UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL, HUMAN AND MATHEMATICAL SCIENCES

Department of Social Statistics and Demography

Exploring the links between women's work and child nutritional status in rapidly developing economies: the cases of Brazil and India

by

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ABSTRACT

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EXPLORING THE LINKS BETWEEN WOMEN'S WORK AND CHILD NUTRITIONAL STATUS IN RAPIDLY DEVELOPING ECONOMIES: THE CASES OF BRAZIL AND INDIA

Stephanie Bispo Amaral

The association between maternal work and child malnutrition is a long studied topic that has been revisited in developed countries due to the concern with the increasing rates of childhood overweight alongside increased female labour force participation (FLFP). Emerging countries, such as Brazil and India, have experienced pronounced economic growth, with different outcomes in terms of work opportunities for women, social development, and child nutrition. However, there is a lack of information about how maternal work relates to child nutrition in these contexts. This thesis explores changes in FLFP in Brazil and India and investigates the effects of maternal work on child stunting and overweight.

Two waves of the Demographic and Health Surveys were used for each country, allowing comparisons of associations over time, using a sample of mothers and their children younger than 60 months. Multilevel models were estimated to examine child stunting, followed by separate analysis for each country. In India, a matching procedure was used to eliminate selection bias between working and non-working mothers; in Brazil, structural equation modelling was used to understand the mechanisms linking maternal work to child's BMI.

Given the different contexts of Brazil and India, the effect of FLFP went in opposite directions by year and in its effect on child nutrition. In India, the increased likelihood of child stunting when the mother worked was related to poverty. In Brazil, maternal work was associated with increased food availability, which reduced stunting, but also increased child BMI. Stratified analysis highlighted the importance of maternal education for better work opportunities, the importance of the partner and family members in dividing childcare responsibilities, and the importance of policies that provide employment rights and support childcare for working mothers. These can minimize the negative effects of the constraints on maternal-child time experienced by working mothers, while at the same time contributing to economic growth and social development, of which FLFP and child's health are direct contributors.

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Academic Thesis: Declaration Of Authorship

I, Stephanie Bispo Amaral declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Exploring the links between women's work and child nutritional status in rapidly developing economies: the cases of Brazil and India

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

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Definitions and Abbreviations

BMI	Body mass index
BMIZ	Body mass index for age z score
BRICS	Economic group composed by Brazil, Russia, India, China and South Africa
CEA	Census enumeration area
CFI	Comparative fit index
CNS	Child nutritional status
DHS	Demographic and Health Surveys
EAs	Enumeration areas
FLFP	Female labour force participation
GDP	Gross Domestic Product
HAZ	Height-for-age z score
ICC	Intraclass correlation coefficient
ICLS	International Conference of Labour Statisticians
ILO	International Labour Organization
IWI	International Wealth Index
LBW	Low birth weight
LMIC	Low and middle-income countries
LR	Likelihood ratio
MDG	Millennium Development Goals
PCA	Principal component analysis
PPS	Probability proportional to size
PSM	Propensity Score Matching
PSU	Primary Sampling Unit
RMSEA	Root mean squared error of approximation
SDG	Sustainable Development Goals

Definitions and Abbreviations

SEM	Structural Equation Modelling
SNA	System of National Accounts
SRMR	Standardized root mean squared residual
SSU	Secondary Sampling Unit
SUS	Unified Health System
WAZ	Weight-for-age z score
WHO	World Health Organization
WHZ	Weight-for-height/length z-score

Chapter 1: Introduction

Malnutrition affects many children in low and middle-income countries. It is estimated that at least 165 million children are stunted worldwide, 69 million of whom live in south-central Asia (Onis *et al.*, 2013). Childhood overweight is also becoming increasingly important, particularly in Latin America, where estimates of overweight children and adolescents in the region range from 42.4 to 51.8 million (Onis, 2015).

There has been a concern in the literature about how time constraints generated by female work relate to rates of child malnutrition. The effect of women's multiple roles on child nutrition was studied largely in low-income countries during the 1980s and 1990s (Leslie, 1988; Engle and Pedersen, 1989; Glick and Sahn, 1998) and in high-income countries after 2000 (Chia, 2008; Scholder, 2008; Morrissey, Dunifon and Kalil, 2011). Further research in this area was conducted partly because of new work opportunities for women and rising women's labour force participation, concomitant with increased child malnutrition. Concerns about childcare and appropriate child feeding when the mother was working were driven by the high levels of child mortality and underweight in low-income countries (Leslie, 1988; Koolwal and Van de Walle, 2010), while in high-income countries, the same concern was driven by changes to diet and lifestyle linked to increasing rates of childhood overweight (Scholder, 2008; Fertig, Glomm and Tchernis, 2009).

Previous studies yielded inconsistent findings and the association between maternal work and child nutrition is still not fully understood. Furthermore, the association between maternal work and child nutrition is complex for many reasons. Work is not a permanent state, as a mother of a young child may decide to join or leave work according to her or her children's needs (Leslie, 1988). This decision can also be grounded in culture, religion, household or socioeconomic status (Gaddis and Klasen, 2014; Lechman and Kaur, 2015).

Brazil and India are two emerging countries[1] that have experienced accelerated economic growth

[1] "Emerging countries" is a term used to describe countries based in six criteria: economic growth rate; economic liberalization (market-oriented systems); export growth rate; financial market development; level and velocity of IT development; and political influence. These countries are very heterogeneous, and despite economic development, they are often facing different levels of inequalities in income distribution, education, and health (see OECD, 2011).

since the end of the 1990s, placed together in a group known as BRICS[2] (O'neill, 2001), what is related with new work opportunities for women and changes in female labour force participation (FLFP) (Rendall, 2013). At the same time, the nutrition transition —characterized by large shifts in dietary and physical activity patterns which are reflected in nutritional outcomes— has been unfolding rapidly in these countries (Tzioumis *et al.*, 2016). Such changes represent an interesting context in which to explore the association between maternal work and child nutrition, and an important area of study. The nature of opportunities for female work in a context of high socioeconomic inequality can have different effects on child nutrition than those previously observed in low and high-income countries, and to date, there is a lack of investigation of this relationship in rapidly emerging economies.

Both, female employment and child nutrition are considered key priorities in international development, and were included in the sustainable development goals (SDGs), specifically the second and fifth goals (UN, 2015). The second goal to “end hunger, achieve food security, improve nutrition and promote sustainable agriculture” targets children and their mothers. Specific aims of the second goal are to end all forms of malnutrition by 2030 and prioritise the eradication of stunting in children under five years of age, and to double agricultural productivity and the income of small-scale food producers, particularly for women, while also offering opportunities for non-farm employment. The fifth SDG aims to achieve gender equality and empower all women and girls by offering education to girls and women, freeing women from unpaid work, and developing infra-structure and social protection policies to women (Hawkes and Popkin, 2015).

Understanding the links between female employment and child nutrition in emerging countries can help to identify policies that may decrease the prevalence of malnutrition while providing adequate work environments for women, with both leading to improved economic growth. It also helps countries at earlier stages of development to follow patterns that promote good health and gender equality.

This thesis does not intend to take a position on women’s family-work choices, but to consider the implications of changing economies on female work and child nutrition due to the mother/child relationship within the context of where they live. To this end, this study explores changes in

[2] The BRICS acronym (Brazil, Russia, India, China and South Africa) was created by Jim O’Neil based on projections of Gross Domestic Product (GDP), capital accumulation and productivity growth. The acronym is simply an economic definition to indicate countries that could overtake the concurrent largest economic group (G7) in terms of world GDP growth and trade shares (Wilson, Purushothaman and Goldman, 2003). It does not imply in any governmental or policy category, what is confirmed by the differences in the type of government, speed of development and priorities of investment for each country.

maternal work in Brazil and India through a comparative analysis between and within countries, and investigates the effect of different types of maternal work on child stunting and overweight.

1.1 Research questions

This study uses nationally representative data from Brazil and India on children under five years old and their mothers, covering two periods of time in each country (pre and post BRICS formation), with the following research questions:

1- How is female work characterized in Brazil and India before and after the BRICS formation?
2- What are the factors that differentiate mothers of young children from other women in each country?
3- Are there differences in the types of work of mothers of young children when compared with other women?
4- How the different types of maternal work (e.g. employed/self-employed, occupation) are associated with child linear growth/ child stunting in Brazil and India in the two periods of time?
5- What is the association between maternal work and child nutrition in India when accounting for regional differences and the factors that determine maternal work in each region?
6- Is maternal work associated with child dietary patterns in Brazil that relate to childhood overweight?

1.2 Organization of the Thesis

The thesis is organized into ten chapters.

Chapter 2 provides information on the background of Brazil and India. It describes the political background and economy of these countries, aspects of FLFP and health.

Chapter 3 presents the literature review and conceptual framework for this research. It starts with the theories of FLFP, the implications of increasing women's labour force participation for the household and for children, and, finally, the definition of malnutrition, its causes and consequences. This section presents a general overview of concepts because the two study countries have different backgrounds and contexts.

Chapter 4 states the methodology used in this study, including information on the datasets, variables and analyses used. It discusses differences between datasets and the subsequent impact on the data quality and analyses.

Chapter 5 and chapter 6 are descriptive, focusing on female work, and child nutrition, respectively. Chapter 5 presents comparative analyses on female work between countries and waves, describing the characteristics and changes in work for mothers of young children when compared with other women. Analyses also probe associations between types of work and sociodemographic characteristics to answer questions such as “who are the women who are working”, “what are their types of work”, and “why are they working?” These analyses are important for contextualizing maternal work in each country, and serve to ground the analyses on how types of work are associated with child nutrition.

Chapter 6 provides descriptive analyses of child nutrition, showing the total prevalence of stunting and overweight at each point of time and in each country, and comparing rates for children from working and non-working mothers. This chapter sets the scene for the subsequent chapters, and provides a further version of the conceptual framework for the specific mechanisms behind associations in Brazil and India.

Chapter 7 evaluates the association between maternal work and child stunting in Brazil and India using multilevel regression models. Hypotheses were based on the findings from previous chapters and the conceptual framework describing how the types of work in each country affect the trade-off between maternal earnings and time available for childcare. Univariate and multivariate models with control covariates were estimated, and the results were discussed based on how maternal work, education, and household wealth are related and can influence each other’s effect on child nutrition.

Chapter 8 investigates the association in India by eliminating confounders when matching working and non-working mothers according to their sociodemographic characteristics. This was done only for India due to the high rates of stunting in the country, and previous analyses showing a higher prevalence of working women in poorer socioeconomic status, suggesting that background characteristics could affect both the probability of women entering the labour force and child nutrition. This analysis was implemented considering differences between rural and urban areas, and North and South regions.

Chapter 9 presents results for the association between maternal work and child BMI in Brazil. Structural equation modelling was used to test whether child diet was a mediator of this association. The justifications for this evaluation in Brazil include the increasing rates of overweight in the country and the important social changes experienced after economic growth.

Chapter 10 summarizes the findings of all chapters, and provides a discussion of results, as well as an overall conclusion.

Chapter 2: Background to study

2.1 Introduction

Brazil and India are two of five countries that have stood out due to their rapid economic growth and have been placed together in a group known as BRICS (Wilson, Purushothaman and Goldman, 2003). Brazil and India both have vast populations. India is the second and Brazil is the fifth most populous country in the world, and both countries are considered important for world trade (Stuenkel, 2015). However, there are strong differences in their positions in global politics, interests, and values. As developing countries, they face different levels of internal challenges such as poverty, economic instability, violence, and health inequality (Stuenkel, 2015). For instance, child malnutrition and FLFP, crucial variables for continuous economic growth, differ greatly between the two countries, and will be explored below.

This chapter provides a background of history and economics for each country, highlighting differences in FLFP and child malnutrition.

2.2 Brazil

Brazil is the fifth most populous country in the world with almost 200 million inhabitants and one of the ten largest global economies. Composed of twenty-six states and a federal district, there are 5,563 municipalities within the country (Figure 2.1, (Paim *et al.*, 2011)). Each state has its own government structure, which reports to the federal level. Brazil is a democracy, where voting is universal and compulsory for all literate citizens aged 18-70 years old (Paim *et al.*, 2011).

The country is divided into five broad geographical regions, which differ in demographic, economic, social and cultural characteristics, as well as inequalities, including health conditions. The richer regions are the South and the Southeast. The latter includes 43% of the population and accounts for 56% of gross domestic product (GDP), although it covers only 11% of the territory geographically. The North is among the poorest region of Brazil, containing the Amazon rainforest, and the country's lowest population density, while the Northeast is composed of a very dry area subject to periodic droughts and high socioeconomic inequality (Paim *et al.*, 2011; Victora *et al.*, 2011).

Figure 2.1- Brazil, Brazilian states and capitals

Source: Adapted from IBGE (IBGE, 2008).

The Brazilian population is multi-ethnic, a result of centuries of European domination as well as the enslavement of African migrants. The majority of the population is classified as white (47.7%) and brown colour or mulatto (43.1%). Black people represent 7.6% of the population, while 1.1% are Asian (IBGE, 2011). The indigenous population, considered a minority, is composed by 0.4% of the population, which corresponds almost 900 thousand people from more than 240 tribes, mainly located in the North region of Brazil (IBGE, 2012a).

2.2.1 Political background and economy

Brazil was colonized by Portugal in 1500. In the early colonial period, Brazil served commercial colonial interests, such as exporting food and minerals to Europe. With the use of African slavery for exploitation of the land, agriculture was focused on the production and exports of sugar in the Northeast, and gold and diamond mining in the Southeast (Fausto, 2014).

Other countries in Europe were also attracted by the possibility of improving their market with products from Brazil, which drove a proliferation of illegal markets and led to a rise of land exploitation and businesses set up by people from Spain, France, Holland and England. The mix between different European nations in different parts of Brazil together with natives and African slaves resulted in high levels of miscegenation (Levine, 1999) that persists until today.

The colonial era continued until 1825, when Brazil became independent. Brazil was predominantly an agrarian country after the colonial era, until around 1930 industrialization was stimulated through an authoritarian corporatist state (Fausto, 2014). The following years were marked by the creation of the Ministry of Labour, Industry and Commerce, the establishment of laws to protect workers, minimum wage and union tax by employees, and by the educational reform with the creation of the Ministry of Education and Health (Fausto, 2014).

Industrialization led to rapid urbanization. While 40% of the population lived in urban areas in 1930, this increased to 70% in 1980. Big cities, populated by both wealthier people and those who left rural areas in search of better job opportunities, faced the upsurge of urban slums, social inequality and inflation. Between 1968 and 1974, Brazil experienced high economic growth, when ruled by military leaders. This period, called an “economic miracle” had annual GDP growth rates of 12%, which were not translated in social development. The period was also accompanied of increased external debt, increased inflation, high socioeconomic inequality, decreased the minimum wage, and worsening of conditions for the poor (Napolitano, 2014). At the end of this period, unemployment levels rose, and the transition to democracy came with difficulties along with corruption, privatisation programs, reforms to social security and assistance transfers (van Klaveren *et al.*, 2009).

