, starting with the head of the household.	
Household head	
Enter first name	
What is the household head's age?	

Is the household head male or female?	[ ] Female [ ] Male
Does the household head have a DSS line number?	[ ] Yes [ ] No
Enter DSS line number	
NOTE: Please assign roster number 1 to this household member on the paper household roster. ***NOTE: Please write this person's name on the paper household roster and assign roster number 1 to this household member on the paper household roster.***	
What is the marital status of the head of the household?	[ ] Married (monogamous) [ ] Married (polygynous) [ ] Engaged [ ] Divorced / separated [ ] Widowed [ ] Never married (Not engaged) [ ] Don't know [ ] Refusal
***If the household head is female and married polygynously:* Is she a first wife or junior wife?**	[ ] First wife [ ] Junior wife [ ] Don't know [ ] Refusal
***If the household head is female:* What is the main reason that the household has a female head?**	[ ] Divorced / separated [ ] Widowed [ ] Polygynous marriage and husband lives in another household [ ] Husband absent for long period e.g. working away [ ] Husband in household but ill or otherwise incapacitated [ ] Other [ ] Don't know [ ] Refusal
What is the highest level of education the head of the household has attended? Please specify other education level.	[ ] Primary school [ ] Secondary school [ ] Technical / vocational training [ ] Higher education

	[ ] Other____________. [ ] None [ ] Don't know [ ] Refusal
What is the occupation of the head of the household? Please specify other work.	[ ] Farmer [ ] Trader [ ] Professional [ ] Driver [ ] Fundi (skilled manual work) [ ] Unskilled labourer [ ] Fishing [ ] Studying [ ] Housewife [ ] Other____________. [ ] None [ ] Don't know [ ] Refusal
What is the religion of the head of the household? Please specify other religion.	[ ] Muslim [ ] Roman Catholic [ ] Other Established Christian [ ] Traditional [ ] No religion [ ] Other____________. [ ] Don't know [ ] Refusal
What is the ethnic group of the head of the household? Please specify other ethnic group.	[ ] Sukuma [ ] Nyamwezi [ ] Bukoba [ ] Ukelewe [ ] Muha [ ] Mgogo [ ] Other____________. [ ] Don't know [ ] Refusal
Do you want to add another household member? **NOTE: If respondent says they have listed everyone, ask the following questions: *Is there anybody we have not yet listed, such as young***	[ ] Yes [ ] No

children, or children who are not the biological child of the head of the household? ***Is there anybody else who is part of this household, even if they are living, working or studying elsewhere at the moment?***	
If yes, the following section is filled out for each additional member.	
Household member	
Enter first name	
What is this household member's age? **[NOTE: If age is less than 1 year, please enter 998]**	
If entered 998: **What is this household member's age in months?**	
Is this household member male or female?	[ ] Female [ ] Male
Does this person have a DSS line number?	[ ] Yes [ ] No
Enter DSS line number	
NOTE: Please assign roster number [#] to this household member on the paper household roster. **NOTE: Please write this person's name on the paper household roster and assign roster number [#] to this household member on the paper household roster.**	
What is this person's relationship to the head of the household?	[ ] Husband or wife [ ] Son or daughter [ ] Grandchild [ ] Sibling (full sibling) [ ] Sibling (half-sibling) [ ] Niece or nephew [ ] Other relative [ ] Other non-relative [ ] Houseboy/Housegirl [ ] Don't know [ ] Refusal
What is the marital status of this household member?	[ ] Married (monogamous) [ ] Married (polygynous) [ ] Engaged [ ] Divorced / separated [ ] Widowed

	[ ] Never married (Not engaged) [ ] Don't know [ ] Refusal
Is she a first wife or junior wife?	[ ] First wife [ ] Junior wife [ ] Don't know [ ] Refusal
Socioeconomic Module	
Now I am going to ask some questions about this household's characteristics.	
Relative Wealth	
Compared to other households in this village, how would you characterize the wealth of this household? Very wealthy, wealthy, average, poor, very poor?	[ ] Very wealthy [ ] Wealthy [ ] Average [ ] Poor [ ] Very poor [ ] Don't know [ ] Refusal
Land owned or rented by household	
Does anyone in the household own any land?	[ ] Yes [ ] No [ ] Don't Know
If yes, how many acres of land are owned?	
Does anyone in the household rent or borrow any land?	[ ] Yes [ ] No [ ] Don't Know
If yes, how many acres of land are rented or borrowed?	[ ] Yes [ ] No [ ] Don't Know
If anyone in your household owns or rents land, how many acres did they cultivate in the last 12 months?	
Animals	
Does this household own any livestock, herds, other farm animals, or poultry?	[ ] Yes [ ] No [ ] Don't Know
If yes: How many of the following animals does this household own?	
Cows / cattle	
Horses or donkeys	
Pigs	
Goats	
Ducks	

Chickens	
Household assets	
Does any member of this household have any of the following?	
Chair	[ ] Yes [ ] No [ ] Don’t Know
Sofa	[ ] Yes [ ] No [ ] Don’t Know
Cupboard	[ ] Yes [ ] No [ ] Don’t Know
Bedstead	[ ] Yes [ ] No [ ] Don’t Know
Mosquito net	[ ] Yes [ ] No [ ] Don’t Know
Panga	[ ] Yes [ ] No [ ] Don’t Know
Mobile phone	[ ] Yes [ ] No [ ] Don’t Know
Clock	[ ] Yes [ ] No [ ] Don’t Know
Radio	[ ] Yes [ ] No [ ] Don’t Know
Sewing machine	[ ] Yes [ ] No [ ] Don’t Know
Bicycle	[ ] Yes [ ] No [ ] Don’t Know
Car	[ ] Yes [ ] No [ ] Don’t Know
Motorcycle	[ ] Yes [ ] No [ ] Don’t Know
Television	[ ] Yes [ ] No [ ] Don’t Know
Fridge / freezer	[ ] Yes [ ] No [ ] Don’t Know
Bank account	[ ] Yes [ ] No [ ] Don’t Know
House materials	
What material are the walls of the house?	[ ] Mud bricks [ ] Stone [ ] Mud and wood [ ] Iron sheet [ ] Grass [ ] Other [ ] Don't know [ ] Refusal
Food security	
The next questions are about your household's food and meals during the past four weeks. Please answer for everyone in the household who regularly eats together.	
In the past four weeks, did you worry that your household would not have enough food?	[ ] Yes [ ] No [ ] Don’t Know
If yes, how often did this happen?	
In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	[ ] Yes [ ] No [ ] Don’t Know
If yes, how often did this happen?	

In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
In the past four weeks, did you or any household member have to eat fewer meals in a day because of lack of resources to get food?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
In the past four weeks, was there ever no food of any kind in your household because of lack of resources to get food?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	[ ] Yes [ ] No [ ] Don't Know
If yes, how often did this happen?	
Consent for minors	
NOTE: Are there any women in this household who are eligible for the Women's Survey and are under 18 years old and unmarried?	
I would like to request for your permission/approval for the unmarried woman in you household, under age 18 years to take part in this study. The interview with her will be about her daily activities and general life experience. We will not record your family name and therefore our talk will be a secret and no one else will know what we have talked about. After your approval/permission, we will also request for her personal consent to take part in the study and her decision won't have any implications or harm on her.	

Do you permit/approve for any unmarried women, under age 18 years to take part in the study?	[ ] Yes [ ] No
Eligible women and children	
NOTE: Are all of the eligible women (age 15-35 years) present today and available for an interview?	[ ] Yes [ ] No
Please enter details about any women who are unavailable for the Women's Survey today.	
NOTE: May we return later to interview this woman?	[ ] Yes [ ] No
Please enter the new household roster number of the respondent to the household survey. (Example, if they are the household head, enter roster number 1)	
Sorry for disturbing you, thank you for your time. If you would like more information about this study, you can ring the number on this sheet.	
Record any comments you have about the interview.	

10.3.2 Children's survey

Introduction	
Welcome to the child's survey.	
Enter today's date	
Village	[ ] Kisesa [ ] Welamasonga
Subvillage	
Balozi	
Household	
Enter the child's name as it appears on the household roster	
Enter the child's new ID number from the household roster	
Enter the name of the respondent as it appears on the household roster	
We would like to ask you some questions about the child. With your permission, we would also like to measure their height and weight. Your participation in this study is entirely voluntary. By that we mean that you may refuse or agree to participate, and your decision will not benefit or harm you in any way. You don't have to be in the study, but we hope you will agree to answer the questions since your views are important. If I ask you any questions you don't want to answer, just let me know and I will go on to the next question, or you can stop the interview at any time. Do you have any questions?	
Would you like to take part in this study?	[ ] Yes [ ] No
Your (the interviewer's) signature	
Child information	
What is the child's date of birth?	
Child's age is calculated from date of birth	
So, the child is *'____'* years old? If not, please go back and enter the correct birthdate.	
Is the child male or female?	[ ] Female [ ] Male
Child's relationships	
We would like to begin by asking you some questions about the child's biological parents and/or guardian.	

What is your relationship to the child? If ‘other’, please specify.	[ ] Biological mother [ ] Biological father [ ] Maternal Grandmother [ ] Paternal Grandmother [ ] Maternal Grandfather [ ] Paternal Grandfather [ ] Sister [ ] Brother [ ] Half-sister [ ] Half-brother [ ] Mother's sister [ ] Mother's brother [ ] Father's sister [ ] Father's brother; [ ] Stepmother [ ] Stepfather [ ] Other _____________. [ ] Don't know
Do you live in this household?	[ ] Yes [ ] No
Enter the respondent's new ID from the household roster.	
Are you the child’s primary guardian? By primary guardian we mean the person who is mostly responsible for the child’s wellbeing.	[ ] Yes [ ] No
Who is the child’s primary guardian? You may select more than one person if it is appropriate. If ‘other’, please specify.	[ ] Biological mother [ ] Biological father [ ] Maternal Grandmother [ ] Paternal Grandmother [ ] Maternal Grandfather [ ] Paternal Grandfather [ ] Sister [ ] Brother [ ] Half-sister [ ] Half-brother [ ] Mother's sister [ ] Mother's brother [ ] Father's sister [ ] Father's brother;

	[ ] Stepmother [ ] Stepfather [ ] Other _____________. [ ] Don't know
Does (one of) the child's guardian live in this household?	[ ] Yes [ ] No
If the child's guardian lives in the household:	
Enter the child's guardians new ID from the household roster.	
Has the child lived in this household since their birth?	[ ] Yes [ ] No [ ] Don't Know
How old was the child when they moved to this household? Please respond in months (if less than 1 year old) or years (if more than 1 year old) and specify the unit.	[ ] Year [ ] Month
Who did the child live with immediately prior to moving into this household? [NOTE: Please write in the relationship of the child to their guardian in the previous household].	
Child's mother	
Where does the child's mother live?	[ ] In the household [ ] Not in the household [ ] Dead [ ] Don't know [ ] Refusal
If the child' mother lives in the household	
Enter the child's mother's new ID from the household roster.	
If the child's mother is dead	
How old was the child when their mother died? Please respond in months (if less than 1 year old) or years (if more than 1 year old) and specify the unit.	[ ] Year [ ] Month
Did the child's mother live with the child in the same household immediately before dying?	

If the child' mother is alive but not resident in the household	
In the last 6 months how often has the child's biological mother seen the child?	[ ] Daily [ ] Weekly [ ] Monthly [ ] Once in 3 months [ ] Never in last 6 months [ ] Don't know
Child's father	
Where does the child's father live?	[ ] In the household [ ] Not in the household [ ] Dead [ ] Don't know [ ] Refusal
If the child' father is dead	
How old was the child's biological father when he died? Please enter his age in years.	
How old was the child when their father died? **Please respond in months (if less than 1 year old) or years (if more than 1 year old) and specify the unit.**	[ ] Year [ ] Month
Did the child's father live with the child in the same household immediately before dying?	[ ] Yes [ ] No [ ] Don't Know
If the child' father lives in the household:	
Enter the child's father's new ID from the household roster.	
If the child' father lives in the household or is alive but resides elsewhere:	
What is the child's biological father's age? **[NOTE: Please enter his age in years.]**	
Are the child's biological parents married?	[ ] Yes [ ] No [ ] Don't Know
Is the child's mother his biological father's first wife?	[ ] Yes [ ] No [ ] Don't Know

What number wife is the child's mother?	
Does the child's biological father have any other wives?	[ ] Yes [ ] No [ ] Don't Know
How many other wives does the child's father have?	[ ] Yes [ ] No [ ] Don't Know
Is the child his biological father's first child?	[ ] Yes [ ] No [ ] Don't Know
If the child' father is alive but does not co-reside with the child :	
Because the child's father does not live in this household, we would like to ask you some questions about his role in the child's life.	
Has the child's biological father and the child ever lived together in the same household? This household, or any other.	[ ] Yes, now [ ] Yes, in the past [ ] No [ ] Don't know
How old was the child when their father stopped living with the child's? Please respond in months (if less than 1 year old) or years (if more than 1 year old) and specify the unit.	[ ] Year [ ] Month
In the last 6 months how often has the child's biological father seen the child?	[ ] Daily [ ] Weekly [ ] Monthly [ ] Once in 3 months [ ] Never in last 6 months [ ] Don't know
Why does the child's biological father not live in the household? You may select more than one reason. If the respondent states 'other' please specify.	[ ] Away for work [ ] Separation/divorce [ ] Child lives away from both biological parents [ ] The father lives with another wife [ ] The child's mother and father are not in a relationship/are not together [ ] Other____________.