In 2002, a popular political party took power, choosing a reformist line. The government reviewed labour and judicial legislation, emphasized efforts to eradicate hunger through the Zero Hunger program, and carried out many social programs to benefit the poor, such as cash assistance based on school attendance (Love and Baer, 2009). At the same time, trade policies reflected an internationalist approach, strengthening ties with other developing countries from the BRICS.

These policies stimulated economic growth again at the highest rates in Latin America, around 4.4% yearly. But, from a global perspective, this growth was rather modest, and incomparable in scale to India and China (Wilson, Purushothaman and Goldman, 2003).

2.2.2 Women's empowerment and female labour force participation in Brazil

In the history of Brazilian society, women's prescribed social roles required them to be responsible for household tasks and childcare, but there were no constraints against FLFP. Since colonization by Portugal, it was common for the women to work for family subsistence while men were away exploring mines in another part of the country (Fausto, 2014). With the majority of the population illiterate, the first school for female professional education was created in 1869, initiating discussion of higher education for females (da Silva, 1987).

The introduction of women into factory and industrial work around 1930 was characterized by underprivileged conditions and low wages, but the law protected the women against further exploitation by restricting night shifts and work during the four weeks before childbirth and eight weeks post-partum, and preventing women from being fired due to pregnancy (da Silva, 1987). The updated Constitution of Brazil in 1988 ended legal subordination of women to men, encouraging equality among genders, and prohibiting discrimination against women. Part of this protection extended to family matters, such as a minimum age for marriage, outlawing polygamy, and giving equal rights to the mother and father in the interests of children (Tartuce, 2007). The creation of the Women's Ministry in 2003 secured women's rights in the areas of violence, maternity leave, and sexual harassment (Htun, 2003).

Still, women face many problems in Brazil and gender equality is far from reality. Violence against women is a common problem in Brazil, and although there are laws to protect women, reports of domestic violence are still high, as well as intimate partner violence against women (Campos Guimarães and Sucupira Pedroza, 2015). Although laws protecting women are comprehensive, failure to address crimes within the criminal justice system lead to a gap between legislation and women's experiences (Amnesty International, 2008).

Women represent 53.7% of the population in economically active age groups, and 45.4% of women employed, compared with 54.6% of men (IBGE, 2012b). Although women's employment rate is below men's, the increase in labour force participation has been equal among women and men in the last ten years. Most employed women are between 25 and 49 years old (64.2%), but those aged 50 years or more had the largest increase in labour force participation in the last decade, reflecting the aging population (IBGE, 2012b).

Education is key for the success of women's labour force participation, and the proportion of young women with higher education has been twice that of men (Beltrão and Alves, 2009). In better educated groups, the main types of work done by women are in public administration, followed by trade and the third sector, in which the third sector had the largest increase since the early 2000s (Beltrão and Alves, 2009; IBGE, 2012b). Still, segmentation and wage inequality between genders persists, especially for those with higher education, in which having better schooling does not always guarantee women the same income levels as men (Leone and Baltar, 2006; Agenor and Canuto, 2015).

Women with poorer socioeconomic status also have a high participation in the labour force, but many of these women have few qualifications and lower negotiating power and, therefore, poorer work conditions. The majority of these women work in non-formal jobs or self-employment, and many are domestic workers, such as maids (Leone & Baltar, 2006).

2.2.3 Patterns of disease and access to health

Before 1988, the Brazilian health system was fragmented, driven by two Ministries: the Ministry of Health, responsible for the preventive measures, such as vaccination programmes; and the Ministry of Social Security, responsible for the provision of curative medical services. The Ministry of Social Security covered only those who contributed through payroll taxes, such as those formally employed (Brasil, 2000). The health sector reform was driven by civil society in 1988, rather than by the government, based on the principle of health as a citizen's right and the state's duty, becoming available for all, free of charge (Paim et al, 2011). The unified health system (SUS) was based in three principles, including universality, integration and equity, where services were organized in levels of complexity, with primary and preventive care a top priority (Brasil, 2000).

The main strategy of the SUS is the Family Health Program (PSF). Family health-care teams consisting of a doctor, nurse, auxiliary nurse and four to six community health workers are assigned to specific geographical areas with defined populations of 600 to 1000 families. The team is responsible for coordinating care, working towards integration with diagnostic, specialist and hospital care (Paim *et al.*, 2011). This strategy is associated with higher health care seeking behaviour (93% in 2008) and improvements in health outcomes such as a lower infant mortality rate, higher vaccination coverage and sustainability (Paim *et al.*, 2011). Furthermore, the creation of the National Food and Nutrition Policy in 1999 established measures to monitor changes in child nutritional status, prevent malnutrition, and promote healthy diet and lifestyle among the population (Coutinho, Gentil and Toral, 2008).

Beyond the SUS, other private subsectors are part of the Brazilian health system. The private (for-profit and non-profit) subsector and private health insurance subsector are widely used to avoid the long queues and slow process of the SUS. The public and private components of the system are interconnected, and people can use services in all three subsectors according to the ease of access or ability to pay for the service (Paim *et al.*, 2011).

Improvements in health access, along with investments to decrease poverty had positive effects in the population's behaviour and health. The expansion in women's education, access to health care, better water and sanitation and increased purchasing power led to decreases in children underweight by 50% from 1996 to 2006, from 13.5% to 6.8% (Monteiro *et al.*, 2009). Similarly, according to the latest national estimates, the prevalence of stunting among children under five years dropped from 19.4% in 1989 to 6.0% in 2009. On the other hand, overweight was increasing sharply and reached 7.3% by 2009 (CEBRAP, 2009). Moreover, more than half (56.9%) of the Brazilian adult population were considered overweight, with no differences observed between income levels (IBGE, 2014b).

Currently, Brazil is in control of most vaccine-preventable diseases, HIV/AIDS, and other communicable diseases. However, dengue fever and other infectious diseases associated with a mosquito-transmitted virus are still not controlled, leading to seasonal outbreaks. Nonetheless, the main public health issue facing Brazil today is the increase of non-communicable diseases, such as hypertension, diabetes and coronary heart disease accompanied by the increase in overweight and obesity rates (Victora *et al.*, 2011).

The indigenous population is usually absent from national surveys. This contributes to their continued invisibility in terms of research publications, and public health initiatives at the country level. Therefore, the situation among the indigenous population in Brazil is less acknowledged in the literature. Studies focused on this population suggest they are also going through the nutrition transition as the result of policies and increased market integration in the Amazon region (Piperata *et al.*, 2011; Coimbra *et al.*, 2013). The coexistence of over and undernutrition among indigenous people is more challenging when compared with the general population. The high rates of food insecurity result in higher prevalence of stunting, anaemia and infectious diseases than non-indigenous people (Cardoso, Coimbra and Werneck, 2013; Horta *et al.*, 2013; Carlos Jr, 2014). At the same time, despite the high practice of subsistence agriculture, there has been a significant increase in purchased products, and in the consumption of refined carbohydrate, and processed fatty-meat over time (Piperata *et al.*, 2011), associated with increased rates of overweight, obesity and chronic diseases (Coimbra *et al.*, 2013). Studies also point to a higher mortality rate due to chronic diseases when compared with the general Brazilian population (Rocha *et al.*, 2011).

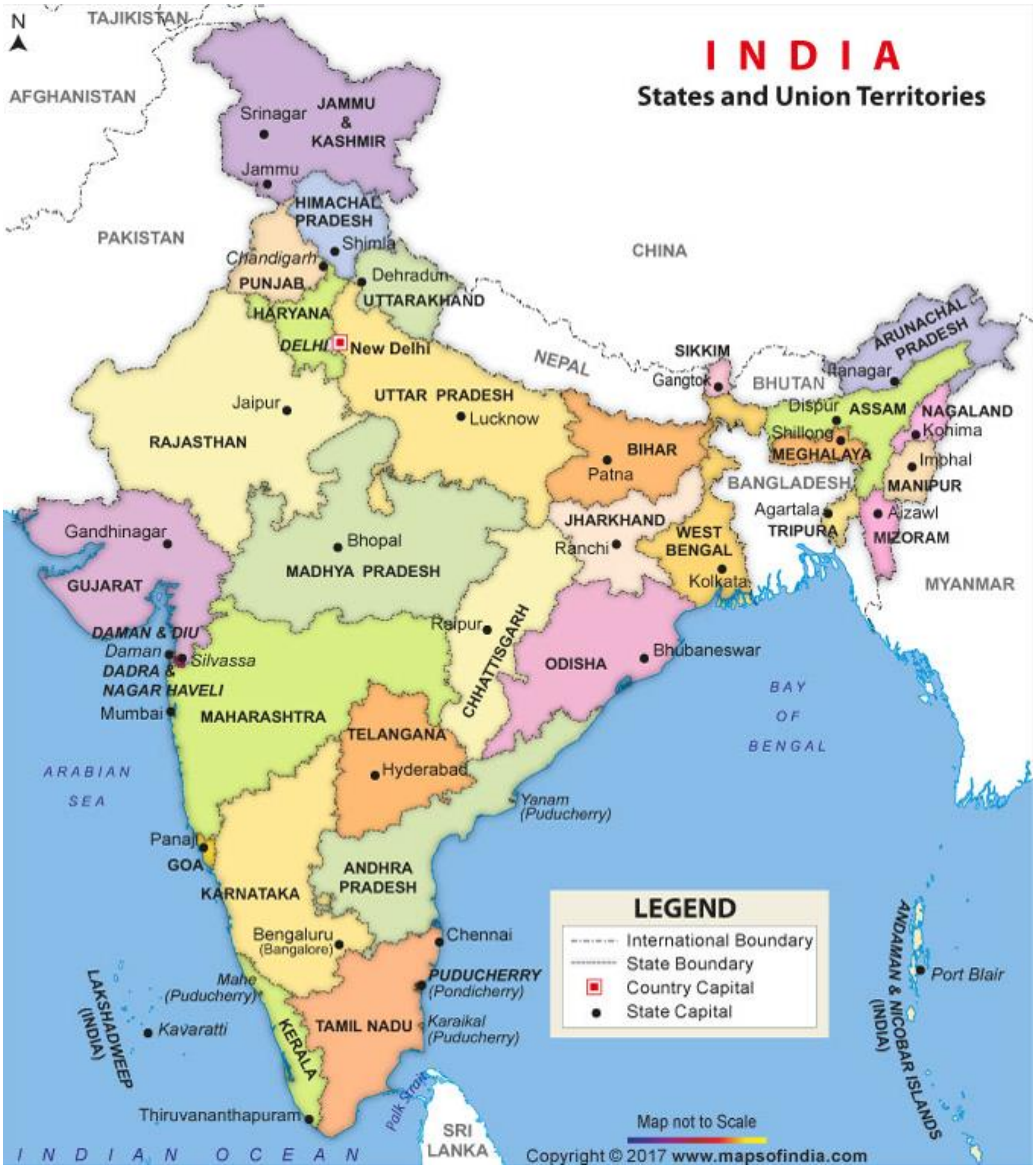
2.3 India

India is the second most populous country in the world, with more than a billion inhabitants, and the seventh-largest country by geographical area. India's economy is the fifth largest economy of the world through enhanced industry and the development of innovative technology (Paul *et al.*, 2011). Its political system is based on parliamentary democracy and an active civil society. The Prime Minister, appointed by the president, is the head of government and has the majority of executive power. There is a division of power between the central and state governments, but the union government has considerable influence on states (van Klaveren *et al.*, 2010).

The country has 29 states and seven union territories[3], with 601 districts within states and union territories, which are subdivided into townships containing villages (Figure 2.2). There are notable variations in language, political structures, demography, and policies among states, where states in the South are reported as more socially advanced than other states in India, with better access to health care and education (Navaneetham and Dharmalingam, 2002).

[3] A union territory is a type of administrative division in India ruled directly by the central government.

Figure 2.2- Map of India, States and Union Territories



Source: (Maps of India, 2017)

The society is divided according to religion and castes[4]. The major religion in the country is Hindu (80.5%), followed by Muslims, Christians and other religions that are considered minorities. Social problems include domestic violence, child marriage and child labour.

2.3.1 Political background and economy

India has a very ancient culture, known by its vast empires. The ancient history of India dates from 2500 BC, followed by the Medieval Indian period. During the 16th century, Europeans established trading posts and colonies in the country and in 1757, the British established political power in India, which would last for two centuries. As a vast British colony, by the 19th century, India was placed under direct rule of the British Crown. In the 20th century, Mahatma Gandhi led the population in the movement for independence, which India gained in 1947 (van Klaveren *et al.*, 2010).

Post-independence, India had a rudimentary industrial economy, as well as high levels of poverty and social disagreements among casts and territorial boundaries. In the years after independence, provinces were reorganized in states based on shared linguistic and ethnic demographics, and democracy was established with the election of a prime-minister. The first government invested in the nationalization of heavy industries such as steel, electricity, mining and aviation, while the second government in the sixties moved economic policies towards agricultural development, and the Green Revolution. Further economic reforms encouraged science and technology, resulting in major expansion of IT and the software industry (van Klaveren et al, 2010).

During the 1990s, governments eased restrictions on investments by large companies, and reduced the number of industries reserved for the public sector. Plans to privatise enterprises were implemented, and India's economy was opened to competition. Consequently, India experienced major economic growth, with GDP increases from 6.5% in the 1990s to 7.7% after 2000. Yet poverty declined only modestly, showing that growth did not benefit the poor, and

[4] Caste refers to a complex form of social organization in Hindu societies, based on a status conferred at birth according to the family. Individuals in the same caste often share similar cultural and religious values and practises, permanently separated from other castes through endogamy, and due to custom and laws. Castes also identify themselves functionally, with occupations designed to specific castes that define them as hierarchal. These should not be confused with ethnic, territorial or religious groups (Cox, 1944; Majumder, 2001).

Scheduled castes are a large minority of the population considered socially backward by others. They often suffer discrimination from higher caste groups, associated with manual labour and poverty (Jensenius, 2015).

there were no major improvements in employment opportunities (van Klaveren et al, 2010). A lack of skills and education is still a major obstacle to improvements in work opportunities and continuous economic growth (van Klaveren et al, 2010).