	[ ] Don't know [ ] Refusal
Where does the child's biological father live? If 'other' please specify.	[ ] Same sub-village [ ] Same village [ ] Mwanza Region [ ] Another region [ ] Not in Tanzania [ ] Other____________. [ ] Don't know [ ] Refusal
How does the child's father communicate with the household? *[NOTE: Tick all that apply, or if he is not in contact with the household tick "He does not communicate with the household"].*	[ ] Visits the child in this household [ ] The child visits him [ ] On the phone [ ] Through email [ ] Writing letters [ ] He does not communicate with the household [ ] Other____________. [ ] Don't know
How often does the child's biological father provide money or goods to this household or the child in specific? [*NOTE: Specify that goods could include food, medicines, clothes, and any other household items].*	[ ] Never [ ] Daily [ ] Weekly [ ] Every month [ ] Once in 3 months [ ] Once in 6 months [ ] Once a year [ ] Don't know
What goods does he provide to the household or to the child? If 'other', please specify.	[ ] Food [ ] Medicine [ ] Clothes [ ] Household items [ ] Money [ ] Other____________.
Childcare: Resource provision	
Who has provided money, food or other household goods (example: medicine, clothes) to this household or for the child in the past 3 months?	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father**

Name each individual and ask for each one if they have provided any of these resources to the child in the previous 3 months.	[ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child** [ ] Yes [ ] No [ ] Don't Know **Mother's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other** [ ] Yes [ ] No [ ] Don't Know
Childcare: Direct care provision	
We would now like to ask you some questions about who provides different types of care for the child. For each type of care please indicate who has provided this care at any time in the past two weeks.	
Who has washed the child at any time in the past two weeks?	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father** [ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child**

	[ ] Yes [ ] No [ ] Don't Know **Mother's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other** [ ] Yes [ ] No [ ] Don't Know
Who has fed the child at any time in the past two weeks?	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father** [ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child** [ ] Yes [ ] No [ ] Don't Know **Mother's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other** [ ] Yes [ ] No [ ] Don't Know

Who has played with the child at any time in the past two weeks?	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father** [ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child** [ ] Yes [ ] No [ ] Don't Know **Mother's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other** [ ] Yes [ ] No [ ] Don't Know
Who has supervised the child at any time in the past two weeks? By this we mean, watching the child passively or actively to make sure they are safe.	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father** [ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child** [ ] Yes [ ] No [ ] Don't Know

	Mother's sister or brother [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other** [ ] Yes [ ] No [ ] Don't Know
Was the child sick in the past 2 weeks?	[ ] Yes [ ] No [ ] Don't Know
If the child had been sick:	
Who has taken care of the child when they were sick or unwell in the past two weeks?	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father** [ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child** [ ] Yes [ ] No [ ] Don't Know **Mother's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other**

	[ ] Yes [ ] No [ ] Don't Know
Who has slept in the same room as the child at any time in the past two weeks?	**Biological mother** [ ] Yes [ ] No [ ] Don't Know **Biological father** [ ] Yes [ ] No [ ] Don't Know **Maternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Paternal Grandparent** [ ] Yes [ ] No [ ] Don't Know **Sister/Brother of the child** [ ] Yes [ ] No [ ] Don't Know **Mother's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Father's sister or brother** [ ] Yes [ ] No [ ] Don't Know **Stepmother/Stepfather** [ ] Yes [ ] No [ ] Don't Know **Other** [ ] Yes [ ] No [ ] Don't Know
Breastfeeding	
We would now like to ask you some questions about the child's breastfeeding status and duration.	
Has the child ever been breastfed?	[ ] Yes [ ] No [ ] Don't Know
Does the child still breastfeed?	[ ] Yes [ ] No [ ] Don't Know
How long was the child exclusively breastfed for? By this we mean that	[ ] Never [ ] 1 month [ ] 1-2 months

they did not drink or eat anything other than breast milk.	[ ] 2-3 months [ ] More than 3, less than 6 months [ ] 6 or more months [ ] Don't know
At what age did the child stop breastfeeding? Please respond in months (if less than 1 year old) or years (if more than 1 year old) and then specify the unit.	[ ] Year [ ] Month
Is the child eating solid foods?	[ ] Yes [ ] No [ ] Don't Know
At what age did the child start eating solid foods? Please respond in months (if less than 1 year old) or years (if more than 1 year old) and then specify the unit.	[ ] Year [ ] Month
Child's health	
Now we are going to ask you a question about the child's health.	
How is the child's health in general?	[ ] Always good [ ] Mostly good [ ] Mostly sick [ ] Always sick [ ] Don't know
Food consumed by the child	
We are now interested in finding out the types of food the child eats. For each food item listed below, please indicate whether the child has eaten it in the past 24 hours. Please select 'yes', 'no' or 'don't know' for each food.	
Ugali, cassava, maize, rice, potatoes	[ ] Yes [ ] No [ ] Don't Know
Animal milk	[ ] Yes [ ] No [ ] Don't Know
Eggs	[ ] Yes [ ] No [ ] Don't Know
Beans, Legumes, peanuts	[ ] Yes [ ] No [ ] Don't Know
Chicken, goat, cow, bush meat	[ ] Yes [ ] No [ ] Don't Know

Fish/degaa	[ ] Yes [ ] No [ ] Don't Know
Fruit (Banana, Papaya, Pineapple, Orange or others)	[ ] Yes [ ] No [ ] Don't Know
Greens	[ ] Yes [ ] No [ ] Don't Know
Carrot, Tomatoes, Other Vegetables	[ ] Yes [ ] No [ ] Don't Know
Child anthropometrics	
Now we would like to take some measurements of the child. We will measure the child's weight and height using a measuring tape and weighing scales.	
Is it okay if we measure the child?	[ ] Yes [ ] No
If they do not give consent, say thank you for your time and for answering all our questions. If you would like more information about this study, you can ring the number on this sheet.	
If the answer is 'Yes':	
Does the child show presence of oedema? **[NOTE: This is indicated by a very swollen belly, or swollen legs, ankles, or arms].**	[ ] Yes [ ] No [ ] Don't Know
Is the child able to stand on his/her own feet?	[ ] Yes [ ] No
If the child can stand on their own feet, take their measurements as follows:	
NOTE: Please measure the height [using the stadiometer] and weight of the child three separate times and then enter each measurement below in centimetres or grams.	
Height in centimetres - measurement 1	
Weight in kilograms - measurement 1	
Height in centimetres - measurement 2	
Weight in kilograms - measurement 2	
Height in centimetres - measurement 3	
Weight in kilograms - measurement 3	
If the child cannot stand on their own feet, take their measurements as follows:	

NOTE: Please measure the length of the child using the measuring mat three separate times and then enter each measurement below in centimetres.	
Length in centimetres - measurement 1	
Length in centimetres - measurement 2	
Length in centimetres - measurement 3	
As the child cannot stand on their own, we will first measure the respondent / mother/guardian's weight alone, and then their weight holding the child to calculate the weight of the child.	
Ask the respondent/mother/guardian: is it okay if we measure your weight as well?	[ ] Yes [ ] No [ ] Don't Know
If they do not give consent, say thank you for your time and for answering all our questions. If you would like more information about this study, you can ring the number on this sheet.	
If they give consent continue with the measurements.	
NOTE: Please measure the weight of the child's mom, and then measure the weight of the child's mom while she holds the child in her arms, and then enter each measurement below in grams. Do this entire procedure 3 separate times.	
The mother/guardian's weight in kg - measurement 1	
The mother's weight while she holds the child in kg - measurement 1	
The child's weight is calculated in kg (1)	
The mother/guardian's weight in kg - measurement 2	
The mother's weight while she holds the child in kg - measurement 2	
The child's weight is calculated in kg (2)	
The mother/guardian's weight in kg - measurement 3	
The mother's weight while she holds the child in kg - measurement 3	
The child's weight is calculated in kg (3)	
Sorry for disturbing you, thank you for your time. If you would like more information about this study, you can ring the number on this sheet. Record any comments you have about the interview.	

10.4 Focus group discussion guides

Understanding the Role of Fathers for Young Children
Focus Group Discussion Guide

Overview

This guide pertains to FGDs that will be conducted with parents of children under the age of five from urban and rural areas in the Mwanza region of Tanzania.

- 4 FGD will take place.
- 10 participants selected, with 8 expected to show.
- 2 FGD in Kisesa, 2 in Welamasonga.
  - *Kisesa*: 1 with mothers, 1 with fathers.
  - *Welamasonga*: 1 with mothers, 1 with fathers.
- Time: 90 minutes per FGD.

Main Objectives

1. Understanding how fathers view their roles and responsibilities towards children under the age of 5 years.
2. Understanding how mothers view the roles and responsibilities of their husbands/partners/children's fathers towards children under the age of 5 years.
3. Understanding who helps mothers care for their children, including fathers and other family members/friends/neighbours.
4. Understanding the role of absent fathers in their children's lives.

Instructions for Interviewer

At the start, please discuss the study's aims and objectives, and the FGD's importance in contributing to the overall project. Remind the participants that the discussion is completely confidential in nature and their names will not be used in any reporting. Try to encourage participation and ensure everyone gets a chance to speak.
Allow your group to listen carefully and discuss the topics. Make sure they know their opinions are extremely important to the project. If you feel the discussion is beginning to lose focus, bring it back to the theme that was being explored. The questions below are meant to keep the discussion on track, not to limit it, and there are no right or wrong answers. The guide should be used to ensure all key themes are explored during the discussion. However, skilled interviewers may elaborate on questions or change the sequence, based on the participants' responses.

Procedures

Participant Characteristics

As participants arrive, a researcher should record information on their **age, sex, marital status (married monogamous, married polygynous, cohabitating, or unmarried), what they do for a living, length of residence in their community, number of children, and sex and age of children**. This information should be recorded by the researcher and not by participants. Names should not be recorded. Ensure each participant has provided consent prior to start of the FGD, including to audio record the session.

Introduction

Greet participants and give them an overview of the project, its aims, and the participants' role in the outcomes of the study. Ensure participants know that the FGD will be a 1.5-hour discussion to hear their views. Tell the group it is important to respect everyone's opinion and allow all to contribute and that are no right or wrong answers. It is ok if they have different opinions – we are interested in hearing all of them If they do not feel comfortable responding to certain questions, they do not have to respond. Their name will not be recorded, and it will not be used in the notes from this recording or any other reporting. Tell them that they have been selected to represent their views as parents within their community, including what they can share about the role fathers play in their young children's lives.

Although the participants will not receive monetary compensation for participating in the FGD, a drink and snack will be provided during the discussion. Ask what language participants are most comfortable using (Sukuma or Swahili).

Tell them that we are happy to answer any questions they have about the research project now or at the end of the discussion. Ask "Do you have any questions now?" Answer any questions that arise.

Ask if it is ok to record this discussion. If it is ok, start recording and say "We are now ready to begin. I am now recording our conversation."

Theme 1

For FGD with mothers: Understanding how mothers perceive the roles and responsibilities of their husbands/partners/children's fathers towards children under the age of 5 years.

For FGD with fathers: Understanding how fathers perceive their roles and responsibilities towards children under the age of 5 years.

- Tell the group that you are interested in learning about the roles and responsibilities that fathers have towards their young children (under-5)
  Kiambie kikundi kwamba ungependa kujua jinsi wababa wanavyoyachukulia majukumu yao na wajibu wao kwa watoto walio chini ya miaka mitano

- Ask them how does the care they *(for FGD with fathers)* or their children's fathers *(for FGD with mothers)* provide to their children (under 5s) vary by the following characteristics:
  Kiambie kikundi kwamba ungependa kujua jinsi wababa wanavyoyachukulia majukumu yao na wajibu wao kwa watoto walio chini ya miaka mitano. Waulize ni jinsi gani malezi wanayoyatoa kwa watoto walio chini ya mika mitano yatafautiana kwa kuzingatia yafutayo:

  - The child's age. Compare new-borns to infants of 1-2 years, 3-4 years and 5-year olds. *Ask for an example.*
    Umri wa mtoto. Linganisha mtoto wa mwaka 1-2; miaka 3-4 na miaka5. Uliza wakupe mfano
  - Whether the child is a boy or a girl. *Ask for an example.*
    Jinsia: uliza kama kuna tofauti wa uwajibikaji wa baba kwa mtoto wa kike na wa kiume . Uliza wakupe mfano
  - Whether they are your first-born child or a later child. *Ask for an example.*
    Kama ni mtoto wa kwanza au wa pili au zaidi. Uliza wakupe mfano
  - What about if you are married to the father/mother or not? This doesn't have to be about their own family! We are interested in their views about fathers in the community. *Ask for an example.*
    Na inakuwaje kama mama wa huyu wa mtoto ni mke wako wa ndoa au siyo mke wako wa ndoa? Hili siyo lazima liwe kwa familia zao ila tunazungumzia kwa ujumla katika kijiji/jamii. Ulizaa wakupe mfano

- Ask them 'What is the most important role and responsibility of a father?' We want to find out the differences between provision of direct care (washing,

feeding, caring for and supervising the child) and provision of resources (money, clothes, medicine, food etc.)
Ni upi wajibu mkuu wa baba katika malezi ya watoto walio chini ya umri wa mika5? Tunataka kujua kuhusu huduma za moja kwa moja za malezi (kumuogesha, kumlisha, kumwangalia kwa ujumla na kumsimamia). Tunapenda kujua pia kuhusu utoaji wa (fedha za matumizi, nguo, dawa, chakula n.k.)

- ***If extra time:*** How does care provided by biological fathers compare to care provided by stepfathers or foster parents?
  Kama muda wa ziada: Je kuna tofauti gani kwa malezi yanayotolewa na baba mzazi wa mtoto na baba wa kufikia/baba wa kambo?

For FGD with fathers:

- Do fathers perceive that there are costs of the time they spent on caring for children?
  Je, wababa wanajisikia kwamba wanapoteza kimapato wanapochukua muda kuangalia/kumlea mtoto wa chini ya miaka mitano?
- Does spending time with children mean you have less time for socialising, working, community involvement, leisure time etc.? *Ask for examples.*
  Je kwa kutumia muda wako kukaa na mtoto ina maana unakuwa na muda mfupi wa kuwa na marafiki zako, muda mdogo wa kufanya kazi, muda mdogo wa kujihusiha na maswala ya kijamii, muda wa starehe n.k.? Uliza wakupe mifano

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Activity 1

Tell the group about a Sukuma father named ______________ who has 3 children, 2 of whom are under the age of 5 years. ______________ wants to provide direct care (taking care of the child, feeding/cooking, supervising, playing, caring when sick etc.) for his children, and help his wife at home so she does not have to do all child-care activities alone, but he is unable to do this due to 'other responsibilities and commitments'. ______________ is torn between working and earning money or providing food, spending time with his friends and other family members or members of the community, and spending time at home with his young children. How would the group advise ______________?

Shughuli 1

Liambie kundi la majadiliano kuhusu baba wa kisukuma anayeitwa ______________ ambaye ana watoto 3 wawili kati yao wakiwa na umri wa chini ya miaka5. ______________ anataka kutoa malezi ya moja kwa moja kwa watoto/mtoto(kumlea mtoto kwa kumpikia, kumlisha, kumwangaliwa wakati wote, pamoja na kucheza, kumwangalia wakati akiwa mgonjwa n.k). Pia kumsaidia mke wake nyumbani ili mwanamke asifanye mambo yote yanayohusiana na malezi ya mtoto peke yake. Hata hivyo anashindwa kufanya yote haya kutokana na kukabiliwa na majukumu mengine. _______________ amegawajika kati ya kazi ili apate pesa na au kuipatia familia chakula, kupata muda na wa kuwa na marafiki na wanafamilia wengine au wanajamii, na kutumia muda nyumbani na mtoto wake mdogo. Je, kikundi kinashauri nini?

Use the following prompts and probes to guide the discussion:
Tumia maswali yafuatayo ili kukusaidia kuendesha majadiliano:

- How do they feel about this story?
  Wanajisikiaje kuhusu hadithi hiyo?

- How do they feel about fathers providing direct care to their children?
  Wanajisikiaje kuhusu baba kutoa huduma za moja kwa moja kwa mtoto (yaani kumlisha, kumogesha, kumvalisha n.k.)

- When is it okay for fathers to not provide direct care? What about when the mother is alone doing everything?
  Ni wakati gani ambao ni mzuri kwa baba kutokutoa huduma ya moja kwa moja kwa mtoto chini ya miaka5? Na vipi wakati mama yupo pekee yake na anafanya kila kitu?

- What other responsibilities or commitments that fathers have are either more important than or impact spending time with/providing direct care to children?
  Je, ni majukumu gani mengine walio nayo wababa ambayo ni muhimu zaidi kuliko kutoa huduma ya moja kwa moja kwa mtoto chini ya miaka5?

  - What about providing resources to the family?
    Je, na kuipatia familia raslimali /matumizi?

- What activities or things do fathers have to give up to provide enough time to their young children?
  Je, ni shughuli gani ambazo baba anapaswa kuzuacha ili aweze kutoa muda wa kutosha kwa watoto?
- Is there Sukuma cultural guidance on the role of father and mother in caring for under five children? If YES what does it say? Is it observed across the board?
  Je, kuna maelekezo ya kimila juu ya wajibu wa akina baba katika kulea watoto walio chini ya miak5? Kama ndiyo inasemaje? Na je inazingatiwa?
- If a father is seen providing direct services to his under 5-years child (with mother around) what will be the feelings/opinions of other men? And what will be the feeling if the mother is not available?
  Je wanaume wengine watajisikiaje/watakuwa na maoni gani wakimuona baba mwenye mtoto wa chini ya miaka mitatu akiwa anampatia huduma za moja kwa (mfano kumuogesha) wakati mama yake yupo? Na kama mama wa mtoto hayupo?