2.3.2 Women's empowerment and female labour force participation - India

Levels and patterns of female autonomy in India vary considerably by region (Alfano, Arulampalam and Kambhampati, 2011; Munro *et al.*, 2014), where cultural traditions and religion (Jejeebhoy and Sathar, 2001; León, 2011) have major importance in these differences. Women are also at a disadvantage with regard to inheritance and, although the national law abolished traditions that enable only men to inherit land from parents, several states allow exclusion of widows and daughters from land inheritance. In the South, more women have equal access to land, property, loans and credit (Roy, 2015). On the contrary, in the North, women's access to bank loans is limited as is freedom of movement (Kishor and Gupta, 2004; Dixon-Mueller, 2013).

Early marriage remains a problem in the country, violating the law that sets the minimum age of marriage at 18. Polygamy is legal for Muslim men, and for Hindu men to a lesser extent. Divorce is legal, but divorced women are stigmatised and therefore, rates of divorce are low (MacKinnon, 2006). The importance of marriage contributes to the high rates of domestic violence, which is thought to be greatly underreported because of beliefs that the husband is justified to beat his wife (Martin *et al.*, 2002; Kishor and Gupta, 2009). Although the Constitution of India prohibits discrimination and delineates punishment for perpetrators of violence against women, it has not been successful in eliminating domestic violence (Chaudhary, 2013).

The government has decreed many laws to protect women's rights. The Ministry of Women and Child Development is responsible for female employment and, within the Ministry of Labour and Employment, there is a separate department dealing with the implementation of the Equal Remuneration Act. However, as in other areas, these laws have not been sufficient to guarantee good conditions for women in the labour force (Budhwar, Saini and Bhatnagar, 2005).

The Indian economy reports very low rates of FLFP, estimated in 2011 as 33% overall. This is well below the global average of around 50 percent and, contrary to most growing economies, FLFP in India is declining across time (Das *et al.*, 2015). Rates of FLFP differ by geographic region, with the South having more women in the labour force than the North, but a high proportion of women working in both regions do so in the informal sector (Das *et al.*, 2015). The services sector has particularly increased in urban areas over the past two decades, but this has not been accompanied by increased rates of FLFP, which have stagnated at around 18% since 1980 (Klasen and Pieters, 2015). The rise in household income due to the improvement in work conditions for men is a proposed explanation for the withdraw of women from the work force, when subject to social constraints against female work (Bhalla and Kaur, 2011; Klasen and Pieters, 2015). Furthermore, employment in sectors suitable for educated women grew less than the supply of educated workers, resulting in lower FLFP rate among educated women (Das *et al.*, 2015).

Disparities in labour force participation between genders are very high in India. In urban areas, this gap has on average 60 percentage points, and in rural areas, this gap is around 45 percentage points due to the higher rates of agricultural work by women in rural areas. Such a gap has remained the same since the 1990s, with no improvements in gender inequality (Das *et al.*, 2015). This was corroborated by the gender gap in education, especially around higher education levels. A UNESCO report in 2010 concluded that the discrepancy in access to education among wealth groups in India is among the largest in the world, reinforced by the regional disparities (UNESCO, 2010).

2.3.3 Patterns of disease and access to health

India has had a national plan of universal health coverage since 1946, when health policies and priorities were outlined in Five Year Plans. In 1983, with the Alma Ata Declaration, the country's vision was to improve primary health care, descentralize the health system, improve community participation, and expand the private sector. In practice, implementation of these policies have been a challenge, and progression has not been as desired (Balarajan, Selvaraj and Subramanian, 2011).

The management of the health system is shared between the federal and state governments, where policies and control of outbreaks are the responsibility of the federal government, while health care and personnel training are provided by the state (John *et al.*, 2011). However, there is low public financing for health. At the national level, India's public per capita expenditure on health was around 1.1% of the GDP, which was much lower than most countries with a comparable per capita GDP. Private health spending was much higher than public spending, and public health did not have adequate functional infrastructure for the prevention of diseases (Deolalikar and Center, 2008; John *et al.*, 2011). Furthermore, because of a lack of a Department of Public Health, the Government uses vertical programmes for disease control, such as the Revised National Tuberculosis Control Programme, or Universal Immunisation Programme, wherein each program has its own central administration and is not integrated with others. This method is inefficient and very expensive to extend to address other important diseases (John *et al.*, 2011).

The access to health care is an issue for vulnerable individuals and those living in poorer areas. Scheduled tribes and castes have lower access to preventive services, such as immunization, and health coverage is lower in rural areas than in urban areas. The number of beds in government hospitals was twice as high in urban areas compared with rural areas, and the development of the private sector in urban areas has led to unequal geographical distribution of services (Deolalikar and Center, 2008). Differences in access to health care also exist between socioeconomic groups, as rich individuals are more likely to be admitted to hospital and more likely to access preventive services than poorer people (Balarajan et al., 2011). The difference in access to health care services and low investments in public health are characteristics of impoverishment and increase inequalities due to proportionally higher out-of-pocket spending on health care among the poor.

The existence of popular beliefs that associate the origins of diseases with supernatural causes, and microbial pathogens, together with the popular understading that individuals are responsible for their own health, contribute to the neglect of public health by political leaders (John *et al.*, 2011). Moreover, basic requirements for preventing infectiousdisease are not met among some rural and urban poor communities, where open-field defecation is widespread (John et al., 2011).

India has achieved success against smallpox, and some infectious disease, but diarrhoea, tuberculosis, and measles have a great share in the burden of infectious disease, while rates of malnutrition are among the highest in the world (John *et al.*, 2011; Paul *et al.*, 2011). Overall, 57 million –or more than a third – of the world’s 146 million undernourished children live in India. The improvement of nutritional indicators appears to be slow, relative to what might be expected in the light of international experience and of India’s recent high rates of economic growth (Deaton and Drèze, 2009). The prevalence of children under five classified as stunted had decreased by approximately 20% over 10 years, going from 48.0% in 2005-06 to 38.4% in 2015-16 (IIPS, 2017), while the prevalence of underweight (around 20.0%) and wasting (around 7.0%) had similar values over the same period. Overweight was not an issue among children under five, and no national estimates are provided. However, it has increased sharply in adults, going from 12.6% in 2006-07 to 20.7% in 2015-16 (IIPS, 2017), while the prevalence of underweight among adult women remained high (22.9%), as evidence of the double burden of malnutrition.

2.4 The different context in Brazil and India

Stuenkel (2015) commented on how economists reacted to the creation of the BRICS. He noted that most observers judged the group as fragile because of the differences between them. This review shows that judgments by observers are coherent, by showing how different two of the BRICS countries are in their history, culture, health organization, and major health problems. Differences in rates of child and adult malnutrition, FLFP, female literacy and urban residence call attention to the different context observed in these countries (Table 2.1).

Table 2.1-Comparative data for Brazil and India

Variables	Brazil	India	Source
GDP growth (annual %)	-3.8 (2015)	7.10 (2016)	(World Bank, 2018)
Population (number)	207,652	1,324,171	(World Bank, 2018)
Children 0-5 (%)			
Stunting	7.1	38.4	Brazil (IBGE, 2010b),
Underweight	2.2	22.9	India (IIPS, 2017)
Overweight	7.3	NR	
Adult(%)			
Underweight	2.7	22.9	Brazil (IBGE, 2014a)
Overweight	56.9	20.7	India (IIPS, 2017)
Female characteristics(%)			
FLFP (15-49 years old)	53.7	33.0	Brazil (IBGE, 2012b)
Literacy rate (15 and above)	91.6	59.3	India (Das *et al.*, 2015)
Urban residence*(%)* [a]	86.0	33.0	(World Bank, 2018)

NR= not reported by national figures.

It is acknowledged by the literature that avoidable health problems are strongly determined by the circumstances in which people live, work, and age (Marmot, 2005). Such circumstances are called “social determinants of health”, and are determined by the macro context as well as the local environment where people are living in. It is common to observe a gradient of morbidity and mortality according to poverty, social exclusion, and lack of education that explains health inequalities between and within countries. Improvements in living and working conditions, as well as health care can lead to dramatic reductions in global inequalities in health (Marmot, 2007; Marmot *et al.*, 2008).

In the study of maternal work and child nutrition, the context needs to be considered, as it determines the conditions of female work and the changes in child nutrition. For instance, economic development, access to education, cultural constraints against female work, policies that protect workers and other factors (Marmot, 2007) determine the conditions in the labour market and the nature of employment for women. Examining the context may also provide insight on whether maternal work brings the opportunity for improving living conditions or not.

In the same way, the drivers of living conditions, the access to health care, education and direct policies can influence child nutrition directly or indirectly. Furthermore, the changes in the environment that promote increased consumption of fats, energy-dense foods and sedentary habits, show that the context influences not only the environment and the opportunities, but also behaviours that lead to health inequities. The nutrition transition has led many countries to the double burden of malnutrition, where under-nutrition and over-nutrition coexist (Marmot *et al.*, 2008; Popkin, Adair and Ng, 2012).

The importance of the context for the topic of study in this thesis requires the definition of context at macro and micro levels. The macro context can be defined as the macro-level effects that shape the society, such as country's development, the economy, social policies, politics, culture, health systems and others. Contextual differences can lead to great inequality not only between countries, but also within countries along several axes of social stratification, such as socioeconomic, political, ethnic, and cultural strata, determining who is marginalized or in low status within a particular society (Marmot, 2007). The micro-level effects are characterized by the local environment, or the background characteristics where someone lives, such as the household, communities and neighbourhoods that define living conditions, physical and psychological well-being (Marmot *et al.*, 2008).

While Brazil and India have many differences in the macro context (referred to as context further in the thesis), the culture is also an important aspect to be considered. The culture or traditions in India such as the caste system, religion and constraints against female work are important contributors to differences in female literacy, FLFP, and child nutrition when compared with Brazil or among states within the country (Marmot, 2007). The Indian political system, where states have more autonomy, lead to major differences in educational levels and female empowerment between states (Navaneetham and Dharmalingam, 2002). At the local enviroment, the caste is often related to socioeconomic status and empowerment, and religion tends to influence women's decision-making in the household.

In Brazil, cultural norms do not have a similar effect on FLFP and education as in India, and states have lower autonomy when subject to the federal government. The social development in Brazil has led to important changes in access to food and behaviours, leading to a faster nutrition transition in the country. This has contributed to decreases in rates of child undernutrition, and increases in rates of childhood obesity, which is considered an important public health concern.

At the local environment, Brazil still faces high socioeconomic inequality, and high number of people living in slums, where a gradient of morbidity can still be observed.

The differences in the FLFP and child malnutrition rates in two emerging countries grouped together in the BRICS, call for a better understanding of the differences in work provided for women and how these differences affect child nutrition, given each country’s context. The next chapter provides the literature review about these associations applying international figures to emerging countries.

Chapter 3: Literature Review

3.1 Introduction

This chapter reviews the literature on FLFP [5], child nutrition and the effects of maternal work on child nutrition. It starts by discussing the theories behind increases in FLFP that consider not only the country's development, but also the reasons behind female work, particularly when women become mothers. Such theories are important for further discussions of changes in FLFP in Brazil and India.

The chapter follows by discussing the changes in household dynamics when the mother works, the conflicts generated by the dual role of women as mothers and workers, and the importance of family structure for maintaining child's well-being. The third section focuses on previous studies exploring the association between maternal work and child nutrition, describing possible mechanisms for these associations. Given that most of the literature is focused on low and high-income countries, each context is discussed separately in order to support the understanding of this association in emerging countries.

Last, this chapter focuses on the definition, prevalence, determinants and consequences of malnutrition. Attention is given to the UNICEF conceptual framework on the causes of child malnutrition (UNICEF, 1998) and the framework developed for this study.

[5] "Work" is defined by any activity performed to produce goods or services for use by others or for own use (paid or unpaid work). It excludes domestic work in someone's own household, such as cooking, cleaning, or caring for children or elderly members of the household, and excludes producing a non-marketed service. More specifically, to be considered employment, the activity must be included in the System of National Accounts (SNA) (ICLS, 2013).
"Labour force participation includes those who are employed in SNA activities, and those unemployed but willing to work and who are actively looking for a job; that is, it refers to availability and participation in the economy (Gaddis and Klasen, 2014).
This study is interested only in women who were working at the time of interview and not those who are unemployed and actively seeking a job, and hence, the term female labour force participation (FLFP), which includes women looking for work, does not apply to the population of study. Still, the term "FLFP" is often used throughout the thesis because it is the most widely used term when referring to economic theories and national estimations of female work.

3.2 Development and female labour force participation

Over the last century, FLFP has increased globally, starting with high-income countries, and the role of women within the family has changed in many places. The work-life balance among women has generated academic interest in choices of work, changes in household dynamics attributed to women's work, and differences of work according to gender. Various researchers have studied women's FLFP in different countries and contexts, suggesting that economic development is related to women's participation in the economy, and female work affects and is affected by household structure (Seguino, 2000; Klasen, 2002; Cavalcanti and Tavares, 2007).

Studies are grounded in two main theoretical frameworks. The first, proposed by Sinha (1965) and developed by Boserup (1970) and Goldin (1994), suggested that FLFP changes according to a country's development. The second theory developed by Becker (1965) linked fertility decisions inside the household with female wage and family income. Both theories are discussed below.

3.2.1 Sinha's U-shape feminization hypothesis

In the sixties, Sinha (1965) suggested that female labour force and the level of economic growth could be described by a long term U-shaped relationship. This hypothesis was further developed by a substantial body of literature, from which Boserup (1970) and Goldin (1994) are highlighted for complementing the theory after observing changes in developed countries. Boserup (1970) explored differences when families start to migrate from the rural and agricultural sector to the industrial sector in urban areas, and Goldin (1994) explored increases on FLFP according to women's education.

The U-shape feminization hypothesis assumes that while men's participation in work activities is stable, women's participation in the labour force tends to follow a U-shape according to a country's level of development, or economic growth, in which the extremes - low development and high development - have higher rates of women who work. Initially, when the income level is low and the agricultural sector dominates economy, FLFP is high due to the necessity of women working to provide for the family unit. At this stage, fertility rate is generally high, and women are mainly involved in unpaid activities for her and her family's subsistence, such as in family farms, or household enterprises, combining at the same time her work with childcare, while men work outside home for money (Gaddis and Klasen, 2014). As the economy improves, there is a shift toward industrial production and formal sector-based economic activities, which makes the involvement of females in economic activities harder, especially for married women with children.

There is a need for a greater amount of time in employment to be spent outside the home, which can be difficult to reconcile with childcare. As a result, and coupled with a low level of education, FLFP decreases. This depressive effect on FLFP is intensified in places where heavy manual labour is required, for example mining and construction, and in places where sociocultural restrictions creates a social stigma against women working outside the home (Boserup, 1970).

With the expansion of education among females, new employment opportunities and decreased stigmatization from women working outside the home, FLFP rises again as well as the value of women's time in the labour market (Goldin, 1994; Gaddis and Klasen, 2014; Das *et al.*, 2015). Later studies link this hypothesis with the inverted-U relationship between population growth and development, suggesting that because children require intensive time from women, as FLFP grows, fertility tends to decline (Lagerlöf, 2003).

The case of the United States is an example of this theory, where changes in FLFP during the so-called quiet revolution[6], followed a U-shape curve. Although women started to enter the labour force in unfair and poor work conditions from 1920, it was only in 1950 that women were seen as educated and skilled enough to do certain jobs, which were previously only available to men. Better education not only allowed women to have better work opportunities, but also allowed women the option of having a career for life satisfaction purposes. This transformation continued with higher attendance and graduation rates in the 1970s and 1980s (Goldin, 2006).

The U-shape feminization hypothesis was broadly accepted by economists, but has been criticized on the grounds that the proposed shift in FLFP would not be straightforward when considering the cultural aspects of a country, or if the growing sector in the economy was not suitable for women (Tam, 2011; Gaddis and Klasen, 2014; Lechman and Kaur, 2015). In fact, the feminization U-hypothesis is based on economic development accompanied by profound structural changes. Such changes are not linearly associated with increases in GDP, and GDP cannot always measure these economic changes. Instead, countries undergo different types and speeds of structural changes that are more determined by the initial conditions of economic development, as well as factor endowments and historical contingencies of each country (Gaddis and Klasen, 2014).

For instance, factors that can delay or anticipate FLFP during country's economic growth are religion and culture (Weber, 1905), war or crises (Fernández, Fogli and Olivetti, 2004) and

[6] Changes in FLFP in the United States occurred slowly in four distinct phases, in which three were evolutionary leading to the revolutionary phase. The slow process was named "the quiet revolution", going from 1920 to 1970. Goldin (2006) explains in detail each phase of the revolution, which follows a similar pattern to the U-shape feminization hypothesis.

ideologies such as socialism (Brainerd, 2000). Religion and culture are particularly important for Brazil and India, creating very different contexts in these two countries.

Weber (1905) was the first to identify and discuss how religion could influence social change. He suggested that while Protestantism and capitalism were positively associated with increased FLFP, Hinduism and Islam were not supportive of this. Brazil's major religion is Christianity, both Catholicism and Protestantism, suggesting lower constraints to FLFP. Furthermore, as previously discussed in section 2.2.2, the Brazilian history and culture is more supportive of the participation of women in the labour force, and better levels of female education provide women with more opportunities in the labour market. On the contrary, India's population is mostly Hindu and Muslim, and the country has many regional differences in terms of gender inequality and women's autonomy (Mishra, 2004). Some states of India are typically patriarchal, decreasing women's decision-making power, which generates a more stigmatised environment towards women's work (Jejeebhoy and Sathar, 2001; Munro *et al.*, 2014)

3.2.2 Becker's theory on female labour force participation and fertility

Becker (1960) was the first to analyse families through an economic framework. Assuming that each family has perfect control over the number of children and space between births, Becker presented a child as a consumer durable, in which the quality of a child was directly related to the amount of money spent on them. Later, Becker (1965) put forward the theory of allocation of time, in which he said childcare is a time-intensive activity that is not productive in terms of earnings and, therefore, increases in female wages would have a positive effect on work and negative effect on the demand for children. Willis (1973) then, developed a new approach to the economic theory of fertility behaviour, suggesting that the decision to enter the labour force depends on whether wages from work exceed women's monetary value. If wages are less than the lower limit of her marginal productivity at home (her value of home time), the mother will not work, and if wages are within the limit, the decision to work is more likely to happen. Both theories –Becker's and Willis' - are only valid under the assumption that all families have identical tastes and consumption, and all women have an identical earnings function and do not have accidental births (Willis, 1973).

Since these theories were proposed, studies have investigated and found a negative association between fertility and FLFP in the United States (Lehrer and Nerlove, 1986; Brewster and Padavic, 2000); and developed countries (Brewster and Rindfuss, 2000). In Europe, highly educated women were more likely to work and have a career, have higher wages, delay first birth and have lower fertility rate than women with little education. Additionally, they had less time available for childcare (Gutiérrez-Domènech, 2008; Angeles Davia and Legazpe, 2013).

Although these theories have worked well to describe changes in developed countries, it is more complex to apply such theories to low and middle-income countries for two reasons. Firstly, low and middle-income countries are at different stages of development and in places where female education is not a priority, women's time is still of low value, even though these countries can have high rates of FLFP due to the need for women to work for household supply (Handler and Hasenfeld, 1997; Srivastava and Srivastava, 2010). Secondly, in some countries, especially in Asia, women face constraints to work from society, which can deter women from choosing to work even when they are highly educated (Das *et al.*, 2015).

3.2.3 FLFP and household dynamics

While the theories above describe the associations between FLFP, increased economic growth, and decreased fertility, they do not account for the implications of changes in FLFP for women's life and the household. Changes in FLFP occurred slowly in developed countries, but have happened much more quickly in emerging countries, with repercussions in women's life, role and household dynamics[7].

To start, defining the term 'role' is important. Role is defined as an expected pattern or behaviour in people's minds (Ilgen and Hollenbeck, 1991). Traditional gender roles prescribe different tasks for women and for men, where men are expected to work outside home, and family responsibilities and home maintenance fall on women (Gutek, Nakamura and Nieva, 1981).

In societies where women have less decision-making power, such as in the Asian context, women's work outside the home has been documented in the literature as a way to increase their domestic decision-making power and control over household resources (Acharya and Bennett, 1983). One of theories explaining this suggests that women's work improves her bargaining power with her husband or in-laws when she generates independent income from work (Manser and Brown, 1980; McElroy and Horney, 1981; Basu, 2006). The same does not

[7] Households and family do not always have the same meaning. Family consists of two or more people who are related by birth, marriage, adoption, or blood. One or more people occupying the same housing unit, regardless of whether they are related, compose a household.
This section considers that, maternal work can affect household dynamics when involving other residents that would care or share the responsibility for the child. Although this is more likely to happen among the family, it is not exclusive to families.

happen, however, when women work for the family or do non-paid jobs (Anderson and Eswaran, 2009).

In societies where women are allowed or encouraged to work, the conflict between work and the family role can be a challenge for women. For mothers, especially mothers of young children, competition between roles is inevitable and one role can gain preference at the expense of the other and generate a work-family conflict (Lobel, 1991; Byron, 2005). This conflict can be detrimental to the woman, and for those dependent on her, for example, a child, when the mother has to split her time between work and child feeding and care. In this case, adequate childcare depends on family structure and the availability of other people to share the caring responsibilities. But regardless of the availability of a substitute carer, the entrance of the mother into the labour force is seen to lead to changes in the household dynamics (Craig and Bittman, 2008).

The first change in the household when women start to work is the lack of time for household activities or caregiving (Sayer, 2005; Craig and Bittman, 2008). The scale of this change depends on the amount of work, for instance, hours at work, or whether work has to be done on weekends and the job demands, or the impact it has on stress, psychological unavailability to family members and energy depletion (Nichols and Roux, 2004). As the type of work can affect the amount of time with family, the opposite is also true. Work can be affected by family demands, as women are more likely to be absent from work due to caregiving demands compared with men (Kossek and Ozeki, 1998; Byron, 2005).

The family structure can influence how female work affects the household. When the spouse works long hours and cannot assist in household tasks or childcare duties, it may be harder for women to coordinate their work schedules and household/childcare duties (Voydanoff, 1988; Craig and Bittman, 2008). Single parents face greater challenges to balance work and finding time to care for their children, while non-nuclear families can draw on familial care on a day-to-day or emergency basis. Non-family paid care is available regardless of family structure, but it depends on whether the family can afford it (Kossek, Noe and DeMarr, 1999; Liu, 2015). The total number of children and number of young children also increase work/family conflict, what is particularly important in the child’s first years of life, when the child needs assistance in all physical care (Kossek and Ozeki, 1998).

Some employers offer assistance to employees to encourage their commitment to work, such as access to a childcare centre, or flexible hours of work. Otherwise, wages from work need to be enough to cover the extra costs of substituted childcare and/or domestic workers. Where policies to support mothers as workers and caregivers are not available, women may leave work or there may be harmful effects on the family, the woman, and the child (Kossek et al., 1999).

The second way maternal work affects the household is through income. Women's work can increase household access to basic needs, goods, services and luxuries. Improvements in household wealth can be beneficial for children in the household, compensating for the absence of the mother (Bianchi, 2011). The next section focuses on the literature on maternal work and child nutrition, where the effects of maternal time and income from work on child's nutrition is further discussed.

3.3 Maternal work and child nutritional status (CNS)

The study of female employment and CNS is not new. Indeed, there have been two periods of research into this topic. The first era focused on the links between female work and CNS in low-income countries and was mostly conducted throughout the 1980s. The second focused on high-income countries and was conducted after 2000.

The first era of studies was driven by concern about the social and economic roles of women in low-income countries. At this time, many low-income countries started to experience urbanization, industrialization, and changing economies, leading to more women working away from home as well as a greater proportion of females becoming heads of households (Leslie, 1988). The worldwide economic recession in late 1970s, and the need to contribute to the economic welfare of the household accelerated this process, and small and slow changes occurred in societies in terms of women becoming educated and greater participation in the labour force (Leslie, 1988; Ukwuani and Suchindran, 2003). At the same time, due to the high rates of child mortality, and the importance of mothers in childcare, public health studies emerged to determine how maternal work affected child health and development (Leslie, 1988).

A number of studies found that in low-income countries, mothers' work was positively associated with nutritional outcomes for the child due to her being paid in cash or in-kind. The main argument was that maternal earnings improved the access to quality food for the child (Tucker, 1989; Engle, 1993), resulting in better anthropometric indices (Leslie, 1988; Engle, 1993; Lamontagne, Engle and Zeitlin, 1998). Other studies did not find this association, concluding that better income was not enough to prevent the child from worsening nutritional status due to other problems related to the maternal time constraint, such as inappropriate feeding and poor childcare (Abbi *et al.*, 1991; Toyama *et al.*, 2001; Ukwuani and Suchindran, 2003). The inconsistent findings come from the fact that most studies considered work as a dichotomous variable (working/not working), not taking into consideration the different types of work and how these types of work reflected on maternal time and income. Furthermore, the context into which mother and child are introduced, and the potential confounding variables, such as mother's education, play a role in this association, and should have been considered in previous studies (Leslie, 1988; Engle, 1993).

The second era of studies happened at the end of 1990s and after 2000, when rates of overweight among children and adults increased in high-income countries, raising concern about the association between CNS and female work. This topic was mainly studied in the United States, Canada, the United Kingdom, and Australia, with the hypothesis that the absence of the mother from the household in this context would be associated with the increased consumption of unhealthy food and sedentary habits, leading to child weight gain or higher BMI (Chia, 2008; Scholder, 2008; Morrissey, Dunifon and Kalil, 2011). Most of the studies focused on the number of hours the mother spent at work and the prevalence of overweight. These findings have been consistent, showing a positive effect of working hours on weight gain and that more hours spent at work increased the likelihood of the child being overweight (Anderson, Butcher and Levine, 2003; Hawkins, Cole and Law, 2008).

The above shows that in both contexts, mother's participation in the labour force generates a trade-off between the income gains associated with maternal employment, and the costs of the reduced time of the mother in childcare when at work. This is illustrated in the proposed framework for this study (Figure 3.1), where maternal work can affect and be affected by economic growth, and child nutritional status can be viewed as a combined outcome of income – related to feeding practices, household conditions and childcare – and time, an important determinant of food production, preparation and feeding, and adult care. Therefore, the effect of maternal participation in the labour force on child nutrition depends on the amount of income/in-kind production and how much these compensate for the lack of maternal time.

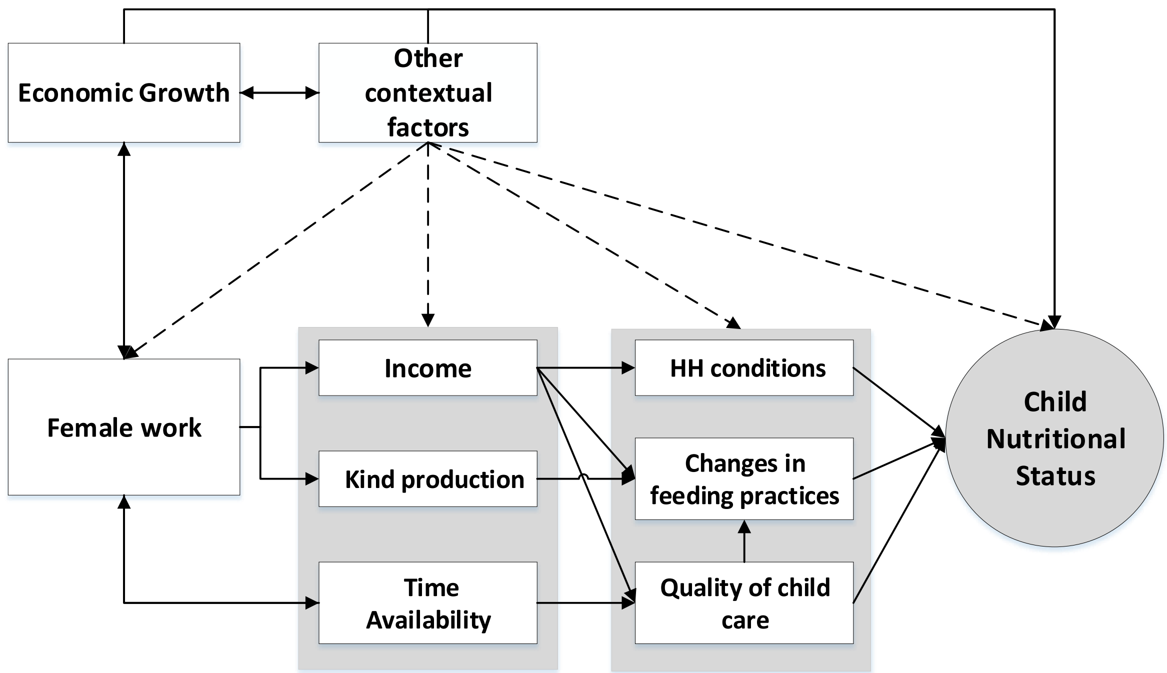
Education and female autonomy play an important part on how income affects child nutrition. While economic empowerment through work and education are components of autonomy (Imai et al, 2014; Anderson and Eswaran, 2009), the control of their earnings is a necessary condition for the use of maternal income for the benefit of the child. The literature suggests that women are more likely to invest in their children's well-being and in the household when given access to financial resources (Vyas and Watts, 2009; Dixon-Mueller, 2013). This is particularly important in places where social and cultural gender-roles restrict women's decisions and the money earned from work is handed over to the women's husbands or to someone in a superior hierarchy in the household (Mencher, 1988; Kibria, 1995).