<u>Theme 2: Understanding who helps mothers care for their children, including fathers and other family members/friends/neighbours.</u>

Mada2: Kuelewa nanai anamsaidia mama katika kulea watoto wakiwemo na wababa na wanafamilia wengine/marafiki/majirani

- Tell the group that you are interested in learning about the care provided to young children (under-5) by their families.
  Kieleze kikundi kwamba unataka kujua kuhusu matunzo yanayotolewa na familia kwa watoto walio chini ya miaka5.

- *For FGD with mothers:* Are there types of care that you would want the children's fathers to provide but they do not? Either you provide this care yourself or other family members, friends, or neighbours help provide it?

Je, kuna aina ya malezi/matunzo ambayo ungependa baba wa mtoto kuyatoa lakini hayatohi? Je, huduma hiyo unaifanya/unaitoa mwenyewe au wanafamilia wengine, marafiki au majirani wanakusaidia kutoa huduma hiyo?

- Who helps mothers provide the care they cannot provide alone?
  Nani anyewasaidia akinamama kutoa malezi ambayo hawawezi kuyatoa wenyewe?
- Who is the best substitute person to provide this care when the 'ideal' caregiver is not available?
  Ni mtu gani ni sahihi zaidi kutoa malezi haya pale ambapo mtoa malezi rasmi hayupo (mfano mama mzazi hayupo)?
- Compare women who live with their husbands/partners with those who are divorced/separated or widowed or those whose husbands are away for work, or those who are in polygynous marriages.
  Linganisha wanawake wanaoishi na wanaume wao (walio kwenye ndoa) na wale ambao wametengana, wameachika au wale ambao wanaume wao wanafanya kazi mbali na pia wale ambao wapo kwenye ndoa ya wanawake wengi.

- *For FGD with mothers:* Are there any types of care that you have to provide on your own completely even though you would have welcomed some help?
  Je kuna matunzo/malezi ambayo unayatoa wewe mwenyewe kabisa ingawa ungeweza kumwita mtu/kupata mtu wa kukusaida?

- *For FGD with fathers:* In what circumstances is it important for fathers to help the mothers in providing child-care to children under the age of 5 years?
  Ni katika mazingira gani inapokuwa muhimu kwa baba kumsaidia mama katika kutoa huduma kwa mtoto wa chini ya miaka mitano?

- *For FGD with mothers:* Are there cultural norms which guide that certain care must be provided by the biological mother for children under-5?
  Je, kuna maelekezio ya kimila ambayo yanaelekze kwamba huduma Fulani lazima zitolewa na mama mzazi wa amtoto aliye chini ya miak mitano?

Theme 3: Understanding the role of absent fathers in their children's lives.

- What does it mean for a child under 5 years to not live in the same house with their alive biological father?
  Je, inatokeaje kwa mtoto wa chini ya miak5 kutoishi katika kaya moja na baba yake mzazi ambaye yupo hai?
- How does this differ by the forms of 'father absence' i.e. divorced separated, father not alive, father away for work, father in a polygynous marriage and splitting time between two families.
  Je hii inatofautiana je ikiwa baba hayupo kwa sababu zifuatazo: kutokana na kutengana au kuvunjika kwa ndoa, baba hayupo hai, baba nafanya kazi mbali, baba ana ndoa ya zaidi ya mke mmoja hivyo inagawa muda wa kukaa katika kila kaya.
- In what ways is father presence important for children under the age of 5?
  Je, kuna umuhimu gani kuwepo kwa baba kwenye kaya zenye watoto walio chini ya mika mitano?
- Under what circumstances does a child under 5-years not live with their biological mother, biological father, or with neither of them?
  Je, ni katika mazingira gani mtoto aliye chini ya miaka mitano haishi na mama yake mzazi, baba yake mzazi au wote wawili?
- Is this acceptable culturally?
  Na je hili linakubalika katika taratibu za kimila?
- For those children for whom both parents are not available, who takes care of them?
  Kwa wale amabo wazazi wote wawili hawapo, nani ambaye ni jukumu lake kumlea mtoto kama huyo?

Closing

Ask participants if they have any additional comments on what they have discussed. Encourage them to ask questions about the project and their contributions as participants. Provide them with a contact number of a researcher to answer any questions they may have after the FGD is over. Offer them a copy of the consent form, if requested. Thank the participants for their time, cooperation, and sharing their thoughts.

10.5 Supplementary material for Chapter 5 - Fathers favour sons, mothers don’t discriminate: sex-biased parental care in north-western Tanzania

Table S5.1 Bivariate analyses showing correlation between child's sex and selected child, parent and household-level socio-demographic characteristics (N=808)

	Girls	Boys	test-statistic	p-value
Number of total children 0-5 years	397	411		
Child Characteristics				
Age in Years - n (%)				
0-1 years	76 (19.14)	83 (20.19)	Pearson-chi2 (4) = 0.59	p=0.96
1-2 years	78 (19.65)	78 (18.98)		
2-3 years	81 (20.40)	85 (20.68)		
3-4 years	94 (23.68)	90 (21.90)		
4-5 years	68 (17.13)	75 (18.25)		
First Child of Biological Father - n (%)				
Yes	89 (23.06)	78 (19.65)	Pearson-chi2 (2) = 1.54	p=0.46
No	291 (75.39)	314 (79.09)		
Don't Know	6 (1.55)	5 (1.26)		
Parent Characteristics				
Mother's Residence/Death - n (%)				
Lives in household	361 (90.93)	367 (89.29)	Pearson-chi2 (2) = 1.83	p=0.40
Does not live in household	32 (8.06)	42 (10.22)		
Dead	4 (1.01)	2 (0.49)		
Father's Residence/Death - n (%)				
In the household	265 (66.75)	282 (68.61)	Pearson-chi2 (3) = 0.88	p=0.83
Not in the household	123 (30.98)	117 (28.47)		
Dead	4 (1.01)	5 (1.22)		
Don't Know / Refusal	5 (1.26)	7 (1.70)		
Household (HH) Characteristics				
HH size - mean (SD)	8.41 (3.6)	8.42 (3.83)	t-test = -0.04	p=0.97
Number of 0-5s in HH - mean (SD)	2.2 (1.21)	2.18 (1.23)	t-test = 0.22	p=0.83
Food Insecurity - mean (SD)	10.21 (7.38)	10.85 (7.73)	t-test = -1.20	p=0.23
Urban/Rural Residence - n (%)				
Urban (Town)	204 (51.39)	211 (51.34)	Pearson-chi2 (1) = 0.00	p=0.99
Rural (Village)	193 (48.61)	200 (48.66)		

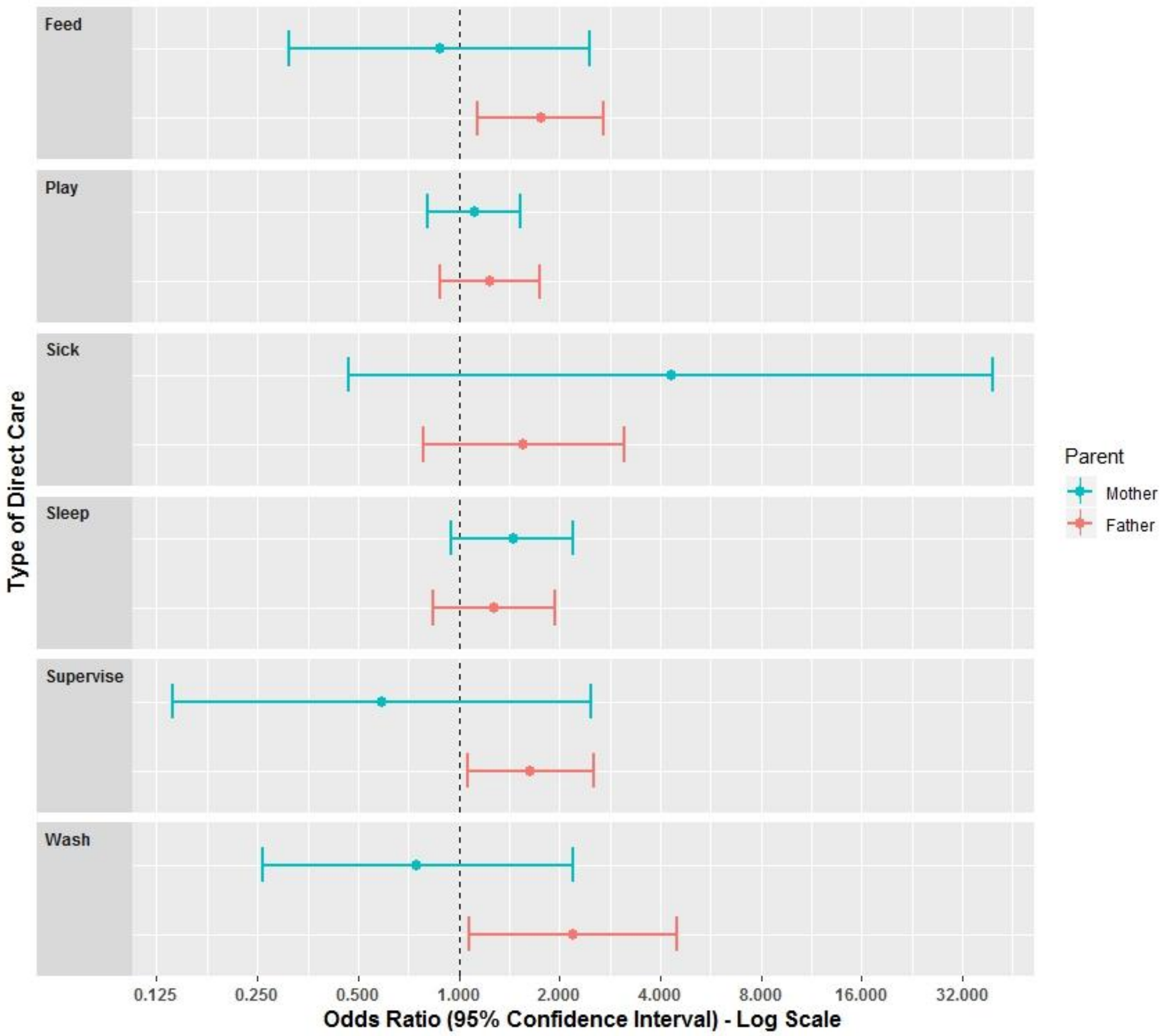

Figure S5.1 Odds Ratios with 95% Confidence Intervals showing relationship between child's sex (ref: female) and provisioning of six types of direct/physical care by co-resident biological mothers and fathers controlling for age and age-squared

Note: (Mothers: feeding n=728, playing n=728, caring if sick n=204, co-sleeping n=727, supervising n=728, washing n=728; Fathers: feeding n=547, playing n=547, caring if sick n=143, co-sleeping n=547, supervising n=547, washing n=547).

Tables S5.2.1-S5.2.2 Logistic regression models for association between child's sex and resource provision from all living mothers and non-co-resident fathers

Supplementary Table S5.2.1: Logistic Regression output showing odds of receiving resources from all mothers (excluding children with dead mothers) in the three months preceding the survey for sons versus daughters, controlling for child's age and age-squared

Number of obs = 801

Resource Provision - Alive Mothers	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf. Interval]**	
Child's Sex					
Male	1.207	0.222	0.304	0.843	1.730
Child's Age	1.338	0.340	0.252	0.813	2.203
Child's Age-Squared	0.944	0.049	0.270	0.853	1.046
_cons	3.159	0.868	0.000	1.844	5.414

Supplementary Table S5.2.2: Logistic Regression output showing odds of receiving resources from non-resident fathers in the three months preceding the survey for sons versus daughters, controlling for child's age and age-squared

Number of obs = 239

Resource Provision - Non-resident Fathers	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf. Interval]**	
Child's Sex					
Male	0.859	0.232	0.575	0.506	1.460
Child's Age	0.739	0.277	0.419	0.354	1.539
Child's Age-Squared	0.993	0.078	0.927	0.851	1.159
_cons	1.896	0.733	0.098	0.889	4.045

Tables S5.3.1-S5.3.6 Logistic regression models for association between child's sex and direct/physical care resource provision from co-resident mothers

Supplementary Table S5.3.1: Logistic Regression output showing odds of co-resident mothers washing their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 728

Resident Mother - Washing	Odds Ratio	Std. Err.	P>z	[95% Conf.	Interval]
Child's Sex					
Male	0.751	0.411	0.600	0.257	2.192
Child's Age	0.846	0.720	0.844	0.159	4.490
Child's Age-Squared	0.961	0.152	0.800	0.705	1.310
_cons	132.936	143.360	0.000	16.058	1100.504

Supplementary Table S5.3.2: Logistic Regression output showing odds of co-resident mothers feeding their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 728

Resident Mother - Feeding	Odds Ratio	Std. Err.	P>z	[95% Conf.	Interval]
Child's Sex					
Male	0.879	0.461	0.805	0.314	2.458
Child's Age	0.827	0.698	0.822	0.158	4.325
Child's Age-Squared	0.957	0.148	0.774	0.706	1.296
_cons	127.606	137.713	0.000	15.390	1058.016

Supplementary Table S5.3.3: Logistic Regression output showing odds of co-resident mothers playing with their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 728					
Resident Mother - Playing	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.116	0.181	0.498	0.812	1.533
Child's Age	0.279	0.072	0.000	0.168	0.464
Child's Age-Squared	1.214	0.061	0.000	1.099	1.340
_cons	9.597	2.965	0.000	5.238	17.583

Supplementary Table S5.3.4: Logistic Regression output showing odds of co-resident mothers supervising their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 728					
Resident Mother - Supervising	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf. Interval]**	
Child's Sex					
Male	0.586	0.432	0.469	0.138	2.484
Child's Age	0.017	0.043	0.113	0.000	2.652
Child's Age-Squared	1.890	0.804	0.135	0.821	4.349
_cons	40354.870	156051.300	0.006	20.621	79000000

Supplementary Table S5.3.5: Logistic Regression output showing odds of co-resident mothers co-sleeping with their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 727					
Resident Mother - Co-sleeping	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.445	0.310	0.086	0.949	2.201
Child's Age	0.044	0.033	0.000	0.010	0.193
Child's Age-Squared	1.384	0.159	0.005	1.104	1.734
_cons	1430.178	1697.988	0.000	139.571	14654.95

Supplementary Table S5.3.6: Logistic Regression output showing odds of co-resident mothers caring for their son versus their daughter if they had been sick in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 204					
Resident Mother - Caring if sick	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	4.303	4.866	0.197	0.469	39.468
Child's Age	0.079	0.180	0.267	0.001	6.962
Child's Age-Squared	1.690	0.808	0.273	0.662	4.316
_cons	277.499	711.625	0.028	1.821	42276.64

Tables S5.4.1-S5.4.6 Logistic regression models for association between child's sex and direct/physical care resource provision from co-resident fathers

Supplementary Table S5.4.1: Logistic Regression output showing odds of co-resident fathers washing their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 547