Macro variables such as country's development, culture, policies and investments in nutrition determine the context around mother and child, affecting the trade-off generated by maternal work (Popkin and Solon, 1976). For instance, children living in an environment that promote better conditions for child growth may be less affected by reduced maternal time for childcare. Oppositely, those living in societies that restrict women's work and decisions suggest that the trade-off is different from places where women can work freely. The micro context can also influence the trade-off, particularly when taking into consideration the income of the spouse or other members of the household that can induce changes in household conditions, and time availability of other family members for childcare.

This framework does not differentiate between types of work, assuming that independently of type of maternal work, the positive or negative effects on child nutrition will come from the balance between generated income and quality of childcare. Chapters six, seven and eight examine these assumptions closely according to different types of work in each country.

The next section discusses each component of this trade-off separately and in detail.

Figure 3.1- Conceptual framework for the study of the association between maternal work and child nutritional status.



3.3.1 Income and CNS

In situations of poverty, maternal work can be seen as a chance to contribute to income and increase expenditure in the household. Furthermore, the argument that money coming from mothers was more important for child well-being than father's earnings has been made in many studies (Blumberg, 1988; Engle, 1993; Lamontagne, Engle and Zeitlin, 1998). This arises from the assumption that women are more likely to be concerned about family needs, and invest money in a better diet, clothes for their children, medication, and children's education (Blumberg, 1988), alongside the idea that earnings from work increases women's decision-making about how to spend the money (Acharya and Bennett, 1983; Engle, 1993).

For instance, a large Brazilian study conducted in 1975 using income from both parents found about 3% increase in food expenditure when additional income came from the women, compared with only 0.6% when it came from the father (Thomas, 1997). The increased income led to higher per capita consumption of both energy and protein, and the marginal effect of additional income from women was significantly larger than that for men. The study also found a higher proportion of maternal income being spent on health and education compared to men. Similar findings were reported in studies in a sample of 20 villages in the South of India (Blumberg, 1988). Although women earned less than men, around 90% of their earnings was invested in the household and family sustenance, while men's contribution was around 70% due to expenses on leisure activities.

Other studies, while not comparing male and female earnings, have shown associations between maternal work and improvements in both child and household diet, which are of particular importance for child nutritional status (Tucker, 1989; Engle and Nieves, 1993). Popkin and Solon (1976) looked at the effect of maternal wages on the welfare of 1,715 children in the Philippines. After controlling for standard economic determinants of food expenditure, mother's work was associated with an increase in weekly food expenditure of 1-5%. The study also found that working mothers had a positive effect on energy and protein intake for their children. However, in poorer and middle household income quartiles this was accompanied by micronutrient deficiency, explained by the low consumption of vegetables and the fact that these foods required more time to prepare, or extra assistance in childcare. Children in poorer and middle-income households were mostly fed with corn porridge or another staple, while children from higher socioeconomic status households experienced increased energy, protein and micronutrient intake when mothers were working (Popkin and Solon, 1976). This finding suggests the effect of income from maternal work on child's diet and nutrition varies according to background characteristics of the family, leading to different results in different socioeconomic environments.

Further studies have found maternal income from work to be associated with improvement in child nutritional status. For instance, studies in Guatemala[8] (Engle, 1993) and Nicaragua (Lamontagne, Engle and Zeitlin, 1998) found positive associations between earnings from work and child's height-for-age and weight-for-age when controlling for potential confounding variables such as socioeconomic status.

In the absence of income, unpaid maternal work did not have positive effects on CNS when compared with mothers who worked and earned income in India and Nigeria (Abbi *et al.*, 1991; Ukwuani and Suchindran, 2003). A proposed explanation was that the lack of time for child-care activities, without the positive effect from income, aggravated the poor nutritional status of economically deprived children (Abbi *et al.*, 1991). Unpaid work is more likely to happen in the agricultural sector, in which women can be paid with part of their own production (Desai and Jain, 1994). In an extensive literature review, Leslie (1988) affirmed that any kind of payment, whether in cash or in kind, can have positive effects on child nutrition, and that mother's food production is associated with increases in the provision of energy-protein dense diets for children. But, this association has not been studied enough, because in many datasets, women who did not earn cash, or were involved in family agriculture were not considered to be working (ICLS, 2013b).

These results have to be interpreted carefully, because most studies were conducted among poorer populations and some studies reported that women who worked for income tended to be poorer than non-workers, what means results may reflect the effect of poverty rather than the effect of maternal work (Johnson and Rogers, 1988; Engle and Pedersen, 1989; Abbi *et al.*, 1991). Another element that needs to be considered is the control of the income, as this may have different effects on food availability and food distribution for children (Engle, 1993; Engle and Nieves, 1993).

In high-income countries, the findings are slightly different, since child mortality or undernutrition are not major problems in these countries. Studies investigating the mechanisms behind the association discuss that maternal work decreases the time available to cook and prepare meals, while also decreasing supervision of the children (Fertig, Glomm and Tchernis, 2009; Brown *et al.*,

[8] Although the studies from Patrice Engle in Guatemala were conducted in areas of minority indigenous, there is the possibility that Maya groups were included in the study. The Guatemalan Civil War, ran from 1960 to 1996 may have affected the health trajectory and growth of Maya and non-Maya groups (Gragnolati and Marini, 2003), and therefore, the study cannot be analysed or used to contextualise others if the war is not mentioned.

2010; Cawley and Liu, 2012). However, the additional household income by maternal work can lead to contradictory dynamics. On one hand, it can enable mothers to purchase fresh and quality food, have access to nutritional information, and organized paid activities/exercises such as gym, and swimming classes (Gordon-Larsen, Adair and Popkin, 2002; Brown *et al.*, 2010). On the other hand, the money can be spent on luxuries such as restaurant meals, fast food, or ready meals. Mothers' engagement in work may also be linked to lack of time to cook or to spend with the child. Further, maternal income may also lead to increased access to electronic objects that encourage sedentary habits in children, such as television, computers, and screen-based entertainment (Scholder, 2008).

Given these mechanisms, the studies are consistent in finding that additional hours of maternal work are associated with increased levels of childhood overweight, where those associations can differ according to socioeconomic status and education. It is known that in developed countries, childhood obesity tends to follow the health inequalities gradient, being more prevalent in low-income households (Devaux and Sassi, 2011). However, this association is not very clear when investigating the effect of maternal work due to the balance between increased financial resources and simultaneous reduced time for domestic and personal activities and childcare. For instance, Brown *et al.* (2010) investigating children aged 4-5 years old in Australia found that the association between maternal work and child overweight was mediated by time watching television, and children in high-income households spent less time watching television. The study did not investigate the type of care received in the absence of the mother. However, the analysis showed that more time watching TV was associated with less time in physical activity, suggesting that children in high-income families were involved in other activities during maternal work hours, leading to lower overweight rates when compared with children of middle and low socioeconomic status. Scholder (2008), following children for 5 years in the UK, compared the association between maternal work and child overweight according to parental occupation and family income, and increases in the probability of having an overweight child when mothers were employed occurred only for lower social class families.

Not all studies had the same findings. A study in the United States (Fertig, Glomm and Tchernis, 2009) stratified analysis by maternal education (lower or higher than 12 years of schooling) and found that for more educated mothers, the effect of maternal working hours on child's BMI was larger and significant, mediated by a fewer number of meals provided to the child. Hawkins et al (2008), in the U.K. stratified the analysis by annual income and the association between maternal working hours and child overweight was only found for those with income higher than £33,000. Anderson, Butcher and Levine (2003) also found that in the United States, higher educated mothers and families with higher income had a greater probability of having an overweight child. However, the studies are not very comparable, since all of them used different age groups. Fertig, Glomm and Tchernis (2009) included teenagers in their analysis, who have higher autonomy in deciding what to eat; Hawkins, Cole and Law (2008) included children from 9 months to 3 years old, who are very dependent on what is offered to them; and Anderson, Butcher and Levine (2003) included a range of 3 to 11 year olds. Furthermore, the studies were clear in their descriptive analysis that higher rates of overweight were found among lower socioeconomic status, irrespective of maternal work. Therefore, the results from further statistical analyses might be indicating that the increase in child's BMI when the mother was working was higher for the highest income/education, as these have more access to food and commodities related to weight gain.

An explanation for the association between maternal work and child overweight among high socioeconomic status and better-educated families is related to the time constraints affecting these mothers' ability to supervise their children's behaviours. Hawkins, Cole and Law (2008) discusses that these findings show it is not lack of money that impedes young children from accessing healthy foods and behaviours, but the long hours of maternal employment and the difficulty of managing children's activities.

Paternal earnings from work have not been associated with child overweight (Phipps, Lethbridge and Burton, 2006). However, the family structure and the presence of the father in the household is important. Although more attention in these studies is given to the additional income generated by the mother, paternal employment and earnings are a great determinant of money and resources available to households (Brown *et al.*, 2010), and differences might exist in the association between maternal work and child overweight among single mothers and other household structures.

In summary, studies about the association between maternal earnings from work and child nutrition were more consistent for high-income countries than for low-income countries. Yet some conclusions can be taken from this review. Studies are in agreement that income from maternal work is beneficial for household resources and food availability, but that it does not always provide an adequate diet for the child, nor compensate for the negative effect of the lack of maternal time. This is particularly important for low-income countries, where poor conditions of work, low payment, no earnings in cash and low autonomy for spending the money can constrain or negate the positive effect of maternal work on CNS. In contrast, in high-income countries, where the environment is conducive to better child nutrition, behaviours and decisions of how to spend the money seem to be a determinant of this association, which can be affected by socioeconomic status and education.

3.3.2 Time Availability and CNS

Feeding and taking care of a child is time consuming, especially for infants who are at their most vulnerable time. During this phase, nutritional deficiencies or morbidities can have enormous effects on the child, particularly in the context of poverty. As discussed above, some studies in low-income countries have found that the income benefit of maternal work does not counter the deleterious effects of limited time available for childcare and breastfeeding (Popkin and Solon, 1976; Glick and Sahn, 1998; Lamontagne, Engle and Zeitlin, 1998). For instance, the study by Popkin and Solon (1976) showed an improvement in food availability alongside micronutrient deficiency, because of the diminished time for cooking vegetables.

In considering time availability in low-income countries, it was assumed that non-working mothers could dedicate more time to childcare, but this could have been incorrect at the time these studies were conducted. Household work, which was not seen as an economic activity, was very time consuming and arduous in some contexts in the past compared to nowadays, and domestic labour was often a factor preventing mothers from entering the labour force (Popkin and Solon, 1976; Desai and Jain, 1994; Bianchi, 2000). The amount of time dedicated to childcare is still dependent on the context in which mothers and children were evaluated, both in the past and now. In places where domestic tasks involved chores such as fetching water and fuel, pounding grain, and collecting firewood, these activities could constrain the time available for childcare, and working would only be beneficial if the increased income was enough to provide better conditions for the child (Desai & Jain, 1994).

A study in urban areas of Colombia (Dufour, Reina and Spurr, 2003) investigated the hours spent on different tasks by working and non-working women, and found no differences in time allocation toward household tasks or childcare between these groups. A possible explanation for this finding is that the tasks performed by working and non-working women in this population were very similar, as many women worked as domestic workers. Another study in rural areas of Guatemala (Engle, 1989) found that non-working women spent more hours per day in household activities than working women spent in their daily jobs outside the home. However, working women also had household tasks to do when getting home, and therefore, they had less free time.

Two crucial factors were highlighted by studies in low-income countries as direct influencers of CNS when the mother was working. The first is how maternal work affects breastfeeding, which is discussed separately in the next section; and the second is the difficulty of benefiting from supplementary feeding programmes or health care. Households where mothers were working were often unable to collect the benefits or take the child to receive benefits on a regular basis (Popkin and Solon, 1976). This mainly affected the poorest mothers, as in general, the programs provided the benefits during office hours, and mothers in lower income groups tended to work longer hours, and therefore were not able to get the benefit.

The second factor calls attention to the pressure on mothers as the only responsible person for the child's situation, excluding the importance of fathers or other family members on childcare. While the investigation of the father's habits and child nutrition has not been raised in the literature, only one study from LICs investigating the effect of maternal work on child nutrition considered the importance of the father's presence or support on this association (Marchione, 1980). Few recent studies conducted in HICs bring the discussion about the father's use of time when their partners are working (Baxter, 2007; Cawley and Liu, 2012). However, data on the role of men on childcare is still limited.

In high-income countries, studies mainly focused on hours that mothers were at work and how it was related to overweight and obesity in their children (Hawkins, Cole and Law, 2008; Scholder, 2008; Fertig, Glomm and Tchernis, 2009; Brown *et al.*, 2010). In this context, the mechanisms leading to childhood overweight would be lack of supervision from the mother, greater exposure to energy dense foods and poor nutritional quality food, and increase of screen-based entertainment together with restriction of outdoor activities (Brown *et al.*, 2010; Cawley and Liu, 2012).

Initially, studies investigated the direct association between maternal hours at work and child overweight, without exploring the mechanisms behind it. Anderson, Butcher and Levine (2003) found that 10 additional hours of maternal employment over six years increased children's obesity by 1.2 to 1.5 percentage points, depending on other background characteristics. The same study discussed that the effect of maternal employment on CNS was small, explaining only 6% of the variation in child weight.

Nock and Kingston (1988), using a subsample of nationally representative data in the United States, proposed that working mothers reallocated their time away from activities inside the house in order to have more time with the child to compensate for their hours at work. Results obtained by Cawley and Liu (2012) confirmed this hypothesis in the investigation on how maternal work affects mother's allocation of time to activities related to child diet and physical activity. Findings showed working women spend less time grocery shopping, cooking, eating with children, or supervising children, resulting in an overall decrease in 127 to 213 minutes per day with these activities, compared to non-working mothers.

Other studies tested whether the association between maternal work and child overweight was mediated by lifestyle behaviours. Brown *et al.* (2010) found that longer maternal working hours were directly associated to Australian children being overweight, and part-time work was associated with lower TV viewing than full time work or not working. Fertig, Glomm and Tchernis (2009) also found that the number of meals, time spent in front of television and doing other activities (reading/talking/listening to music) mediated the association between maternal work and child overweight. Time spent watching television, which was significant in both studies, is of particular interest because besides being a sedentary behaviour, it also affects time available for playing or doing physical activity, is associated with snacking, and exposes children to commercials for fast-food, and energy-dense foods (Brown *et al.*, 2010).

The lack of supervision was also raised in some studies. When parents are less involved with and less responsive to their children, or when children are left unsupervised, there are fewer opportunities to monitor children's energy intake and physical activity, or to enforce regular mealtimes and bedtimes, which may all have adverse potential consequences for children's BMI (Morrissey, Dunifon and Kalil, 2011).

Anderson (2012) highlighted the lack of family routines as another mechanism by which maternal work affects children's obesity. In a longitudinal study following children from 1st year to 8th grade in the United States, and collecting data on family routines and parental employment, weekly maternal working hours was negatively associated with fewer family meals, fewer meals at regular times and fewer rules about watching television.

Popkin (1976) acknowledged that the determinants of the effects of lack of maternal time on CNS depend on four factors, assuming that food and household conditions are constant:

i) the extent to which the job is compatible with childcare;
ii) the quality of care provided by the person who substitutes for the mother;
iii) the availability and extent to which market purchased goods and services can substitute for mother's time;
iv) the availability and quality of social services that provide substitutes for the mother's time.

This calls for attention to the trade-off between income and time availability, where income can influence the quality of care, and buy goods and services that substitute mother’s time. It also calls attention to the importance of substitute care, and policies that ensure high quality social services. Although most studies focus on maternal work and child overweight, the responsibilities of raising a child and ensuring its needs goes beyond the mother, involving the father, the whole household structure and the outsource childcare. Those will be discussed in more detail in the next sections.

3.3.2.1 Lack of time for breastfeeding

According to the World Health Organization (WHO) guidelines (WHO, 2003), infants from birth to 6 months should be exclusively breastfed to avoid risk of infections through other food or contact with dirty and non-sterilized containers and cutlery. Breastfeeding should then continue after the introduction of complementary food until up to 24 months. The benefits of breastfeeding for child health and nutrition are well known (Huffman and Lamphere, 1984; Victora *et al.*, 2016), and associated with both undernutrition and overweight. However, breastfeeding is likely to decrease when the mother has to work and the child cannot be breastfed at the mother’s work place (Popkin and Solon, 1976). Studies have found associations between maternal work and shorter durations of breastfeeding in both low-income countries and high-income countries, although the type of work in each place can affect this association.

In Nigeria, women’s work reduced the length of breastfeeding, especially for mothers who earned cash and could not take their child to work. The duration of breastfeeding did not improve when mothers were able to take their child to work. The study did not provide information on the occupation of the mothers, which could possibly explain this finding (Ukwuani and Suchindran, 2003). In Thailand, Yimyam, Morrow and Srisuphan (1999) noted women committed to breastfeeding; but the resumption of employment presented serious difficulties in doing so. These were higher for those working in the formal sector, because they had less contact with their child and a lacked time for expressing breastmilk, leading to less production of breast milk or breast refusal by the child. In India (Aggarwal, Arora and Patwari, 1998), almost 80% of interviewed mothers reported using bottle feeding because of household or professional work resumed after 45 days postpartum. Similarly, mothers in Nigeria reported they would have breast-fed longer if they had not returned to work (Di Domenico and Asuni, 1979). In Ghana, mothers who worked close to home were more likely to breastfeed longer than those living further away from work (Benefo and Parnell, 1991).

The literature for low-income countries shows that work did not affect the decision to initiate breastfeeding, but could decrease the duration of breastfeeding, and increase early initiation of mixed feeding (Vial, Muchnik and Mardones, 1989). The findings, however, are inconsistent about how work affects breastfeeding duration because this decision is based on many factors, such as whether the mother is formally or informally employed, the distance from the household to the workplace, and other characteristics of the environment that allow or restrict women from breastfeeding while working.

Because of reduced time to breastfeed for working mothers, children start bottle-feeding earlier. In very poor households, studies showed this to be problematic because bottle-feeding was less nutritious, and associated with a higher incidence of disease. For instance, in the Philippines, bottle-fed babies had a 50% greater incidence of heavy loads of hookworm, ascaris and severe disease. Also, among children in the bottom household income quartile, the weight of children being breastfed was 10% greater than those being bottle fed (Popkin and Solon, 1976). Nowadays, formula milk is more nutritious, but the risk of contamination in poorer environments still exists. Another problem is the price of formula food, which is often expensive, and not all working mothers are able to purchase it. For many families in a poorer context, formula feeding was not affordable, and the replacement feeding was not adequate. This is a reason why some studies suggest that the effect of maternal work on CNS is worse for infants than older children (Leslie, 1988; Engle, 1991; Ukwuani and Suchindran, 2003).

In high-income countries, findings regarding breastfeeding and maternal work were consistent about the lower initiation and duration of breastfeeding. However, in this context, lack of breastfeeding was mostly associated with overweight and obesity (Hopkins *et al.*, 2015) rather than undernutrition as seen above for lower-income countries. Women were less likely to initiate breastfeeding when they knew they had to go back to full time employment and when they had maternity leave shorter than 6 weeks. No differences in initiation of breastfeeding were found between part-time working mothers compared with non-working mothers (Fein and Roe, 1998; Hawkins, Cole and Law, 2008), but the likelihood of breastfeeding initiation was higher among educated mothers (Fein and Roe, 1998; Fein, Mandal and Roe, 2008).

Rates of breastfeeding worldwide are decreasing, and in middle-income countries, poorer people tend to breastfeed for longer than their richer counterparts do. The prevalence of exclusive breastfeeding for five months in low and middle-income countries (LMIC) was 35%, and the percentage of those continuing breastfeeding at 12 months was 55% (Victora *et al.*, 2016). Although the effect of maternal work on breastfeeding rates in emerging countries has not been studied broadly, health inequities and social disparities in these countries suggest that results would vary according to regional types of work.

3.3.2.2 Type of care provided for the child

Some studies suggest that the effect of maternal employment on child nutrition would be minimal or null if good childcare was available. Considering the total care the child receives is presumably the sum of the substitute caregiver's time with the mother's time, there should theoretically be no difference in total childcare for children of working and non-working mothers (Tucker, 1989, Lamontagne et al., 1998). However, this association is not as simple, as it depends on where the care takes place, who the caregiver is, and who is supporting the family (Engle, 1992). Care from the mother could occur at the work place. Otherwise, support from another caregiver is needed, and childcare can be provided at home, at the home of another caregiver, or at an institutional site. The person responsible for substitute care could be an adult or a young sibling. Support could be given by both parents, or by the mother only, or even by an extended family. Different types of care can have different relationships with CNS depending on socioeconomic status, which is normally related to the reason behind the choice of care, and the type of maternal work.

Regarding where the care takes place in low-income countries, the first assumption is that the child could be taken to work with the mother, and this could have the benefit of allowing constant childcare by the mother. However, this depends on the environment where the mother is and the nature of work she performs. For instance, a study in Nicaragua found that taking children to work when mothers worked as street vendors was not adequate, as this type of job did not provide time or space for adequate care (Lamontagne, Engle and Zeitlin, 1998).

In India, Pakistan, and Nepal, some households have extended families, and the use of relative adult care. Having the grandmother as a regular caregiver is common. Studies in Nepal (Nakahara *et al.*, 2006) and Nicaragua (Lamontagne, Engle and Zeitlin, 1998) agreed that extended familial support was a good option of care, and better suited working mothers than living in nuclear families when the child was young. Furthermore, joint families have shared domestic responsibilities, often leaving more free time for childcare. Other substitute adult caregivers can also compensate for decreased maternal input, although Jain and Choudhry (1993) suggested that maternal childcare in India was considered more beneficial for child weight and growth than non-maternal care. Leaving the child with siblings was considered the worst option because siblings are often young or teenagers, and they are not capable of taking appropriate care of young children (Engle, 1991; Lamontagne, Engle and Zeitlin, 1998).

Since 1963, the World Health Organization has considered care centres as an auxiliary aid for families in need of care for children while their parents were working, providing appropriate conditions for their full growth and development (WHO, 1964). This influenced governments in different countries to create funded care centres for families in poverty. This has been shown to be positive for child nutrition, particularly in low socioeconomic contexts (Silva *et al.*, 2000; Bueno, Marchioni and Fisberg, 2003).

In high-income countries, parents tend to allocate an amount of their earnings for childcare, since relative-care is not a popular option in these countries, where families are nuclear, and women are more likely to be in the labour market. Relative-care is mainly used when the family has a low socioeconomic status, as it involves no payment or low costs. It is also used by mothers who work fewer hours or jobs with erratic schedules when there are other adults available in the household (De Marco, Crouter and Vernon-Feagans, 2009; Liu, 2015).

Private care centres (nurseries) are often the most expensive type of care, afforded by families with higher socioeconomic status and more educated women when they have fewer children (Liu, 2015). Research in high-income countries suggests that paid care centres are the best option of care, associated with better cognitive development (Liu, 2015) and with lower risk of overweight compared with other types of care, considering that the child is often involved in activities or playing with other children (Lumeng *et al.*, 2005). This type of care tends to be more formal, subject to regulations regarding physical safety, ratio of carer per children, and training of carers, improving the quality of childcare (Liu, 2015). However, there might still be differences in the quality of care offered from place to place that affect the child in different ways.

Informal care arrangements have been associated with higher rates of overweight in high-income countries. This was found by Hawkins, Cole and Law (2008) in the United Kingdom, and by Kim and Peterson (2008) in the United States. The latter study also suggested that early initiation of non-parental care was associated with higher child weight gain.

Studies in high-income countries also point to the importance of the partner in determining the association between maternal work and child nutrition. Some studies that did not find significant associations between paternal work and child overweight discuss that mothers continue to carry a greater share of domestic and childcare responsibilities than fathers do (Phipps, Lethbridge and Burton, 2006; Courtemanche, Tchernis and Zhou, 2017). Yet, other studies investigating maternal work and CNS considering the presence of the father found that fathers who share some responsibilities in childcare offset decreases in time spent by mothers on childcare. Cawley and Liu (2012) found the decrease in maternal time for activities related to child feeding were lower in households with a spouse/partner than in households with single mothers. Time spent by men on such activities also increased when they had a working spouse/partner, although the magnitude of the increase by men was much less than the decrease by women.

No studies used data that informed what children did while the mother was at work. Although the studies provide some input on the quality of care offered to the child, specific data collection on children's daily habits while the mother works could help the understanding of this association.

3.3.3 Occupation and types of employment and CNS

The previous discussion about income, time availability, time for breastfeeding and type of childcare shows that the nature of work and the context of work are very important for the understanding of associations. Child demands differ according to age, and work demands differ according to country's development and maternal skills. However, not many studies have investigated the association between types of work and CNS.

In Indonesia (Toyama *et al.*, 2001) and Guatemala (Engle and Pedersen, 1989; Engle, 1991) children of mothers working in the informal sector had significantly lower values of height-for-age and weight-for-age compared with children from non-working mothers or those in the formal sector. Engle and Pedersen (1989) showed that mothers in the informal sector were the poorest and least educated, and when the statistical analysis included cofounders, the association was no longer significant.

Adelman (1983) found that children of women in Peru who worked part-time were significantly taller than children of women who worked full time and, at age five, mothers working full time needed almost double the income of part-time mothers or non-employed mothers to ensure the child did not suffer from nutritional deficits.

Haggerty (1981) classified mothers in Haiti as merchants or other, and whether the mother worked at home or away from home. She found that infants of merchant mothers had poorer growth than children of mothers in other jobs or non-working mothers; and children from mothers who worked at home had the greatest growth. Another study in Ghana that compared children of women working in agriculture and whether or not they worked with trades and found trading was the most significant and positive variable associated with better weight-for-age outcomes (Tripp, 1981).

As discussed previously, maternal work and CNS is a very complex topic involving a range of family decisions and affected by characteristics of maternal work, type of substitute childcare, household, and community. No study has looked fully at this complexity. Instead, studies focus on one particular characteristic of maternal work, which reinforces the notion that the mother is the most important and irreplaceable figure for child's wellbeing. Furthermore, many studies came to final conclusions on the association between maternal work and CNS without taking into account the fact that in some contexts, women who worked had different socioeconomic status when compared with non-working women. Leslie (1988) in her systematic review about this association in low-income countries effectively highlighted that some of the findings from previous studies were reflecting poverty, instead of the effect of work.

The next section further extends the understanding of this association when explaining measures, prevalences, causes and consequences of child malnutrition.

3.4 Child malnutrition (stunting and overweight)

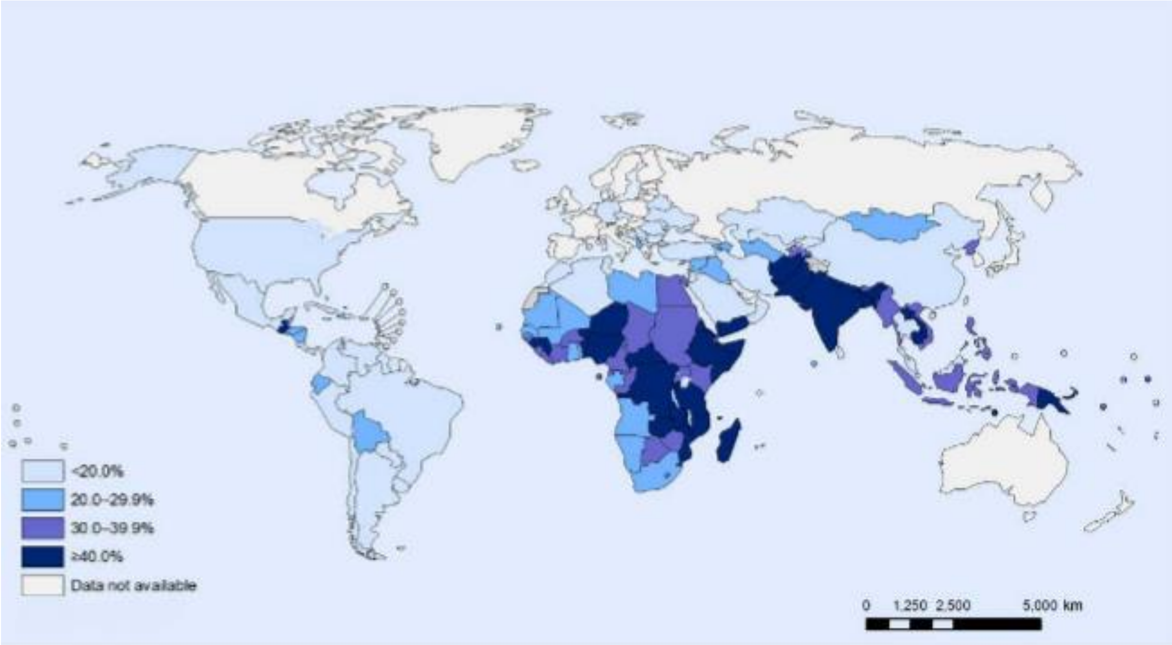
3.4.1 Prevalence and consequences of stunting and overweight

Malnutrition refers to measures of both under and over nutrition, as well as specific nutrient deficiencies. The dual burden of malnutrition, characterised by the coexistence of measures of malnutrition within individuals, households, and populations, has reached the majority of low and middle-income countries (Steiber *et al.*, 2015). This thesis focuses on stunting and overweight as measures of child malnutrition because both measures reflect chronic changes rather than short-term factors that affect malnutrition, such as severe disease.