Resident Father - Washing	Odds Ratio	Std. Err	P>z	[95% Conf.	Interval]
Child's Sex					
Male	2.185	0.798	0.032	1.068	4.471
Child's Age	3.693	2.463	0.050	0.999	13.647
Child's Age-Squared	0.830	0.100	0.121	0.655	1.051
_cons	0.007	0.006	0.000	0.001	0.041

Supplementary Table S5.4.2: Logistic Regression output showing odds of co-resident fathers feeding their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 547

Resident Father - Feeding	Odds Ratio	Std. Err.	P>z	[95% Conf.	Interval]
Child's Sex					
Male	1.759	0.389	0.011	1.139	2.714
Child's Age	2.431	0.837	0.010	1.238	4.774
Child's Age-Squared	0.843	0.058	0.013	0.737	0.964
_cons	0.076	0.032	0.000	0.034	0.172

Supplementary Table S5.4.3: Logistic Regression output showing odds of co-resident fathers playing with their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 547

Resident Father - Playing	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.238	0.216	0.220	0.880	1.742
Child's Age	0.758	0.193	0.276	0.461	1.247
Child's Age-Squared	1.006	0.051	0.907	0.910	1.112
_cons	1.791	0.520	0.045	1.014	3.163

Supplementary Table S5.4.4: Logistic Regression output showing odds of co-resident fathers supervising their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 547

Resident Father - Supervising	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.629	0.361	0.028	1.055	2.516
Child's Age	0.759	0.245	0.393	0.404	1.428
Child's Age-Squared	1.090	0.073	0.197	0.956	1.244
_cons	3.425	1.209	0.000	1.714	6.842

Supplementary Table S5.4.5: Logistic Regression output showing odds of co-resident fathers co-sleeping with their sons versus daughters in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 547

Resident Father - Co-sleeping	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.277	0.270	0.247	0.844	1.931
Child's Age	0.239	0.109	0.002	0.098	0.583
Child's Age-Squared	1.097	0.087	0.243	0.939	1.280
_cons	46.539	29.225	0.000	13.592	159.349

Supplementary Table S5.4.6: Logistic Regression output showing odds of co-resident fathers caring for their son versus their daughter if they had been sick in the 2 weeks preceding the survey, controlling for child's age and age-squared

Number of obs = 143

Resident Father - Caring if sick	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.564	0.553	0.206	0.782	3.129
Child's Age	1.008	0.582	0.990	0.325	3.123
Child's Age-Squared	1.057	0.129	0.653	0.831	1.343
_cons	0.962	0.601	0.950	0.283	3.272

Tables S5.5.1-S5.5.3 Association between child's sex and breastfeeding duration

Supplementary Table S5.5.1: Logistic Regression output showing odds of being exclusively breastfed for six months or longer (versus less than six months) for sons compared to daughters, controlling for child's age and age-squared (n=541)

Number of obs = 541

Exclusive Breastfeeding	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	0.850	0.151	0.358	0.600	1.203
Child's Age	1.097	0.639	0.874	0.350	3.438
Child's Age-Squared	0.993	0.093	0.944	0.826	1.195
_cons	1.412	1.204	0.686	0.265	7.516

Supplementary Table S5.5.2: Discrete Time Survival Analysis Regression output showing odds of stopping overall breastfeeding as age increases for boys vs girls **for each individual month (1-25).** Age is cut off at 25 months due to data sparsity after this period (i.e., very few children continued breastfeeding after 25 months of age). Results indicate that the odds of stopping breastfeeding increase with child's age and the highest odds of stopping are at 12 months, 18 months, 20 months and 24 months. There is no evidence of a difference in time at weaning between sons and daughters. *A model including an interaction term between time and child's sex showed no evidence of a difference and has not been displayed here.*

Number of obs = 10,808					
Event: Stopping Breastfeeding	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval**
Age at Weaning (months)					
1	0.015	0.009	0.000	0.005	0.049
2		1 (empty)			
3	0.022	0.011	0.000	0.008	0.060
4	0.017	0.010	0.000	0.005	0.053
5	0.040	0.016	0.000	0.019	0.087
6	0.047	0.018	0.000	0.023	0.098
7	0.018	0.011	0.000	0.006	0.057
8	0.025	0.013	0.000	0.009	0.067
9	0.071	0.023	0.000	0.038	0.133
10	0.033	0.015	0.000	0.013	0.080
11	0.041	0.017	0.000	0.018	0.093
12		1 (base)			
13	0.035	0.018	0.000	0.013	0.096
14	0.207	0.050	0.000	0.129	0.333
15	0.343	0.072	0.000	0.228	0.517
16	0.353	0.076	0.000	0.231	0.540
17	0.553	0.109	0.003	0.375	0.814
18	1.539	0.258	0.010	1.108	2.138
19	0.760	0.166	0.208	0.495	1.166
20	1.407	0.290	0.098	0.939	2.109
21	0.371	0.128	0.004	0.189	0.732
22	0.077	0.056	0.000	0.019	0.317
23	0.039	0.039	0.001	0.005	0.282
24	31.974	10.362	0.000	16.941	60.346
25		1 (empty)			
Child's Sex					
Male	1.103	0.110	0.326	0.907	1.341
_cons	0.230	0.027	0.000	0.183	0.288

Supplementary Table S5.5.3: Discrete Time Event History Analysis Regression output showing odds of stopping overall breastfeeding as age increases for boys vs girls with **age categorised into four groups.** Age is cut off at 25 months due to data sparsity. **Results mirror those in Table S5.2,** and show that the odds of stopping breastfeeding increase as children grow older.

Number of obs = 11,608

Event: Stopping Breastfeeding	Odds Ratio	Std. Err.	P>z	[95% Conf. Interval	
Age at Weaning					
0-6 months	1 (base)				
7-12 months	7.021	1.528	0.000	4.582	10.757
13-18 months	17.280	3.686	0.000	11.376	26.248
19-25 months	49.838	10.848	0.000	32.531	76.355
Child's Sex					
Male	1.074	0.097	0.427	0.900	1.281
_cons	0.005	0.001	0.000	0.004	0.008

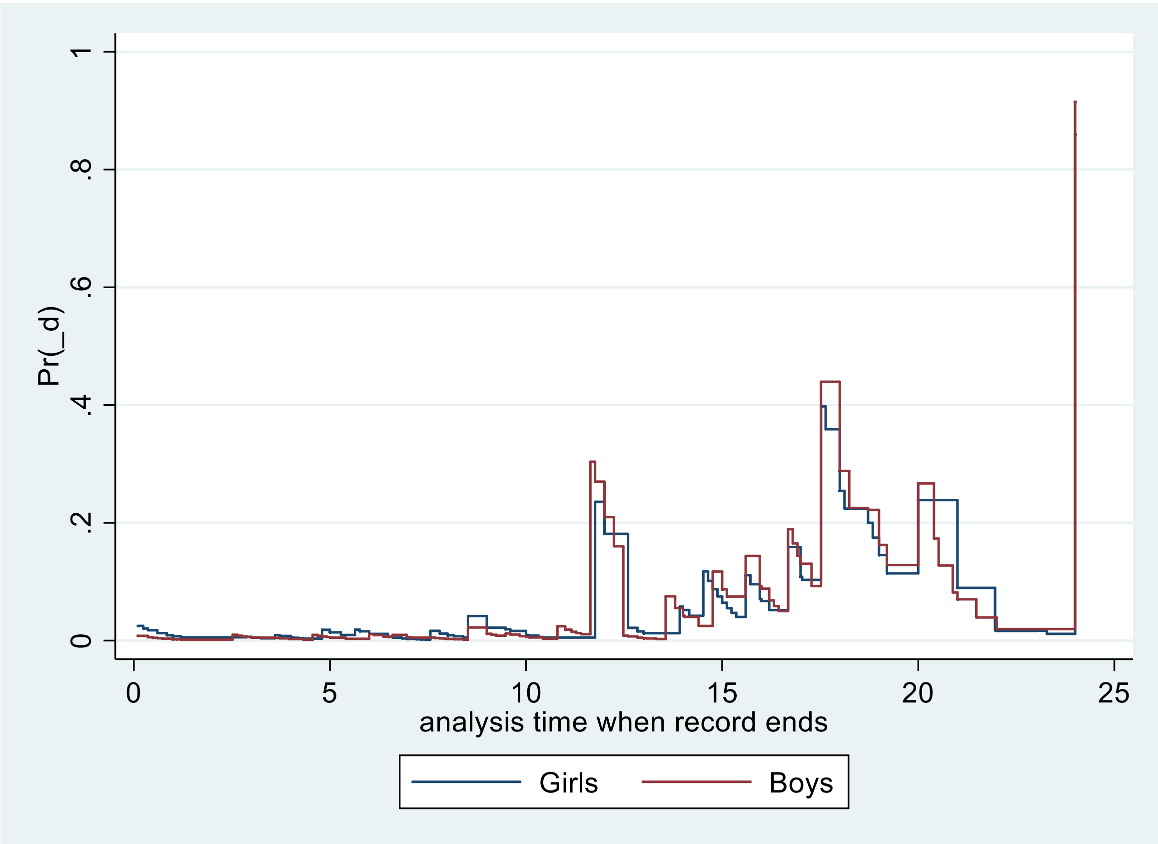

Figure S5.2 Hazard of stopping overall breastfeeding for boys and girls (time cut off at 24 months due to data sparsity after this period).

Tables S5.6.1-S5.6.4 Association between child's sex and parental marital status and co-habiting status

Supplementary Table S5.6.1: Logistic Regression output showing odds of parents being married versus divorced if their child was a boy compared to a girl, controlling for age and age-squared, using sample of children whose biological parents were currently or previously married (n=653)

Number of obs = 653

Parents Married vs Divorced	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf. Interval]**	
Child's Sex					
Male	1.002	0.222	0.994	0.649	1.546
Child's Age	1.069	0.352	0.840	0.560	2.039
Child's Age-Squared	0.940	0.060	0.326	0.830	1.064
_cons	8.218	3.240	0.000	3.795	17.797

Supplementary Table S5.6.2: Logistic Regression output showing odds of parents being married versus divorced if their child was a boy compared to a girl, controlling for age and age-squared, using sample of first-born children only (n=101)

Number of obs = 101

Parents Married vs Divorced	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf. Interval]**	
Child's Sex					
Male	1.131	0.528	0.792	0.453	2.822
Child's Age	4.301	2.894	0.030	1.151	16.079
Child's Age-Squared	0.702	0.092	0.007	0.542	0.908
_cons	1.136	0.842	0.863	0.266	4.857

Supplementary Table S5.6.3: Logistic Regression output showing odds of child's biological parents residing with each other versus living apart if their child was a boy compared to a girl, controlling for age and age-squared, using full sample of children (n=793)

Number of obs = 793

Parents co-habiting vs. not	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.116	0.172	0.477	0.825	1.508
Child's Age	1.579	0.338	0.033	1.037	2.402
Child's Age-Squared	0.912	0.040	0.035	0.837	0.994
_cons	1.424	0.332	0.129	0.902	2.248

Supplementary Table S5.6.4: Logistic Regression output showing odds of child's biological parents residing with each other versus living apart if their child was a boy compared to a girl, controlling for age and age-squared, using sample of first-born children only (n=166)

Number of obs = 166

Parents co-habiting vs. not	**Odds Ratio**	**Std. Err.**	**P>z**	**[95% Conf.**	**Interval]**
Child's Sex					
Male	1.42	0.47	0.29	0.74	2.73
Child's Age	5.54	2.77	0.00	2.08	14.75
Child's Age-Squared	0.73	0.07	0.00	0.60	0.88
_cons	0.11	0.07	0.00	0.04	0.36

Tables S5.7.1-S5.7.17 Interaction between child's age and child's sex for all types of care provision

Supplementary Table S5.7.1: Logistic Regression output showing odds of child's mother (all except dead) providing resources to sons versus daughters in the three months preceding the survey with an interaction term for child's age

Number of obs = 801

Resource Provision - All Mothers	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.05	0.39	0.13	0.9	0.51	2.16
Child Age	0.99	0.09	-0.1	0.93	0.83	1.19
Child's Sex#Child Age						
Male	1.06	0.14	0.44	0.66	0.82	1.38
_cons	4.17	1.08	5.5	0	2.51	6.93

Supplementary Table S5.7.2: Logistic Regression output showing odds of child's non-resident fathers providing resources to sons versus daughters in the three months preceding the survey with an interaction term for child's age

Number of obs = 239

Resource Provision - Non-Cores Fathers	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf. Interval]**	
Child's Sex						
Female	1	(base)				
Male	0.68	0.35	-0.76	0.447	0.25	1.86
Child Age	0.68	0.09	-2.8	0.005	0.52	0.89
Child's Sex#Child Age						
Male	1.11	0.21	0.54	0.588	0.76	1.61
_cons	2.19	0.77	2.21	0.027	1.09	4.37

Supplementary Table S5.7.3: Logistic Regression output showing odds of child's co-resident mother washing sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 728

Mother - Washing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	3.34	4.62	0.87	0.384	0.22	50.29
Child Age	0.90	0.27	-0.34	0.731	0.50	1.63
Child's Sex#Child Age						
Male	0.60	0.26	-1.18	0.239	0.26	1.40
_cons	76.36	66.70	4.96	0	13.78	423.05

Supplementary Table S5.7.4: Logistic Regression output showing odds of child's coresident mother feeding sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 728

Mother - Feeding	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.06	0.10	-1.63	0.103	0.00	1.77
Child Age	0.38	0.16	-2.33	0.02	0.17	0.86
Child's Sex#Child Age						
Male	2.33	1.13	1.74	0.082	0.90	6.04
_cons	991.55	1548.59	4.42	0	46.44	21169.69

Supplementary Table S5.7.5: Logistic Regression output showing odds of child's co-resident mother playing with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 728						
Mother - Playing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.66	0.23	-1.23	0.22	0.33	1.29
Child Age	0.65	0.06	-4.97	0	0.54	0.77
Child's Sex#Child Age						
Male	1.24	0.15	1.77	0.077	0.98	1.57
_cons	5.47	1.39	6.68	0	3.33	9.01

Supplementary Table S5.7.6: Logistic Regression output showing odds of child's co-resident mother supervising sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 728						
Mother - Supervising	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	4.67	8.99	0.8	0.423	0.11	203.04
Child Age	0.94	0.40	-0.14	0.891	0.41	2.17
Child's Sex#Child Age						
Male	0.51	0.30	-1.15	0.249	0.16	1.61
_cons	137.22	164.01	4.12	0	13.18	1428.20

Supplementary Table S5.7.7: Logistic Regression output showing odds of child's co-resident mother co-sleeping with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 727						
Mother - Co-sleeping	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.76	0.56	-0.38	0.706	0.18	3.25
Child Age	0.30	0.05	-7.83	0	0.22	0.40
Child's Sex#Child Age						
Male	1.22	0.26	0.94	0.349	0.80	1.86
_cons	122.29	65.21	9.01	0	43.00	347.79

Supplementary Table S5.7.8: Logistic Regression output showing odds of child's co-resident mother caring if sick for sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 204						
Mother - Caring if Sick	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	16.73	45.52	1.04	0.3	0.08	3459.55
Child Age	1.05	0.45	0.12	0.906	0.46	2.42
Child's Sex#Child Age						
Male	0.61	0.53	-0.57	0.569	0.11	3.41
_cons	20.69	21.08	2.97	0.003	2.81	152.32

Supplementary Table S5.7.9: Logistic Regression output showing odds of child's co-resident father washing sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 547						
Father - Washing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.84	0.72	-0.21	0.837	0.15	4.53
Child Age	1.10	0.25	0.44	0.66	0.71	1.71
Child's Sex#Child Age						
Male	1.40	0.39	1.2	0.231	0.81	2.42
_cons	0.04	0.02	-4.94	0	0.01	0.14

Supplementary Table S5.7.10: Logistic Regression output showing odds of child's co-resident father feeding sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 547						
Father - Feeding	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.53	0.72	0.92	0.36	0.61	3.82
Child Age	1.03	0.13	0.23	0.821	0.80	1.32
Child's Sex#Child Age						
Male	1.06	0.17	0.33	0.741	0.77	1.46
_cons	0.17	0.06	-4.82	0	0.08	0.35

Supplementary Table S5.7.11: Logistic Regression output showing odds of child's co-resident father playing with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 547						
Father - Playing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.78	0.29	-0.67	0.502	0.38	1.60
Child Age	0.71	0.07	-3.61	0	0.59	0.85
Child's Sex#Child Age						
Male	1.21	0.16	1.42	0.154	0.93	1.56
_cons	2.24	0.61	2.95	0.003	1.31	3.82

Supplementary Table S5.7.12: Logistic Regression output showing odds of child's co-resident father supervising sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 547						
Father - Supervising	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.98	0.43	-0.05	0.963	0.42	2.30
Child Age	1.03	0.11	0.27	0.784	0.83	1.28
Child's Sex#Child Age						
Male	1.25	0.21	1.34	0.18	0.90	1.73
_cons	3.17	0.98	3.72	0	1.73	5.82

Supplementary Table S5.7.13: Logistic Regression output showing odds of child's co-resident father co-sleeping with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 547						
Father - Co-Sleeping	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.78	0.48	-0.41	0.682	0.23	2.60
Child Age	0.37	0.05	-7.12	0	0.28	0.48
Child's Sex#Child Age						
Male	1.18	0.23	0.86	0.39	0.81	1.72
_cons	33.42	15.26	7.68	0	13.65	81.79

Supplementary Table S5.7.14: Logistic Regression output showing odds of child's co-resident father caring if sick for sons versus daughters in the 2 weeks preceding the survey with an interaction term for child's age

Number of obs = 143

Father - Caring if Sick	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.63	0.45	-0.64	0.521	0.16	2.57
Child Age	1.01	0.23	0.05	0.957	0.65	1.57
Child's Sex#Child Age						
Male	1.58	0.49	1.47	0.142	0.86	2.90
_cons	1.29	0.68	0.48	0.632	0.46	3.63

Supplementary Table S5.7.15: Logistic Regression output showing odds of child being exclusively breastfed for sons versus daughters, with an interaction term for child's age

Number of obs = 541

Exclusive Breastfeeding	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.77	1.05	0.96	0.339	0.55	5.69
Child Age	1.19	0.16	1.32	0.186	0.92	1.55
Child's Sex#Child Age						
Male	0.79	0.15	-1.29	0.198	0.55	1.13
_cons	1.02	0.44	0.04	0.968	0.44	2.35

Supplementary Table S5.7.16: Logistic Regression output showing odds of child's biological parents being married versus divorced if the child was a boy versus a girl with an interaction term for child's age (sample of children with biological parents who were currently or previously married, n=653)

Number of obs = 653						
Parents Married vs. Divorced	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.59	0.81	0.9	0.368	0.58	4.33
Child Age	0.85	0.10	-1.38	0.168	0.68	1.07
Child's Sex#Child Age						
Male	0.85	0.14	-1.01	0.31	0.61	1.17
_cons	8.59	3.06	6.03	0	4.27	17.28

Supplementary Table S5.7.17: Logistic Regression output showing odds of child's biological parents residing with each other if the child was a boy versus a girl with an interaction term for child's age (n=793)

Number of obs = 793						
Parents co-habiting vs. not	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	2.13	0.66	2.42	0.015	1.16	3.92
Child Age	1.17	0.09	1.95	0.051	1.00	1.36
Child's Sex#Child Age						
Male	0.76	0.09	-2.4	0.016	0.61	0.95
_cons	1.45	0.31	1.73	0.083	0.95	2.21

Tables S5.8.1-S5.8.17 Interaction between child's age and being father's first-born child for all types of care provision

Supplementary Table S5.8.1: Logistic Regression output showing odds of child's mother (all except dead) providing resources to sons versus daughters in the three months preceding the survey (n=766) with an interaction term for child being father's first born or not

Number of obs =766						
Resource Provision - All Mothers	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.38	0.31	1.5	0.147	0.89	2.14
Father's First Child						
No	1.00	(base)				
Yes	0.78	0.23	-0.8	0.399	0.43	1.39
Child's Sex#First Child						
Male#Yes	0.58	0.25	-1.3	0.195	0.25	1.33
Child Age	1.27	0.33	0.9	0.371	0.76	2.12
Child Age-Squared	0.96	0.05	-0.7	0.474	0.87	1.07
_cons	3.38	1.00	4.1	0	1.90	6.03

Supplementary Table S5.8.2: Logistic Regression output showing odds of non-resident fathers providing resources to sons versus daughters in the three months preceding the survey (n=228) with an interaction term for child being father's first born or not

Number of obs =228						
Resource Provision - Non-Cores Fathers	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.08	0.39	0.21	0.83	0.53	2.20
Father's First Child						
No	1.00	(base)				
Yes	1.74	0.67	1.43	0.154	0.81	3.70
Child's Sex#First Child						
Male#Yes	0.67	0.37	-0.72	0.47	0.22	1.99
Child Age	0.78	0.31	-0.62	0.535	0.36	1.69
Child Age-Squared	0.99	0.08	-0.16	0.871	0.84	1.16
_cons	1.38	0.63	0.71	0.475	0.57	3.37

Supplementary Table S5.8.3: Logistic Regression output showing odds of child's co-resident mother washing sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =711						
Mother - Washing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.86	0.53	-0.3	0.802	0.26	2.85
Father's First Child						
No	1.00	(base)				
Yes	1.26	1.39	0.21	0.835	0.14	11.03
Child's Sex#First Child						
Male#Yes	1.01	1.57	0	0.996	0.05	21.47
Child Age	0.66	0.59	-0.5	0.639	0.11	3.84
Child Age-Squared	1.02	0.17	0.14	0.891	0.73	1.43
_cons	137.11	157.13	4.29	0	14.51	1295.81

Supplementary Table S5.8.4: Logistic Regression output showing odds of child's co-resident mother feeding sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =572						
Mother - Feeding	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.88	0.47	-0	0.814	0.31	2.48
Father's First Child						
No	1.00	(base)				
Yes	1.00	(empty)				
Child's Sex#First Child						
Female#Yes	1.00	(empty)				
Male#Yes	1.00	(empty)				
Child Age	0.93	0.79	-0	0.933	0.18	4.91
Child Age-Squared	0.93	0.15	-0	0.668	0.69	1.27
_cons	89.21	96.15	4.2	0	10.79	737.69

Supplementary Table S5.8.5: Logistic Regression output showing odds of child's co-resident mother playing with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =711

Mother - Playing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.05	0.19	0.3	0.804	0.73	1.49
Father's First Child						
No	1.00	(base)				
Yes	0.98	0.28	-0.1	0.945	0.56	1.70
Child's Sex#First Child						
Male#Yes	1.84	0.82	1.4	0.171	0.77	4.40
Child Age	0.30	0.08	-4.6	0	0.18	0.50
Child Age-Squared	1.20	0.06	3.5	0	1.08	1.32
_cons	8.85	2.80	6.9	0	4.76	16.45

Supplementary Table S5.8.6: Logistic Regression output showing odds of child's co-resident mother supervising sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =711

Mother - Supervising	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf. Interval]**	
Child's Sex						
Female	1	(base)				
Male	0.72	0.66	-0.36	0.72	0.12	4.39
Father's First Child						
No	1.00	(base)				
Yes	0.57	0.71	-0.45	0.65	0.05	6.49
Child's Sex#First Child						
Male#Yes	0.74	1.26	-0.18	0.86	0.03	21.29
Child Age	0.00	0.00	-1.79	0.07	0.00	2.40
Child Age-Squared	5.16	4.72	1.79	0.07	0.86	31.03
_cons	35100000	263000000	2.32	0.02	14.52	84800000000000

Supplementary Table S5.8.7: Logistic Regression output showing odds of child's co-resident mother co-sleeping with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =710

Mother - Co-Sleeping	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.21	0.28	0.8	0.425	0.76	1.92
Father's First Child						
No	1.00	(base)				
Yes	1.24	0.49	0.56	0.576	0.58	2.68
Child's Sex#First Child						
Male#Yes	3.72	2.60	1.88	0.06	0.95	14.64
Child Age	0.05	0.04	-3.89	0	0.01	0.23
Child Age-Squared	1.33	0.16	2.47	0.013	1.06	1.67
_cons	1115.67	1315.77	5.95	0	110.58	11256.52

Supplementary Table S5.8.8: Logistic Regression output showing odds of child's co-resident mother caring if sick for sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =156

Mother - Caring if Sick	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	4.75	5.38	1.4	0.169	0.52	43.78
Father's First Child						
No	1.00	(base)				
Yes	1.00	(empty)				
Child's Sex#First Child						
Female#Yes	1.00	(empty)				
Male#Yes	1.00	(empty)				
Child Age	0.09	0.21	-1	0.309	0.00	9.27
Child Age-Squared	1.64	0.82	1	0.32	0.62	4.35
_cons	181.05	472.93	2	0.047	1.08	30283.23

Supplementary Table S5.8.9: Logistic Regression output showing odds of child's co-resident father washing sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =543						
Father - Washing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.79	0.77	1.36	0.175	0.77	4.16
Father's First Child						
No	1.00	(base)				
Yes	0.68	0.73	-0.4	0.718	0.08	5.57
Child's Sex#First Child						
Male#Yes	4.95	5.87	1.35	0.177	0.49	50.56
Child Age	3.73	2.62	1.88	0.061	0.94	14.75
Child Age-Squared	0.82	0.10	-1.6	0.117	0.64	1.05
_cons	0.01	0.01	-5.3	0	0.00	0.04

Supplementary Table S5.8.10: Logistic Regression output showing odds of child's co-resident father feeding sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =543						
Father - Feeding	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.69	0.41	2.2	0.029	1.06	2.70
Father's First Child						
No	1.00	(base)				
Yes	0.68	0.38	-1	0.489	0.22	2.05
Child's Sex#First Child						
Male#Yes	1.64	1.15	0.7	0.484	0.41	6.50
Child Age	2.51	0.88	2.6	0.009	1.26	5.00
Child Age-Squared	0.83	0.06	-3	0.009	0.73	0.96
_cons	0.08	0.03	-6	0	0.03	0.18

Supplementary Table S5.8.11: Logistic Regression output showing odds of child's co-resident father playing with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =543						
Father - Playing	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.15	0.21	0.7	0.464	0.79	1.66
Father's First Child						
No	1.00	(base)				
Yes	1.12	0.42	0.3	0.76	0.54	2.33
Child's Sex#First Child						
Male#Yes	1.96	1.06	1.2	0.213	0.68	5.66
Child Age	0.75	0.19	-1.2	0.252	0.45	1.23
Child Age-Squared	1.01	0.05	0.1	0.916	0.91	1.11
_cons	1.81	0.53	2	0.043	1.02	3.23

Supplementary Table S5.8.12: Logistic Regression output showing odds of child's co-resident father supervising sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =543						
Father - Supervising	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.59	0.37	1.98	0.05	1.00	2.52
Father's First Child						
No	1.00	(base)				
Yes	1.20	0.55	0.4	0.69	0.49	2.93
Child's Sex#First Child						
Male#Yes	1.24	0.89	0.29	0.77	0.30	5.08
Child Age	0.75	0.24	-0.9	0.37	0.40	1.41
Child Age-Squared	1.09	0.07	1.31	0.19	0.96	1.25
_cons	3.41	1.21	3.45	0	1.70	6.86

Supplementary Table S5.8.13: Logistic Regression output showing odds of child's co-resident father co-sleeping with sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =543						
Father - Co-Sleeping	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.23	0.28	0.91	0.361	0.79	1.92
Father's First Child						
No	1.00	(base)				
Yes	1.27	0.56	0.55	0.585	0.54	3.02
Child's Sex#First Child						
Male#Yes	1.58	1.04	0.69	0.487	0.43	5.73
Child Age	0.24	0.11	-3.1	0.002	0.10	0.59
Child Age-Squared	1.09	0.09	1.12	0.262	0.94	1.28
_cons	45.52	28.68	6.06	0	13.24	156.48

Supplementary Table S5.8.14: Logistic Regression output showing odds of child's co-resident father caring if sick for sons versus daughters in the 2 weeks preceding the survey with an interaction term for child being father's first born or not

Number of obs =140						
Father - Caring if Sick	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	1.60	0.61	1.2	0.22	0.76	3.37
Father's First Child						
No	1.00	(base)				
Yes	1.94	1.46	0.9	0.378	0.44	8.47
Child's Sex#First Child						
Male#Yes	2.30	3.06	0.6	0.533	0.17	31.36
Child Age	1.22	0.73	0.3	0.741	0.38	3.96
Child Age-Squared	1.02	0.13	0.1	0.902	0.79	1.31
_cons	0.72	0.47	-0.5	0.612	0.20	2.60

Supplementary Table S5.8.15: Logistic Regression output showing odds of child being exclusively breastfed for sons versus daughters, with an interaction term for child being father's first born or not

Number of obs =515

Exclusive Breastfeeding	Odds Ratio	Std. Err.	z	P>z	[95%	Conf. Interval]
Child's Sex						
Female	1	(base)				
Male	0.70	0.14	-1.7	0.081	0.46	1.05
Father's First Child						
No	1.00	(base)				
Yes	0.53	0.16	-2	0.042	0.29	0.98
Child's Sex#First Child						
Male#Yes	3.12	1.41	2.5	0.012	1.28	7.58
Child Age	0.94	0.59	-0.1	0.923	0.28	3.20
Child Age-Squared	1.02	0.10	0.2	0.874	0.83	1.24
_cons	2.07	1.90	0.8	0.431	0.34	12.58

Supplementary Table S5.8.16: Logistic Regression output showing odds of child's biological parents being married versus divorced if the child was a boy versus a girl with an interaction term for child being father's first born or not (sample of children with biological parents who were currently or previously married, n=649)

Number of obs =649

Parents Married vs. Divorced	Odds Ratio	Std. Err.	z	P>z	[95%	Conf. Interval]
Child's Sex						
Female	1	(base)				
Male	1.07	0.29	0.26	0.793	0.63	1.83
Father's First Child						
No	1.00	(base)				
Yes	0.31	0.11	-3.33	0.001	0.15	0.61
Child's Sex#First Child						
Male#Yes	0.85	0.44	-0.32	0.751	0.31	2.32
Child Age	0.91	0.32	-0.26	0.797	0.46	1.81
Child Age-Squared	0.98	0.07	-0.37	0.709	0.86	1.11
_cons	11.78	5.04	5.77	0	5.10	27.25

Supplementary Table S5.8.17: Logistic Regression output showing odds of child's biological parents residing with each other if the child was a boy versus a girl with an interaction term for child being father's first born or not (n=767)

Number of obs =767						
Parents co-habiting vs. not	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95%**	**Conf. Interval]**
Child's Sex						
Female	1	(base)				
Male	0.98	0.20	-0.1	0.93	0.66	1.45
Father's First Child						
No	1.00	(base)				
Yes	0.17	0.04	-6.8	0	0.10	0.28
Child's Sex#First Child						
Male#Yes	1.34	0.50	0.77	0.439	0.64	2.79
Child Age	1.45	0.34	1.6	0.11	0.92	2.30
Child Age-Squared	0.93	0.04	-1.5	0.136	0.85	1.02
_cons	2.63	0.71	3.6	0	1.55	4.45

Tables S5.9.1-S5.9.2 Additional analyses exploring sex-biased care provision from a number of different alloparents

Supplementary Table S5.9.1: Logistic regression outputs showing associations between child's sex and provision of material resources from five different alloparents (maternal grandparents, paternal grandparents, maternal aunts/uncles, paternal aunts/uncles and child's siblings). Effect sizes (Odds Ratios) adjusted for child's age (continuous) and age-squared.