It was estimated in 2016 that 155 million children under five years of age were stunted (United Nations, 2017). Although the worldwide prevalence of stunting has been decreasing, it is still significant in low and middle-income countries, particularly in Southern Asia and sub-Saharan Africa. The prevalence in low and middle-income countries was estimated at 28%, compared to 7.0% of children in high-income countries (Figure 3.2) (Black *et al.*, 2013; United Nations, 2017).

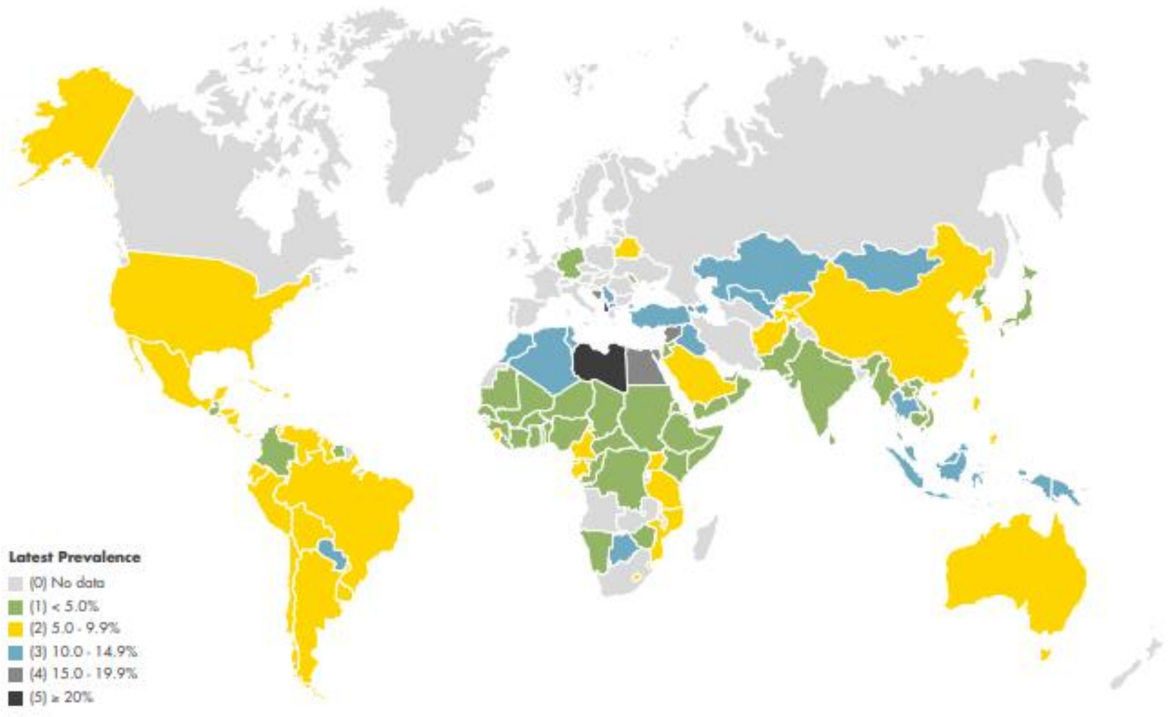
On the contrary, the prevalence of child obesity has increased to a worrying proportion in the last decades (Figure 3.3). In high-income countries obesity prevalence seems to plateauing while in several middle and low-income countries it is increasing more rapidly mainly due to changes in the environment (Lobstein *et al.*, 2015). In 2010, 43 million children under five years of age were considered overweight or obese, with a global prevalence of 6.7%, and another 93 million were at risk for becoming overweight (De Onis, Blössner and Borghi, 2010; Tzioumis and Adair, 2014).

Figure 3.2- Stunting among children under 5 years old (de Onis et al, 2013).



Source: (Onis *et al.*, 2013).

Figure 3.3- Age-standardized prevalence of overweight in children under 5 years of age, comparable estimates, 2014



Source: (WHO, 2016)

Stunting is characterized as early growth failure, often caused by suboptimal health and/or nutritional conditions. It is common where sanitary conditions are poor and water supplies inadequate, especially in the critical period when children are introduced to complementary foods and exposed to food-borne pathogens. On a population basis, high levels of stunting can be associated with poor socioeconomic conditions and higher risk of frequent and early exposure to illness and/or inappropriate feeding practices.

Up to two years old, the child can catch-up growth, if in a better environment that allows increased growth velocity to be achieved. However, if the child is placed in a context of unchanged environmental factors, full growth potential is unlikely to be recovered (Branca and Ferrari, 2002).

Stunting cannot only result in short adult height, but also in consequences in infancy that can persist until adulthood. One of the consequences is a developmental delay that starts early in life, such as deficits in cognitive ability, delayed pubertal stage, and increased risk of chronic diseases at older ages (Branca and Ferrari, 2002; Stein *et al.*, 2010). Studies suggest this form of malnutrition can cause direct structural damage to the brain, impairing infant motor development and exploratory behaviour (Brown and Pollitt, 1996; Pitcher, Henderson-Smart and Robinson, 2006; Grantham-McGregor *et al.*, 2007). This delay in development can result in decreased productivity later in life, and difficulties in getting better-paid jobs, which would alleviate poverty (Victora *et al.*, 2008; Stein *et al.*, 2010; Dewey and Begum, 2011).

Obesity is defined as excess adiposity, and one of the explanations for this is the increase in the number of adipocytes during the first two years of life (Burniat *et al.*, 2006). Studies have suggested that the first years of life have crucial effect on obesity and comorbidities later in life. Weight gain between 0 and 24 months predicted higher insulin resistance in adults, and after 48 months, weight gain was a risk factor for adult glucose intolerance (Norris *et al.*, 2012). In fact, high blood pressure, triglycerides, and insulin resistance have been associated with obesity in childhood (Cook *et al.*, 2000; Sorof *et al.*, 2004).

The fact that obesity is likely to persist in adolescence and adult life is worrying because of its association with many chronic disorders and recurrent morbidity, bringing negative effects on health-related quality of life and disability-free life years (Wang *et al.*, 2011), also related to lower academic achievement and lower economic productivity (Wang *et al.*, 2011; Lobstein *et al.*, 2015). Once obesity affects productivity and increases morbidity, its effects on society are enormous in terms of health care costs. For instance, in the U.S., it was estimated that compared to normal weight individuals, adult obese patients had 46% increased inpatient costs and 80% more spending on prescription drugs (Finkelstein *et al.*, 2009). In Brazil, costs with obesity-related diseases accounted for 32.9% of total hospitalizations, and approximately 11% of these costs could be attributable to overweight and obesity (Bahia *et al.*, 2012).

3.4.2 Definitions of child malnutrition

Anthropometry is used to classify nutritional status. It is a universally applicable, non-invasive and inexpensive method (Waterlow *et al.*, 1977; Jelliffe *et al.*, 1989). For children, the most common measurements are weight and height, which, relative to a child's age, provide indices that are compared to a reference population. The most common anthropometric indices used to define nutritional status are indicated in Table 3.1, together with its classification for the child in terms of chronic and acute malnutrition when compared with the WHO reference standards. Those are described in more detail in Appendix A.

The 2007 WHO Child Growth Standards were developed using standardised data collection from Brazil, Ghana, India, Norway, Oman and the United States to generate international standards for healthy children. These standards are based in a reference population from widely diverse ethnic backgrounds and cultural settings, and are used to classify the child accordingly as stunted, wasted, underweight, normal weight, overweight or obese (de Onis *et al.*, 2007).

In this thesis, the indicator length/height-for-age z-score (HAZ) was used as a measure of linear growth, and categorized to indicate stunting (Hamill *et al.*, 1977; de Onis *et al.*, 2007). Among two possible indicators of overweight (weight-for height and bmi-for age), bmi-for-age z-score (BMIZ) was used as recommended by Cole *et al.* (2000), seeing that weight and height change substantially with age, and this measure has the advantage of providing age and sex specific cut off points.

Although bmi is an easy indicator available to measure overweight, its applicability in LMICs is questionable due to the coexistence of stunting and overweight within these populations. The shortened height of stunted people may increase body fat, altering body proportions and misleading bmi classification (Wilson *et al.*, 2011). It would be ideal to use the bmi as an indicator of overweight in conjunction with other measurements of body fat . However, the difficulty in using other methods in a large number of people makes it unsuitable for national surveys.

Table 3.1- Definition and classification of anthropometric measures to indicate malnutrition

Indicator	Definition	Classification
	Major indicators	
Length/height-for-age (HAZ)	Measure of linear growth based on length (0-24 months) or height (2 to 5 years),	HAZ < -2 SD → stunting (chronic malnutrition)
Weight-for-length/height (WHZ)	Measure to reflect body weight relative to growth	WHZ <-2 SD → wasting (acute malnutrition) WHZ > 2 SD → overweight
BMI-for-age (BMIZ)	Measure to reflect body weight relative to growth	WHZ <-2 SD → wasting (acute malnutrition) WHZ > 2 SD → overweight
Weight-for-age (WAZ)	Measure of body mass relative to chronological age	WAZ <-2 SD → underweight (acute and chronic malnutrition)
	Other indicators	
Mid Upper Arm Circumference (MUAC)	measure of severe acute malnutrition and a strong predictor of mortality	-
Skinfolds, waist and waist/height	measures correlated with the amount of fat in the body	-

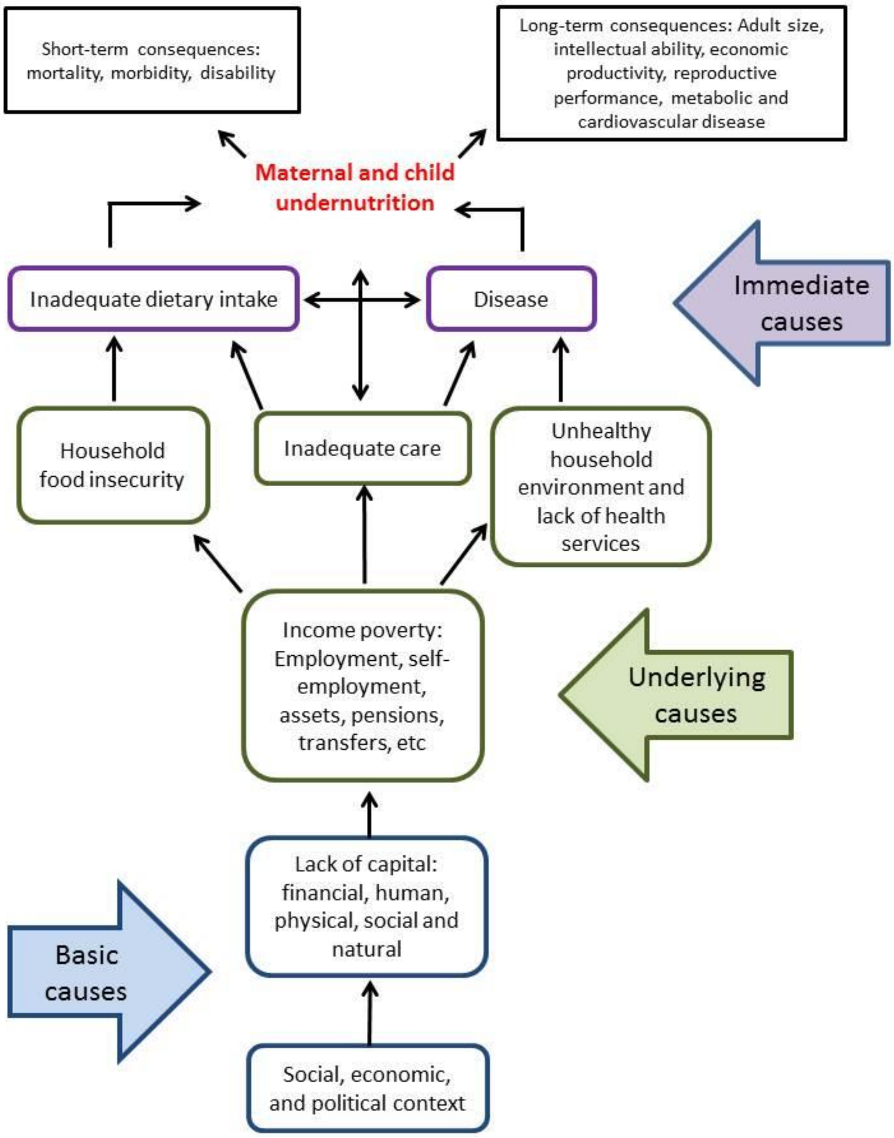
3.4.3 Determinants and causes of Malnutrition

The UNICEF (1998) framework (Figure 3.2) emphasizes some of the determinants of undernutrition, recognizing basic and underlying causes which include environmental, economic and socio-political factors, and poverty as central roles (Black *et al.*, 2008).

At the most proximate level, nutrition is determined by dietary intake, which should be in the right quantity and quality, offering both macro and micronutrients. At this level, undernutrition can be occasioned by inadequate intake or by occurrence of disease, as the latter can affect appetite, absorption of nutrients, and health status (UNICEF, 1998; Headey, 2013). Overweight, instead, would happen when energy intake is higher than expenditure.

Then, the framework recognizes that the quality of diet and the reoccurrence of diseases are directly affected by household food insecurity, inadequate care and feeding practices, and by an unhealthy household environment and inadequate health services. The household status is often predetermined by poverty, education and macro elements as sociocultural, economic, and political context, which are also basic factors related to undernutrition.

Figure 3.4. UNICEF conceptual framework of malnutrition (Adapted from Black et al, 2008)



Source: Black et al, 2008.

The framework suggests the existence of a vicious cycle of child nutrition, where malnutrition can feed back to its underlying and basic determinants due to its influence on economic productivity, reproductive performance and further disease. Economic productivity can be affected due to impaired cognitive ability, or diseases related to undernutrition, which influence the possibility of getting better jobs and changing the poverty situation. Then, the individual keeps an unhealthy household environment for future generations (Neeliah and Shankar, 2008; Stein *et al.*, 2010; Dewey and Begum, 2011).

Still, studies suggest that even in wealthier environments, children can still become malnourished when receiving inadequate care, such as when they receive sufficient quantities of food but low quality. The opposite is also true. Some individual determinants of child malnutrition, such as poverty, can be attenuated depending on the caregiver's decisions (Imai *et al.*, 2014; Cunningham *et al.*, 2015). The mother is often highlighted as the main caregiver, as they are the ones that bear children and they are typically the principal providers of nourishment during the most crucial periods of children's development, the primary caregivers in households, and the ones who instruct a substitute caregiver (Network, 2003; Black *et al.*, 2013).