	Odds Ratio (95% CI)				
Alloparent	**Maternal Grandparent**	**Paternal Grandparent**	**Maternal Aunt/Uncle**	**Paternal Aunt/Uncle**	**Child's Sibling**
	Resource Provision				
n	808	808	808	808	808
Child is Male	0.86 (0.62-1.20)	1.25 (0.81-1.93)	1.09 (0.70-1.73)	1.01 (0.57-1.81)	1.10 (0.54-2.23)
Child's Age	0.72 (0.46-1.15)	1.44 (0.77-2.69)	0.88 (0.47-1.67)	2.74* (1.05-7.18)	0.80 (0.29-2.15)
Child's Age-squared	1.08 (0.98-1.18)	0.89~ (0.78-1.02)	1.02 (0.90-1.16	0.82 (0.68-0.99)	1.06 (0.97-1.30)

~p<0.10; *p<0.05; **p<0.01; ***p<0.001

Supplementary Table S5.9.2: Logistic regression outputs showing associations between child's sex and each type of direct/physical care provision from five different alloparents (maternal grandparents, paternal grandparents, maternal aunts/uncles, paternal aunts/uncles and child's siblings). Effect sizes (Odds Ratios) adjusted for child's age (continuous) and age-squared. Caring for sick children is limited to children who had been sick in past two weeks (n=215).

	Odds Ratio (95% CI)				
Alloparent	**Maternal Grandparent**	**Paternal Grandparent**	**Maternal Aunt/Uncle**	**Paternal Aunt/Uncle**	**Child's Sibling**
			Washing		
n	808	808	808	808	808
Child is Male	0 .91 (0.65-1.28)	1.13 (0.72-1.77)	1.08 (0.74-1.57)	1.00 (0.60-1.68)	1.28~ (0.96-1.71)
Child's Age	0.79 (0.49-1.28)	1.99* (1.00-3.93)	1.43 (0.81-2.54)	2.00~ (0.89-4.49)	2.47*** (1.59-3.85)
Child's Age-squared	1.06 (0.96-1.17)	0.84* (0.72-0.97)	0.95 (0.85-1.07)	0.87~ (0.74-1.02)	0.86** (0.79-0.94)
			Feeding		
n	808	808	808	808	808
Child is Male	1.04 (0.73-1.48)	1.54~ (0.97-2.44)	1.25 (0.84-1.84)	1.11 (0.67-1.86)	1.29~ (0.96-1.74)
Child's Age	1.53 (0.90-2.60)	4.94*** (2.20-11.10)	1.65 (0.90-3.01)	3.99** (1.60-9.94)	3.22*** (2.02-5.12)
Child's Age-squared	0.95 (0.86-1.06)	0.71*** (0.60-0.84)	0.93 (0.83-1.05)	0.76 (0.64-0.92)	0.83*** (0.75-0.90)

~p<0.10; *p<0.05; **p<0.01; ***p<0.001

	Odds Ratio (95% CI)				
Alloparent	**Maternal Grandparent**	**Paternal Grandparent**	**Maternal Aunt/Uncle**	**Paternal Aunt/Uncle**	**Child's Sibling**
			Playing		
n	808	808	807	807	808
Child is Male	1.11 (0.73-1.68)	1.58~ (0.98-2.56)	1.44~ (0.97-2.15)	1.09 (0.62-1.90)	1.12 (0.81-1.57)
Child's Age	0.41** (0.23-0.71)	1.06 (0.55-2.06)	0.77 (0.44-1.33)	1.03 (0.47-2.25)	3.05*** (1.95-4.77)
Child's Age-squared	1.17** (1.04-1.31)	0.94 (0.81-1.08)	1.05 (0.94-1.18)	0.92 (0.77-1.10)	0.84*** (0.77-0.92)
			Supervising		
n	808	808	808	807	808
Child is Male	0.96 (0.70-1.33)	1.22 (0.81-1.83)	1.23 (0.85-1.78)	1.17 (0.68-2.01)	0.98 (0.74-1.31)
Child's Age	0.72 (0.46-1.12)	1.63 (0.89-2.96)	0.82 (0.49-1.37)	1.38 (0.62-3.08)	1.82** (1.19-2.79)
Child's Age-squared	1.08~ (0.99-1.18)	0.87* (0.77-0.99)	1.05 (0.94-1.16)	0.94 (0.80-1.10)	0.90* (0.83-0.98)

~p<0.10; *p<0.05; **p<0.01; ***p<0.001

	Odds Ratio (95% CI)				
Alloparent	**Maternal Grandparent**	**Paternal Grandparent**	**Maternal Aunt/Uncle**	**Paternal Aunt/Uncle**	**Child's Sibling**
			Caring if Sick		
n	215	215	215	215	215
Child is Male	0.95 (0.49-1.82)	0.57 (0.20-1.63)	3.34* (1.03-10.79)	0.57 (1.13-2.48)	0.70 (0.34-1.45)
Child's Age	0.77 (0.28-2.11)	2.47 (0.39-15.62)	4.07 (0.54-30.68)	1.75 (0.15-20.48)	3.93~ (0.99-15.57)
Child's Age-squared	1.09 (0.89-1.33)	0.80 (0.54-1.20)	0.83 (0.57-1.19)	0.83 (0.47-1.46)	0.82 (0.64-1.07)
			Co-sleeping		
n	807	808	808	808	808
Child is Male	0.72 (0.43-1.20)	1.76 (0.73-4.27)	1.48 (0.74-2.96)	0.48 (0.09-2.65)	1.00 (0.71-1.42)
Child's Age	2.63* (1.04-6.64)	32.41* (2.14-491.84)	1.03 (0.35-3.03)	2.16 (0.08-56.88)	2.56** (1.32-4.96)
Child's Age-squared	0.89 (0.75-1.06)	0.58* (0.36-0.91)	1.07 (0.87-1.31)	0.96 (0.55-1.69)	0.96 (0.85-1.08)

~p<0.10; *p<0.05; **p<0.01; ***p<0.001

10.6 Supplementary material for Chapter 6 - Childcare in transition: Evidence that patterns of childcare differ by degree of market integration in north-western Tanzania

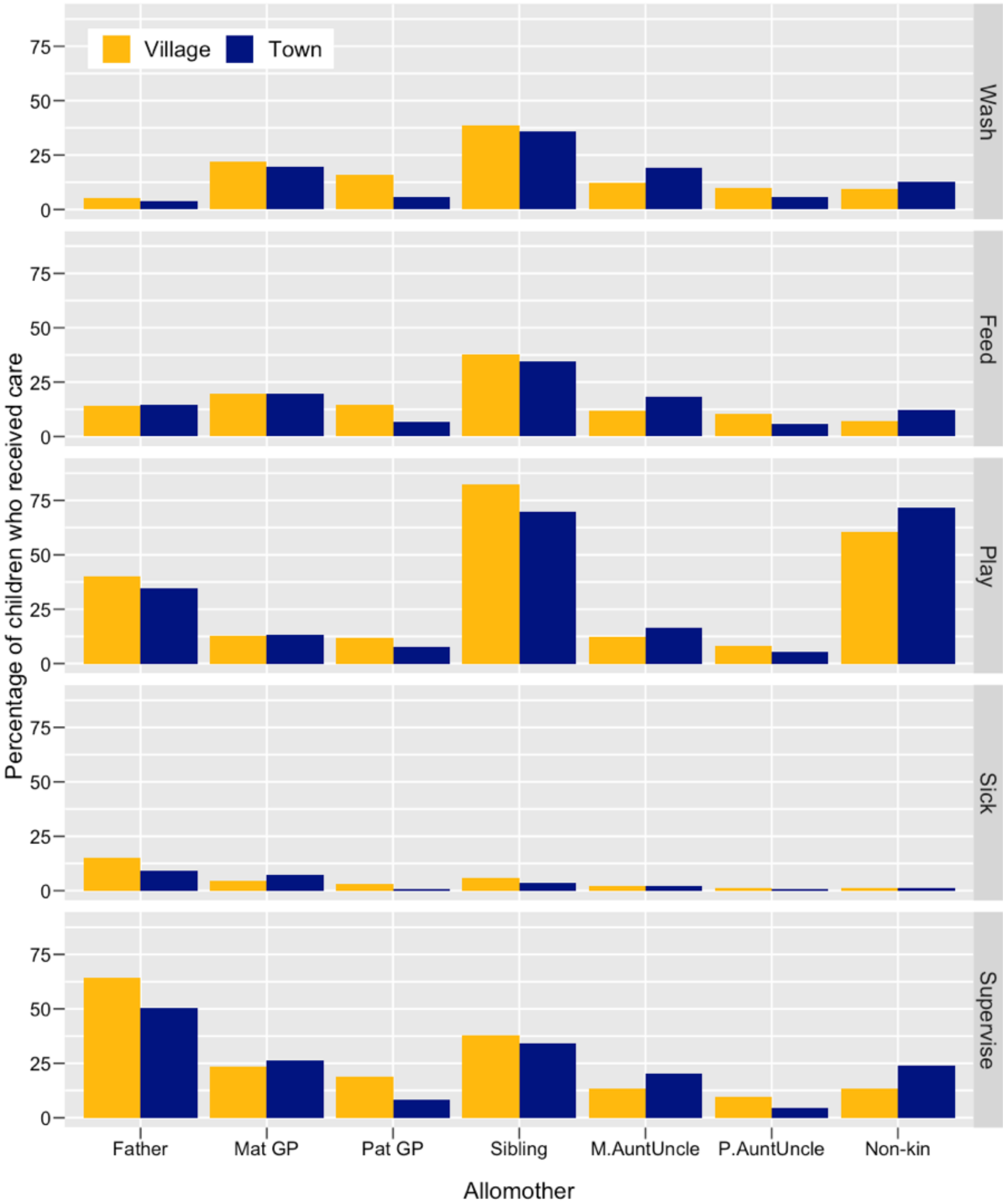

Figure S6.1 - Percentage of children who received each of five care-types from each allomother in the town and village: washing, feeding, playing, caring when sick (categorised as high-intensity care) and supervising (categorised as low-intensity care). Restricted to children with co-resident mothers (n=728).

Tables S6.1.1-S6.1.14 Full regression model output for Odds Ratios presented in Table 2 in the manuscript. Results show associations between town residence and receiving low- and high-intensity care from each allomother.

Supplementary Table S6.1.1 – Logistic regression output showing odds of children receiving low-intensity care from fathers in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(2)	=	24.87
				Prob > chi2	=	0
Log likelihood =	-473.54			Pseudo R2	=	0.03
Father - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.52	0.08	-4.23	0.00	0.38	0.70
Child's Age	1.17	0.07	2.80	0.01	1.05	1.31
_cons	1.57	0.26	2.68	0.01	1.13	2.18

Supplementary Table S6.1.2 – Logistic regression output showing odds of children receiving high-intensity care from fathers in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	9.64
				Prob > chi2	=	0.01
Log likelihood =	-497.48			Pseudo R2	=	0.01
Father - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.74	0.11	-2.05	0.04	0.55	0.99
Child's Age	0.89	0.05	-2.23	0.03	0.80	0.99
_cons	1.32	0.22	1.71	0.09	0.96	1.82

Supplementary Table S6.1.3 – Logistic regression output showing odds of children receiving low-intensity care from maternal grandparents in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(2)	=	3.02
				Prob > chi2	=	0.22
Log likelihood =	-371.48			Prob > chi3	=	0.00
Mat GP - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.21	0.22	1.03	0.30	0.84	1.73
Child's Age	0.91	0.06	-1.44	0.15	0.80	1.03
_cons	0.30	0.06	-6.17	0.00	0.20	0.44

Supplementary Table S6.1.4 – Logistic regression output showing odds of children receiving high-intensity care from maternal grandparents in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	6.09
				Prob > chi2	=	0.05
Log likelihood =	-392.61			Pseudo R2	=	0.01
Mat GP - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.08	0.19	0.46	0.65	0.77	1.53
Child's Age	0.86	0.05	-2.43	0.02	0.75	0.97
_cons	0.42	0.08	-4.72	0.00	0.29	0.60

Supplementary Table S6.1.5 – Logistic regression output showing odds of children receiving low-intensity care from paternal grandparents in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(2)	=	28.45
				Prob > chi2	=	0
Log likelihood =	-250.17			Pseudo R2	=	0.05
Pat GP - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.34	0.09	-4.26	0.00	0.21	0.56
Child's Age	0.78	0.07	-2.76	0.01	0.66	0.93
_cons	0.35	0.08	-4.62	0.00	0.23	0.55

Supplementary Table S6.1.6 – Logistic regression output showing odds of children receiving high-intensity care from paternal grandparents in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	25.14
				Prob > chi2	=	0
Log likelihood =	-276.89			Pseudo R2	=	0.04
Pat GP - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.38	0.09	-4.19	0.00	0.24	0.60
Child's Age	0.83	0.07	-2.34	0.02	0.70	0.97
_cons	0.36	0.08	-4.68	0.00	0.24	0.56

Supplementary Table S6.1.7 – Logistic regression output showing odds of children receiving low-intensity care from siblings in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(2)	=	9.33
				Prob > chi2	=	0.01
Log likelihood =	-476.44			Pseudo R2	=	0.01
Siblings - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.85	0.13	-1.05	0.29	0.63	1.15
Child's Age	1.18	0.07	2.90	0.00	1.05	1.31
_cons	0.44	0.08	-4.80	0.00	0.32	0.62

Supplementary Table S6.1.8 – Logistic regression output showing odds of children receiving high-intensity care from siblings in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	50.96
				Prob > chi2	=	0
Log likelihood =	-350.16			Pseudo R2	=	0.07
Siblings - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interva l]**
Residence						
Town	0.48	0.09	-3.78	0.00	0.33	0.70
Child's Age	1.53	0.11	5.96	0.00	1.33	1.76
_cons	2.28	0.45	4.21	0.00	1.56	3.36

Supplementary Table S6.1.9 – Logistic regression output showing odds of children receiving low-intensity care from maternal aunts/uncles in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(2)	=	4.7
				Prob > chi2	=	0.10
Log likelihood =	-299.77			Pseudo R2	=	0.01
Mat Aunt/Uncle - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.52	0.33	1.95	0.05	1.00	2.31
Child's Age	0.93	0.07	-1.00	0.32	0.80	1.08
_cons	0.16	0.04	-7.85	0.00	0.10	0.25

Supplementary Table S6.1.10 – Logistic regression output showing odds of children receiving high-intensity care from maternal aunts/uncles in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	4.65
				Prob > chi2	=	0.10
Log likelihood =	-351.18			Pseudo R2	=	0.01
Mat Aunt/Uncle - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.43	0.27	1.85	0.06	0.98	2.08
Child's Age	0.92	0.06	-1.17	0.24	0.81	1.06
_cons	0.23	0.05	-7.05	0.00	0.15	0.35

Supplementary Table S6.1.11 – Logistic regression output showing odds of children receiving low-intensity care from paternal aunts/uncles in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	727
				LR chi2(2)	=	6.93
				Prob > chi2	=	0.03
Log likelihood =	-151.41			Pseudo R2	=	0.02
Pat Aunt/Uncle - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.43	0.15	-2.41	0.02	0.22	0.86
Child's Age	0.91	0.11	-0.75	0.45	0.72	1.16
_cons	0.10	0.03	-7.02	0.00	0.05	0.19

Supplementary Table S6.1.12 – Logistic regression output showing odds of children receiving high-intensity care from paternal aunts/uncles in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	15.65
				Prob > chi2	=	0.00
Log likelihood =	-220.38			Pseudo R2	=	0.03
Pat Aunt/Uncle - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interv al]**
Residence						
Town	0.54	0.14	-2.34	0.02	0.32	0.91
Child's Age	0.75	0.07	-3.02	0.00	0.62	0.90
_cons	0.26	0.06	-5.55	0.00	0.16	0.41

Supplementary Table S6.1.13 – Logistic regression output showing odds of children receiving low-intensity care from others/non-kin in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(2)	=	14.95
				Prob > chi2	=	0.00
Log likelihood =	-331.05			Pseudo R2	=	0.02
Non-kin - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.97	0.40	3.33	0.00	1.32	2.94
Child's Age	1.13	0.08	1.68	0.09	0.98	1.30
_cons	0.11	0.03	-9.42	0.00	0.07	0.17

Supplementary Table S6.1.14 – Logistic regression output showing odds of children receiving high-intensity care from others/non-kin in the town (baseline: village), controlling for child's age (continuous). Analysis restricted to children with co-resident mothers.

Logistic regression				Number of obs	=	728
				LR chi2(1)	=	50.81
				Prob > chi2	=	0
Log likelihood =	-441.5859			Pseudo R2	=	0.05
Non-kin - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.43	0.23	2.19	0.03	1.04	1.96
Child's Age	1.49	0.09	6.49	0.00	1.32	1.67
_cons	0.68	0.12	-2.29	0.02	0.48	0.94

Tables S6.2.1-S6.2.14 Full regression model output for Odds Ratios presented in Table 3 in the manuscript. Results show associations between town residence and receiving low- and high-intensity care from each allomother, stratified by parental residence (restricted to children with both parents' co-resident).

Supplementary Table S6.2.1 – Logistic regression output showing odds of receiving low-intensity care from fathers in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident						
					Number of obs =	533
					LR chi2(2) =	6.22
Log likelihood =	-257.10				Prob> chi2 =	0.04
					Pseudo R2 =	0.01
Father - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.63	0.14	-2.10	0.04	0.40	0.97
Child's Age	1.13	0.09	1.45	0.15	0.96	1.32
_cons	4.08	0.99	5.79	0.00	2.53	6.56

Supplementary Table S6.2.2 – Logistic regression output showing odds of receiving high-intensity care from fathers in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident						
					Number of obs =	533
					LR chi2(2) =	13.24
Log likelihood =	-355.36				Prob> chi2 =	0.00
					Pseudo R2 =	0.02
Father - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.84	0.15	-0.98	0.33	0.59	1.19
Child's Age	0.80	0.05	-3.40	0.00	0.70	0.91
_cons	2.65	0.54	4.81	0.00	1.78	3.93

Supplementary Table S6.2.3 – Logistic regression output showing odds of receiving low-intensity care from maternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	1.24
Log likelihood =	-91.04				Prob> chi2 =	0.54
					Pseudo R2 =	0.01
Mat GP - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.61	0.28	-1.08	0.28	0.25	1.49
Child's Age	0.98	0.16	-0.12	0.90	0.71	1.35
_cons	0.06	0.03	-6.25	0.00	0.02	0.14

Supplementary Table S6.2.4 – Logistic regression output showing odds of receiving high-intensity care from maternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	4.22
Log likelihood =	-137.41				Prob> chi2 =	0.12
					Pseudo R2 =	0.02
Mat GP - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.53	0.19	-1.81	0.07	0.27	1.05
Child's Age	0.91	0.11	-0.77	0.44	0.71	1.16
_cons	0.13	0.04	-5.99	0.00	0.07	0.25

Supplementary Table S6.2.5 – Logistic regression output showing odds of receiving low-intensity care from paternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	30.16
Log likelihood =	-195.95				Prob> chi2 =	0
					Pseudo R2 =	0.07
Pat GP - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.30	0.09	-4.13	0.00	0.17	0.53
Child's Age	0.74	0.07	-3.03	0.00	0.61	0.90
_cons	0.48	0.12	-2.90	0.00	0.29	0.79

Supplementary Table S6.2.6 – Logistic regression output showing odds of receiving high-intensity care from paternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	28.4
Log likelihood =	-218.01				Prob> chi2 =	0
					Pseudo R2 =	0.06
Pat GP - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.36	0.10	-3.86	0.00	0.21	0.61
Child's Age	0.74	0.07	-3.26	0.00	0.61	0.88
_cons	0.55	0.13	-2.49	0.01	0.34	0.88

Supplementary Table S6.2.7 – Logistic regression output showing odds of receiving low-intensity care from siblings in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	2.34
Log likelihood =	-364.78				Prob> chi2 =	0.31
					Pseudo R2 =	0.00
Sibling - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.93	0.16	-0.43	0.67	0.66	1.31
Child's Age	1.10	0.07	1.49	0.14	0.97	1.25
_cons	0.65	0.13	-2.20	0.03	0.45	0.95

Supplementary Table S6.2.8 – Logistic regression output showing odds of receiving high-intensity care from siblings in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	18.29
Log likelihood =	-207.39				Prob> chi2 =	0.00
					Pseudo R2 =	0.04
Sibling - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.44	0.11	-3.15	0.00	0.26	0.73
Child's Age	1.32	0.13	2.97	0.00	1.10	1.59
_cons	5.11	1.40	5.93	0.00	2.98	8.75

Supplementary Table S6.2.9 – Logistic regression output showing odds of receiving low-intensity care from maternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident						
					Number of obs =	533
					LR chi2(2) =	0.8
Log likelihood =	-106.44				Prob> chi2 =	0.67
					Pseudo R2 =	0.00
Mat Aunt/Uncle - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.37	0.55	0.80	0.43	0.63	3.00
Child's Age	1.05	0.15	0.35	0.73	0.79	1.40
_cons	0.04	0.02	-7.03	0.00	0.02	0.10

Supplementary Table S6.2.10 – Logistic regression output showing odds of receiving high-intensity care from maternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident						
					Number of obs =	533
					LR chi2(2) =	0.4
Log likelihood =	-158.80				Prob> chi2 =	0.82
					Pseudo R2 =	0.00
Mat Aunt/Uncle - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interva l]**
Residence						
Town	0.88	0.27	-0.43	0.67	0.48	1.60
Child's Age	0.95	0.11	-0.44	0.66	0.76	1.19
_cons	0.12	0.04	-6.57	0.00	0.06	0.22

Supplementary Table S6.2.11 – Logistic regression output showing odds of receiving low-intensity care from paternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident						
					Number of obs =	533
					LR chi2(2) =	3.2
Log likelihood =	-127.53				Prob> chi2 =	0.20
					Pseudo R2 =	0.01
Pat Aunt/Uncle - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.64	0.23	-1.24	0.22	0.31	1.30
Child's Age	0.85	0.11	-1.20	0.23	0.66	1.10
_cons	0.12	0.04	-5.93	0.00	0.06	0.24

Supplementary Table S6.2.12 – Logistic regression output showing odds of receiving high-intensity care from paternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident						
					Number of obs =	533
					LR chi2(2) =	12.91
Log likelihood =	-170.52				Prob> chi2 =	0.00
					Pseudo R2 =	0.04
Pat Aunt/Uncle - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.61	0.18	-1.65	0.10	0.34	1.10
Child's Age	0.71	0.08	-3.03	0.00	0.57	0.89
_cons	0.29	0.08	-4.37	0.00	0.17	0.51

Supplementary Table S6.2.13 – Logistic regression output showing odds of receiving low-intensity care from others/non-kin in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	17.38
Log likelihood =	-239.59				Prob> chi2 =	0.00
					Pseudo R2 =	0.04
Distant/Non-kin - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	2.42	0.58	3.71	0.00	1.52	3.87
Child's Age	1.13	0.10	1.48	0.14	0.96	1.34
_cons	0.10	0.03	-8.27	0.00	0.06	0.17

Supplementary Table S6.2.14 – Logistic regression output showing odds of receiving high-intensity care from others/non-kin in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with both parents' co-resident.

Both parents' resident					Number of obs =	533
					LR chi2(2) =	28.09
Log likelihood =	-320.41				Prob> chi2 =	0
					Pseudo R2 =	0.04
Distant/Non-kin - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.21	0.23	1.00	0.32	0.83	1.76
Child's Age	1.44	0.10	5.01	0.00	1.25	1.66
_cons	0.84	0.17	-0.84	0.40	0.57	1.25

Tables S6.3.1-S6.3.14 Full regression model output for Odds Ratios presented in Table 3 in the manuscript. Results show associations between town residence and receiving low- and high-intensity care from each allomother, stratified by parental residence (restricted to children with resident mothers, non-resident fathers).

Supplementary Table S6.3.1 – Logistic regression output showing odds of receiving low-intensity care from fathers in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	1.61
Log likelihood =	-51.91				Prob> chi2 =	0.45
					Pseudo R2 =	0.02
Father - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.50	0.27	-1.27	0.20	0.17	1.45
Child's Age	1.01	0.19	0.04	0.97	0.69	1.46
_cons	0.12	0.07	-3.93	0.00	0.04	0.35

Supplementary Table S6.3.2 – Logistic regression output showing odds of receiving high-intensity care from fathers in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	2.88
Log likelihood =	-71.03				Prob> chi2 =	0.24
					Pseudo R2 =	0.02
Father - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.62	0.78	1.01	0.31	0.63	4.15
Child's Age	0.80	0.13	-1.38	0.17	0.58	1.10
_cons	0.16	0.08	-3.82	0.00	0.06	0.41

Supplementary Table S6.3.3 – Logistic regression output showing odds of receiving low-intensity care from maternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident						Number of obs =	193
						LR chi2(2) =	3.77
Log likelihood =	-121.42					Prob> chi2 =	0.15
						Pseudo R2 =	0.02
Mat GP - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**		**[95% Conf.**	**Interval]**
Residence							
Town	0.56	0.18	-1.79	0.07		0.29	1.06
Child's Age	1.09	0.12	0.79	0.43		0.88	1.35
_cons	2.40	0.81	2.58	0.01		1.23	4.67

Supplementary Table S6.3.4 – Logistic regression output showing odds of receiving high-intensity care from maternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident						Number of obs =	193
						LR chi2(2) =	3.02
Log likelihood =	-121.10					Prob> chi2 =	0.22
						Pseudo R2 =	0.01
Mat GP - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**		**[95% Conf.**	**Interval]**
Residence							
Town	0.59	0.19	-1.60	0.11		0.31	1.12
Child's Age	0.94	0.10	-0.53	0.60		0.76	1.17
_cons	3.19	1.11	3.34	0.00		1.61	6.31

Supplementary Table S6.3.5 – Logistic regression output showing odds of receiving low-intensity care from paternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	0.51
Log likelihood =	-49.95				Prob> chi2 =	0.77
					Pseudo R2 =	0.01
Pat GP - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.81	0.46	-0.37	0.71	0.27	2.45
Child's Age	0.89	0.18	-0.59	0.56	0.60	1.32
_cons	0.11	0.06	-3.90	0.00	0.04	0.34

Supplementary Table S6.3.6 – Logistic regression output showing odds of receiving high-intensity care from paternal grandparents in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	1.21
Log likelihood =	-52.11				Prob> chi2 =	0.55
					Pseudo R2 =	0.01
Pat GP - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.65	0.35	-0.78	0.43	0.23	1.89
Child's Age	1.17	0.22	0.83	0.41	0.81	1.70
_cons	0.08	0.04	-4.41	0.00	0.02	0.24

Supplementary Table S6.3.7 – Logistic regression output showing odds of receiving low-intensity care from siblings in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	5.62
Log likelihood =	-90.05				Prob> chi2 =	0.06
					Pseudo R2 =	0.03
Sibling - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.21	0.48	0.48	0.63	0.56	2.62
Child's Age	1.35	0.18	2.25	0.02	1.04	1.75
_cons	0.10	0.05	-5.06	0.00	0.04	0.25

Supplementary Table S6.3.8 – Logistic regression output showing odds of receiving high-intensity care from siblings in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with resident mothers, non-resident fathers.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	26.9
Log likelihood =	-116.36				Prob> chi2 =	0
					Pseudo R2 =	0.10
Sibling - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.80	0.26	-0.68	0.50	0.42	1.52
Child's Age	1.79	0.22	4.81	0.00	1.41	2.26
_cons	0.54	0.18	-1.84	0.07	0.29	1.04

Supplementary Table S6.3.9 – Logistic regression output showing odds of receiving low-intensity care from maternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with mothers' resident, fathers' non-resident.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	0.04
Log likelihood =	-130.19				Prob> chi2 =	0.98
					Pseudo R2 =	0.00
Mat Aunt/Uncle - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.96	0.29	-0.14	0.89	0.53	1.73
Child's Age	0.99	0.10	-0.13	0.90	0.81	1.21
_cons	0.72	0.23	-1.06	0.29	0.39	1.33

Supplementary Table S6.3.10 – Logistic regression output showing odds of receiving high-intensity care from maternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with mothers' resident, fathers' non-resident.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	0.87
Log likelihood =	-132.90				Prob> chi2 =	0.65
					Pseudo R2 =	0.00
Mat Aunt/Uncle - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.31	0.39	0.89	0.37	0.73	2.35
Child's Age	1.02	0.10	0.23	0.82	0.84	1.25
_cons	0.70	0.22	-1.12	0.26	0.38	1.30

Supplementary Table S6.3.11 – Logistic regression output showing odds of receiving low-intensity care from paternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with mothers' resident, fathers' non-resident.

Mother resident, father non-resident						
					Number of obs =	73
					LR chi2(2) =	0.25
note: 0.urban !=1 predicts failure perfectly					Prob> chi2 =	0.62
0.urban dropped and 119 obs not used					Pseudo R2 =	0.01
note: 1.urban omitted because of collinearity						
Log likelihood =	-18.11					
Pat Aunt/Uncle - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1	(empty)				
Child's Age	1.18	0.39	0.50	0.62	0.62	2.26
_cons	0.05	0.05	-3.35	0.00	0.01	0.29

Supplementary Table S6.3.12 – Logistic regression output showing odds of receiving high-intensity care from paternal aunts/uncles in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with mothers' resident, fathers' non-resident.

Mother resident, father non-resident						
					Number of obs =	193
					LR chi2(2) =	3.34
Log likelihood =	-48.54				Prob> chi2 =	0.19
					Pseudo R2 =	0.03
Pat Aunt/Uncle - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	0.44	0.25	-1.45	0.15	0.15	1.33
Child's Age	0.81	0.17	-0.99	0.32	0.54	1.22
_cons	0.18	0.09	-3.32	0.00	0.07	0.50

Supplementary Table S6.3.13 – Logistic regression output showing odds of receiving low-intensity care from others/non-kin in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with mothers' resident, fathers' non-resident.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	0.62
Log likelihood =	-89.54				Prob> chi2 =	0.73
					Pseudo R2 =	0.00
Distant/Non-kin - Low Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	1.12	0.44	0.29	0.77	0.52	2.44
Child's Age	1.10	0.15	0.71	0.48	0.85	1.43
_cons	0.16	0.07	-4.30	0.00	0.07	0.37

Supplementary Table S6.3.14 – Logistic regression output showing odds of receiving high-intensity care from others/non-kin in the town (baseline village), controlling for child's age (continuous). Analysis restricted to children with mothers' resident, fathers' non-resident.

Mother resident, father non-resident					Number of obs =	193
					LR chi2(2) =	25.28
Log likelihood =	-116.75				Prob> chi2 =	0
					Pseudo R2 =	0.10
Distant/Non-kin - High Intensity	**Odds Ratio**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Residence						
Town	2.59	0.83	2.97	0.00	1.38	4.86
Child's Age	1.56	0.18	3.78	0.00	1.24	1.96
_cons	0.36	0.12	-3.02	0.00	0.18	0.70

Table S6.4 Logistic regression outputs showing association between paternal non-residence and receiving low- or high-intensity care from each allomother. Models were stratified by children's village/town residence.

	Low intensity care								High intensity care							
	Village residence Model Set A				**Town residence** Model Set B				**Village residence** Model Set C				**Town residence** Model Set D			
	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value
Father (Model 1)																
Paternal Residence																
Father non-res	0.02	0.01	0.05	0.00	0.02	0.01	0.04	0.00	0.06	0.03	0.14	0.00	0.11	0.06	0.20	0.00
Child's Age	0.93	0.74	1.16	0.52	1.26	1.04	1.54	0.02	0.85	0.71	1.02	0.08	0.76	0.64	0.89	0.00
Maternal GP (Model 2)																
Paternal Residence																
Father non-res	54.22	25.40	115.7	0.00	51.02	22.88	113.8	0.00	27.24	14.04	52.86	0.00	30.41	15.56	59.44	0.00
Child's Age	1.03	0.78	1.37	0.82	1.07	0.85	1.35	0.56	0.96	0.76	1.22	0.74	0.90	0.73	1.12	0.36
Paternal GP (Model 3)																
Paternal Residence																
Father non-res	0.31	0.13	0.77	0.01	0.97	0.40	2.33	0.94	0.33	0.14	0.77	0.01	0.70	0.30	1.62	0.41
Child's Age	0.69	0.55	0.87	0.00	0.91	0.68	1.21	0.50	0.74	0.60	0.91	0.01	0.92	0.71	1.19	0.53
Sibling (Model 4)																
Paternal Residence																
Father non-res	0.25	0.13	0.48	0.00	0.34	0.20	0.56	0.00	0.18	0.09	0.35	0.00	0.36	0.22	0.58	0.00
Child's Age	1.13	0.95	1.33	0.17	1.16	1.00	1.36	0.06	1.82	1.40	2.37	0.00	1.36	1.14	1.62	0.00
Maternal Aunt/Uncle (Model 5)																
Paternal Residence																
Father non-res	15.19	7.20	32.04	0.00	10.86	5.72	20.64	0.00	7.22	3.88	13.42	0.00	10.67	6.00	18.95	0.00
Child's Age	0.94	0.72	1.23	0.65	1.05	0.85	1.30	0.63	1.03	0.82	1.29	0.82	0.96	0.79	1.17	0.72

Paternal Aunt/Uncle (Model 6)																
Paternal Residence																
Father non-res	0.78	0.28	2.15	0.63	1 (empty)				0.76	0.33	1.73	0.51	0.57	0.22	1.46	0.24
Child's Age	0.76	0.55	1.03	0.08	1.18	0.79	1.77	0.43	0.71	0.55	0.92	0.01	0.77	0.57	1.03	0.08
Distant kin/Non-kin (Model 7)																
Paternal Residence																
Father non-res	1.47	0.71	3.04	0.30	0.74	0.43	1.29	0.29	0.49	0.29	0.84	0.01	1.07	0.66	1.76	0.78
Child's Age	0.92	0.72	1.17	0.49	1.25	1.05	1.49	0.01	1.39	1.17	1.65	0.00	1.55	1.31	1.84	0.00

Notes: [1]A separate model was run for each allomother (Models 1-7) assessing the effect of paternal non-residence on receiving low-intensity care in the village (Model Set A); low-intensity care in the town (Model Set B); high-intensity care in the village (Model Set C); and high-intensity care in the town (Model Set D). [2]Models for village residence: n=375; models for town residence: n=351 except for low-intensity care from paternal aunts/uncle for which n=255. [3]All models control for child's age in years (continuous). Odds Ratios represent likelihood of receiving either low or high intensity care from each allomother in father non-resident households versus both parents' co-resident households.

10.7 Supplementary material for Chapter 7 – Which kin matter? The impact of allomaternal care on children's health in north-western Tanzania

Table S7.1 Correlation matrix showing correlation between receiving low intensity care from different allomothers, and high intensity care from different allomothers

High intensity	Father	Maternal GP	Paternal GP	Sibling	Mat Aunt / Uncle	Pat Aunt / Uncle	Distant / Non-kin
Father	1						
Mat GP	**-0.25**	1					
p-value	0.00						
Pat GP	**0.16**	**-0.13**	1				
p-value	0.00	0.00					
Sibling	**0.10**	**-0.19**	-0.02	1			
p-value	0.01	0.00	0.63				
Mat Aunt / Uncle	**-0.19**	**0.50**	0.00	**-0.14**	1		
p-value	0.00	0.00	0.95	0.00			
Pat Aunt / Uncle	0.07	0.01	**0.48**	-0.04	0.02	1	
p-value	0.06	0.76	0.00	0.27	0.51		
Distant/Non-kin	0.05	-0.01	**0.09**	**0.10**	**0.10**	0.07	1
p-value	0.15	0.86	0.01	0.01	0.00	0.05	

Low intensity	Father	Maternal GP	Paternal GP	Sibling	Mat Aunt / Uncle	Pat Aunt / Uncle	Distant / Non-kin
Father	1						
Mat GP	**-0.50**	1					
p-value	0.00						
Pat GP	**0.12**	**-0.16**	1				
p-value	0.00	0.00					
Sibling	**0.27**	**-0.15**	-0.05	1			
p-value	0.00	0.00	0.18				
Mat Aunt / Uncle	**-0.30**	**0.45**	**-0.07**	**-0.09**	1		
p-value	0.00	0.00	0.04	0.01			
Pat Aunt / Uncle	**0.10**	**-0.07**	**0.41**	-0.05	-0.02	1	
p-value	0.00	0.05	0.00	0.19	0.57		
Distant/Non-kin	0.06	0.06	**0.10**	**0.11**	**0.20**	**0.19**	1
p-value	0.11	0.08	0.00	0.00	0.00	0.00	

Table S7.2 Linear Regression model showing the effect of mother being alive but not co-residing with child, versus co-residing with child, on children's HAZ and WHZ

	HAZ				WHZ			
	coef.	95% CI		p-value	coef.	95% CI		p-value
Mother non- resident	0.05	-0.41	0.51	0.83	-0.16	-0.57	0.25	0.45
Child's Age (cont.)	-0.10	-0.19	-0.01	0.03	-0.11	-0.19	-0.03	0.01
Child is Male	-0.20	-0.43	0.04	0.10	-0.01	-0.22	0.20	0.91
Child is First Child	-0.32	-0.61	-0.03	0.03	0.27	0.01	0.53	0.04
Residence is Town	0.13	-0.10	0.37	0.26	-0.04	-0.25	0.17	0.72
Food Insecurity (cont.)	-0.02	-0.03	0.00	0.05	0.00	-0.02	0.01	0.73
_cons	-1.13	-1.48	-0.78	0.00	0.57	0.25	0.88	0.00

* Models control for: child's age, sex & birth order, rural/urban residence and food insecurity.
* Models restricted to children with alive mothers (n=802)
* Models for HAZ: n=705; WHZ: n=702.

Supplementary Results – Linear regression models assessing relationship between allomaternal care and child health, including maternal age and height as control variables

We did not have data on maternal age and height for all children and so did not include these as controls in the main models presented in the manuscript. However, to assess the effect of maternal age and height, we ran a supplementary analysis using the sub-sample of children for whom we had these data. The four main models (exploring the effect of low/high-intensity care on HAZ/WHZ) were run twice: with and without including maternal variables as controls. As we only had data on maternal age and height for those children who co-resided with their mothers all eight of these models were restricted to children who had co-resident mothers only. Full models are presented in Supplementary Tables S7.3 and S7.4.

Table S7.3 Linear Regression Model showing the effect of receiving low-intensity care from all allomothers on children's HAZ, restricted to sub-sample of children with data on maternal variables and including maternal age and height as controls

	HAZ								WHZ							
	Low intensity care				High intensity care				Low intensity care				High intensity care			
	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value
Father	-0.10	-0.43	0.23	0.54	-0.25	-0.53	0.04	0.09	0.04	-0.26	0.34	0.77	**0.28**	**0.02**	**0.54**	**0.03**
Maternal GP	-0.24	-0.65	0.17	0.25	-0.20	-0.58	0.18	0.31	-0.07	-0.43	0.30	0.73	-0.04	-0.38	0.31	0.84
Paternal GP	0.12	-0.31	0.56	0.58	0.21	-0.21	0.64	0.32	0.15	-0.24	0.55	0.45	-0.10	-0.48	0.28	0.60
Sibling	-0.07	-0.38	0.23	0.64	0.18	-0.19	0.55	0.34	**0.32**	**0.04**	**0.59**	**0.02**	-0.29	-0.63	0.04	0.09
Maternal Aunt/Uncle	-0.22	-0.65	0.20	0.30	-0.09	-0.48	0.31	0.67	0.21	-0.17	0.59	0.28	0.15	-0.21	0.51	0.41
Paternal Aunt/Uncle	-0.57	-1.19	0.04	0.07	-0.40	-0.90	0.10	0.11	0.25	-0.30	0.81	0.37	0.17	-0.27	0.61	0.45
Distant kin/Non-kin	0.20	-0.18	0.59	0.30	-0.12	-0.42	0.18	0.42	-0.23	-0.58	0.12	0.19	-0.14	-0.41	0.13	0.32
Child's Age (cont.)	-0.14	-0.24	-0.03	0.01	-0.15	-0.25	-0.04	0.01	-0.08	-0.18	0.01	0.07	-0.06	-0.16	0.04	0.23
Child is Male	-0.18	-0.45	0.09	0.19	-0.18	-0.45	0.08	0.18	0.01	-0.23	0.25	0.94	0.00	-0.25	0.24	0.98
Child is First Child	-0.12	-0.51	0.26	0.53	-0.07	-0.46	0.32	0.72	0.25	-0.10	0.60	0.16	0.14	-0.22	0.49	0.45
Mother's Age (ref: 15-19 years)																
20-24 years	-0.50	-1.15	0.14	0.13	-0.53	-1.18	0.12	0.11	-0.40	-0.99	0.18	0.18	-0.32	-0.91	0.27	0.28
25-29 years	-0.21	-0.88	0.47	0.55	-0.26	-0.95	0.42	0.45	-0.29	-0.90	0.32	0.36	-0.19	-0.82	0.43	0.55
30-35 years	-0.06	-0.76	0.65	0.87	-0.10	-0.83	0.62	0.78	-0.61	-1.25	0.03	0.06	-0.46	-1.11	0.20	0.17
Mother's Height (cont.)	4.69	2.52	6.87	0.00	4.80	2.63	6.97	0.00	0.54	-1.42	2.50	0.59	0.53	-1.43	2.49	0.60
Residence is Town	0.04	-0.24	0.33	0.76	0.10	-0.18	0.38	0.48	0.21	-0.05	0.47	0.12	0.13	-0.12	0.39	0.30
Food Insecurity (cont.)	-0.01	-0.03	0.01	0.24	-0.01	-0.03	0.00	0.12	0.01	-0.01	0.02	0.38	0.01	0.00	0.03	0.15

* All models control for: care provision from all other allomothers, child's age, sex, birth order, maternal age, maternal height, rural/urban residence, and household food insecurity levels.
* Models with mothers' co-resident: HAZ: low-intensity, n=547; high-intensity, n=548; WHZ: low-intensity, n=544; high-intensity, n=545.

Table S7.4 Linear Regression Model showing the effect of receiving low-intensity care from all allomothers on children's HAZ, restricted to sub-sample of children with data on maternal variables but without including maternal age and height as controls

	HAZ								WHZ							
	Low intensity care				High intensity care				Low intensity care				High intensity care			
	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value	coef.	95% CI		p-value
Father	-0.15	-0.48	0.19	0.39	-0.21	-0.50	0.07	0.15	0.03	-0.27	0.32	0.86	**0.26**	**0.01**	**0.52**	**0.04**
Maternal GP	-0.35	-0.75	0.06	0.10	-0.26	-0.64	0.13	0.19	-0.03	-0.39	0.34	0.89	-0.01	-0.35	0.33	0.97
Paternal GP	0.03	-0.41	0.46	0.91	0.09	-0.33	0.51	0.67	0.19	-0.20	0.57	0.34	-0.08	-0.45	0.29	0.68
Sibling	-0.02	-0.33	0.28	0.88	0.22	-0.14	0.58	0.23	0.26	-0.01	0.53	0.06	**-0.33**	**-0.65**	**0.00**	**0.05**
Maternal Aunt/Uncle	-0.21	-0.64	0.22	0.34	-0.08	-0.48	0.33	0.71	0.22	-0.16	0.60	0.26	0.17	-0.19	0.52	0.36
Paternal Aunt/Uncle	-0.40	-1.01	0.21	0.20	-0.29	-0.78	0.20	0.25	0.40	-0.14	0.94	0.14	0.26	-0.17	0.69	0.23
Distant kin/Non-kin	0.18	-0.22	0.57	0.38	-0.15	-0.45	0.15	0.34	-0.25	-0.59	0.10	0.16	-0.15	-0.42	0.12	0.27
Child's Age (cont.)	-0.13	-0.23	-0.02	0.02	-0.14	-0.24	-0.03	0.01	-0.09	-0.18	0.00	0.05	-0.06	-0.15	0.04	0.22
Child is Male	-0.12	-0.39	0.15	0.39	-0.13	-0.40	0.14	0.35	0.01	-0.23	0.25	0.94	0.00	-0.24	0.24	0.99
Child is First Child	-0.21	-0.57	0.15	0.25	-0.15	-0.53	0.22	0.43	0.36	0.04	0.68	0.03	0.20	-0.14	0.53	0.24
Residence is Town	0.09	-0.20	0.37	0.55	0.15	-0.13	0.43	0.30	0.16	-0.09	0.42	0.21	0.10	-0.15	0.35	0.44
Food Insecurity (cont.)	-0.01	-0.03	0.01	0.19	-0.02	-0.03	0.00	0.10	0.01	-0.01	0.02	0.50	0.01	-0.01	0.03	0.18

* All models control for: care provision from all other allomothers, child's age, sex, birth order, rural/urban residence, and household food insecurity levels.
* Models with mothers' co-resident: HAZ: low-intensity, n=550; high-intensity, n=551; WHZ: low-intensity, n=547; high-intensity, n=548.