The intergenerational influence hypothesis raised by Emanuel (1986) states that factors, conditions, exposures and environments experienced by one generation are related to the health and development of the next generation. This hypothesis emphasizes the influence of growth and development of female children on the quality of later reproduction, showing that this cycle is also biological, and not only related to the environment. This is also discussed by Barker's hypothesis on the developmental origins of health and disease, showing an association between intrauterine environment and diseases later in life (Barker, 1990). This hypothesis goes further in showing that malnutrition at a critical early life leads to persisting changes in blood pressure, insulin response to glucose and cholesterol metabolism, while low weight gain during infancy was associated to hypertrophy of the left ventricle in childhood and adult life. All of these are predictor of coronary heart disease, suggesting that any form of undernutrition is a predictor of coronary disease at later life (Barker, 1997).

3.4.4 Child, maternal and household factors associated with nutritional status

During pregnancy, maternal health has the first impact on child nutrition, and issues during this period, such as maternal malnutrition and low weight gain during pregnancy can lead to short gestation period (prematurity), or retarded intrauterine growth, both drivers of low birth weight (LBW) (Kramer, 1987). LBW is an important contributor to stunting, also related to long-term consequences for the child and in the child's later adult life, such as lower height, cognitive function and development (Walker *et al.*, 2007; Black *et al.*, 2013).

The maternal fertility behaviour, particularly the timing of pregnancies can affect prematurity, low birth weight and child nutrition at early ages. Specifically, very short birth intervals and early pregnancy have been associated with child stunting and underweight (Dewey and Cohen, 2007; Rutstein and Winter, 2014). A plausible mechanism for this association is the maternal nutrition depletion caused by the close succession of pregnancy and lactation, in which the folate depletion is particularly related to the risk of adverse pregnancy outcomes (Smits and Essed, 2001; Conde-Agudelo *et al.*, 2012).

Short birth interval and having more children in the household can also play a part in child nutrition due to intra-household allocation of resources when family size is large. Basically, in a low income situation, parents are more likely to invest in the child who has earlier return to the family (Horton, 1988). At the same time, the arrival of a new-born in the household is reported in many countries as related to weaning of the older child in a context of poverty and consequently no provision of enough nutrients to the older child. These effects can be attenuated by longer birth-interval, keeping the health status of the mother and the weaned child.

Biological and sociodemographic factors explain the association between early pregnancy and child nutrition. Young teenager mothers may not have reached their full physiological and reproductive maturity, increasing the likelihood of having poor weight gain during pregnancy and having complications during pregnancy and birth (Rutstein and Winter, 2014). Moreover, young mothers are socially disadvantaged due to the lack of full education (Reichman and Pagnini, 1997).

As the child ages, the first 1,000 days are crucial for catch-up growth and are influenced by the socioeconomic environment. Young children are more vulnerable to diseases due to their immature immune system. The exposure to an environment of poverty, with poor health care access and poor access to clean water and sanitation, increases the chances of spreading infectious diseases. Diarrhoea is particularly prevalent, as a cause of malnutrition, as well as species of intestinal parasites, and malaria (Walker *et al.*, 2007). In a two-way association, disease can lead to malnutrition or can have higher impact on child's health due to existing malnutrition (Victora *et al.*, 2003).

Exclusive breastfeeding in the first six months of age provides all needed nutrients in a safe environment, avoiding exposing the child to dirty and non-sterilized containers and cutlery that increase the risk of infections and malnutrition. Exclusive breastfeeding has been associated with reduction in both all cause and infection related neonatal mortality (Huffman and Lamphere, 1984). After six months, the WHO recommends the introduction of complementary feeding, where the child should receive a healthy and adequate diet for optimal growth.

Studies have reported associations between the sex of the child and CNS due to preferences for male children as the future provider and heir of the household (Ravindran, 1986; Pande, 2003). More evidence on this was found in Asian countries, such as Bangladesh, India and Pakistan, and it is suggested that male children have more access to food, vaccinations and treatment. This problem has led to a mortality disadvantage among girls due to differential behaviour. In societies holding male preference, malnutrition can be intensified due to high fertility rates in cases where there is a preference to achieve a family of more sons than daughters (Arnold, 1997; Clark, 2000). Furthermore, large family size, and high number of children in the household in the context of poverty can affect child nutrition due to preferences in the allocation of resources. This problem is exacerbated by differences in gender inequality and lack of power of decision-making from the mother in the household (Haddad, 1999; Duflo, 2011).

Maternal education can affect maternal choices, which can exert influence directly or indirectly on child nutrition. Directly, education is associated with a higher likelihood of breastfeeding, healthier choices of diet for their children and themselves, avoidance or decreased chances of infection by using safe water and utilizing practices such as handwashing, and higher likelihood of seeking health care when the child has a disease (Engle et al, 2011; Black et al, 2008). Indirect maternal choices reportedly affected by education are postponement of marriage and earlier cessation of childbearing, which would promote a safer environment for reproduction, and having fewer children in the household (Cleland and Van Ginneken, 1988). These choices would prevent both under and over nutrition, providing a safer environment for the child.

However, education is also linked to maternal socioeconomic status, employment and decision-making. Firstly, education can be considered as an indicator of socioeconomic status, because in poorer places, females have more difficult access to education, as well as cultural constraints to attending school. At the same time, if the mother is not empowered in the household, she is less likely to have autonomy to decide what to do about her own health or the child's health, or how to spend money from her activities in the labour force (Ramalingaswami, Jonsson and Rodhe, 1996). In fact, education and power of decision-making are independently related to CNS, and are key variables affecting the type of work for women, and how work will influence CNS.

3.5 Summary

This chapter has covered two theories about country's development and FLFP changes. Both theories suggested increases in FLFP occurs with increases in female education, firstly because it generates wider opportunities of work for women (Goldin, 1994), and secondly because better-paid jobs are more attractive for women (Becker, 1965; Willis, 1973). Theories go further in suggesting that work participation decreases fertility and the desire to have more children, raising questions about reasons behind the decision to work by mothers, and the decision to have a child when the woman is committed to work.

The literature on the association between maternal work and child nutrition was contextualized in low or high-income countries, due to the lack of studies in emerging countries. The studies do indicate a similar mechanism behind this association, where earnings from work can be seen as a positive effect of maternal work, and the lack of time available for childcare is a negative effect. Increased income can lead to improvements in household conditions and feeding practices, and in some cases, it can also pay for better quality of childcare and health care. Lack of time available for childcare can be detrimental for the child if no adequate substitute caregiver is provided.

The divergent findings on how maternal work affects child nutrition when examining the literature review suggest that there is no consistent finding without considering the micro and macro context of mothers and children. Brazil and India have very different contexts, as shown in Chapter 2, and further investigation on the association between maternal work and child nutrition should consider this.

Chapter 4: Methods

4.1 Introduction

This chapter aims to introduce the data used to investigate maternal work and child nutrition, as well as to describe the variables and methods used. The first section describes the survey design of each data used, discussing the differences in the questionnaires and sampling methods. Four datasets were used, including two different waves of the same data for each country to allow comparisons before and after the BRICS entrance.

The next section presents the variables used in the study. The section explains the creation and categorization of anthropometric indicators, and exposes the prevalence of missing and flagged values. It also discusses the variables used to define maternal work and the control variables.

The third section focuses on the quality of the data, discussing aspects such as sample size, missing data, and the quality of anthropometric data. Finally, the different statistical methods used in the thesis are reviewed.

4.2 Data Sources and Survey design

The Brazilian (Pesquisa Nacional do Desenvolvimento em Saude) and Indian (National Family Health Survey) datasets chosen to be used in this study are both part of Demographic and Health Surveys (DHS) programme. Therefore, attention is first given to the DHS in general, followed by the specific survey design for both countries.

4.2.1 Demographic and Health Surveys (DHS)

The DHS is a standardized repeated cross-sectional survey conducted in various developing countries since 1984. The DHS program was initiated and funded by the U.S. Agency for International Development, aiming to evaluate population and maternal and child health (Rutstein and Rojas, 2006). The information collected provides estimates on family welfare, reproductive history, fertility, and health status. In maternal and child health, data include information about prenatal health and care, child birth, immunization, nutritional status, infant feeding and common diseases during childhood.

Countries involved in the DHS programme usually conduct a survey every five years. As it intends to be representative across countries, data, questionnaires, manual and field procedures are standardized to allow comparison across countries. Nevertheless, due to different context-specific questions that are added to specific country questionnaires, complete similarity is not achieved and countries may diverge.

The DHS intends to ensure national representativeness, including all national territory in the geographical coverage. In general, the selection of households in the DHS follows a multistage design, with a two stage stratified sample. It uses an existing sampling frame, which is commonly the list of enumeration areas (EAs) from a recently completed census. The sample is then stratified in groups that are as homogeneous as possible, aiming to decrease sampling errors. The sampling unit for the first stage of selection is called Primary Sampling Unit (PSU), and for the second stage of selection, it is called Secondary Sampling Unit (SSU) (Macro, 1996; IFC, 2012).

The main instruments to collect data are the household and individual questionnaires, implemented by trained interviewers. The first provides a list of household members and basic demographic information about each member. This information is used for selecting women of reproductive age for answering the individual questionnaire. Women are also asked to provide information about their young children. Male surveys have been implemented in recent years (Macro, 1996; Rutstein and Rojas, 2006).

Most surveys also include the collection of anthropometric measures, such as the weight and height of women, children (under five years old) and men. According to protocols, for children younger than 60 months of age, height or length is measured to the nearest 0.1cm. If the child is less than 24 months, a measuring board is used to measure child's recumbent length; and standard height is measured for children older than 24 months. Weight is measured to the nearest 0.1kg on a paediatric scale or other beam balance scale. All members responsible for data collection receive standardized training, and should guarantee that two separate measurements of child's length/height and weight agree within 0.1cm (Assaf, Kothari and Pullum, 2015).

Weights are used to extrapolate the sample to the target population using design weights and sampling weights for both households and individuals. The design weight is the inverse of the overall probability of being selected in the sample. The sampling weight of a sampling unit is the design weight corrected for non-response of other calibrations (IFC, 2012). The DHS policy is to correct for non-response at the strata level because at the PSU level, it can increase the variability of sampling weights and increase sampling errors.

The particularities of the DHS for Brazil and India are discussed below.

4.2.2 Pesquisa Nacional do Desenvolvimento em Saúde (PNDS), Brazil

The PNDSs were collected in four rounds, the first was in 1986, followed by 1991 (both not used in this study), 1996 and 2006. The survey from 1996 included 13,283 households and 14,579 women. The total response rate was 81% (Brasil, Demographic and Surveys, 1997). The PNDS 2006 covered 14,617 households and 15,575 women, with a response rate of 89% (CEBRAP, 2009).

The sample design was slightly different between both rounds. For PNDS 1996, the sample was collected as a subsample of the Brazilian National Household Sample Survey (PNAD) and designed to obtain representative and independent results for the seven regions included in PNAD. The seven regions (Rio de Janeiro, Sao Paulo, South, East Central, Northeast, North and Midwest) included all 27 states of Brazil, and municipalities were considered the stratum (Brasil, Demographic and Surveys, 1997).

For the PNDS 2006, the sampling frame was obtained from a recent census, and the country was stratified in five macro-regions (North, Northeast, Midwest, Southeast and South) which were subdivided into rural and urban strata, generating ten strata in total (CEBRAP, 2009). The 2006 questionnaire was slightly changed in comparison with previous questionnaires in order to satisfy the need of the Brazilian Ministry of Health, which removed a few questions regarding employment and empowerment of women.

4.2.3 National Family Health Surveys (NFHS) - India

The NFHS was collected in three rounds, the NFHS-1 in 1992-93 (not used in this study), NFHS-2 in 1998-99 and NFHS-3 in 2005-2006. A further round of data (NFHS-4) has been recently released at the end of 2017, and not included in this study. Besides the normal estimates obtained by the DHS, the NFHS also collected data on new and emerging issues of importance for the country.

The NFHS-2 covered a representative sample of 91,000 married women aged 15-49 years across 26 states of India, covering 99 percent of India’s population. The survey provided urban and rural estimates for all states except for Tripura because of delayed fieldwork (IIPS, 2000).

The NFHS-3 covered all 29 states in India. The number of states increased compared to the NFHS-2 because three new states were created between both waves: Bihar had been split into Jharkhand and Bihar, Madhya Pradesh split into Chhattisgarh and Madhya Pradesh, and Uttar

Pradesh split into Uttarakhand and Uttar Pradesh (Figure 2.2). This wave expanded the population of study to never and ever-married women, covering 109,041 households, and 257,801 women (IIPS, 2007).

Due to great differences between the rural and urban population in India, populations were stratified by urban and rural area of residence in each state. The samples were drawn separately for each area, and allocated proportionally to the size of the state's urban and rural populations. In states where the proportion of the urban population was not sufficiently large to provide a sample of at least 1,000 eligible women, the sample size was corrected to guarantee representativeness (IIPS, 2000;2007). For rural areas, villages were selected as PSUs, and the sample size was calculated intending to keep precision of the analysis domain for the following variables: village size, percentage of males working in the non-agricultural sector, percentage of the population belonging to scheduled castes or scheduled tribes, and female literacy (IIPS, 2007).

In urban areas, a three-stage procedure was performed. In the first stage, wards were selected with probability proportional to size (PPS) sampling, and the second stage involved the random selection of a Census enumeration area (CEA) from each sample ward, followed by random section of households within each CEA. Both rounds followed the same sampling scheme with few differences. The ever-married criterion, applied as an eligibility condition in the 1998-99 round was changed in the 2005 round, that included all women in the sample (IIPS, 2007).

The NFHS-2 measured anthropometric data of children under three years of age of ever-married women. Children whose mothers were absent, dead, or under age 15 or over 50 were not measured (IIPS, 2000). The NFHS-3 included anthropometric data of all children less than five years of age in the NFHS-3, independent of who the mother was, providing a lower proportion of missing data in this variable (IIPS, 2007). Response rates were very similar between rounds, with 95.5% for women in 1998-99 and 94.5% in 2005-2006 (IIPS, 2000;2007).

4.3 Hypotheses and plan of analyses

This study investigates changes in child nutritional status according to maternal employment. From the literature review, two initial hypotheses are raised for this study. The first is that the association between female work and child nutrition is different in Brazil and India due to the different context in each country. The second is that the trade-off between earnings from work and time availability for childcare differs according to the types of work performed by women.

For the investigation of these hypotheses, the population analysed in this thesis comprised mothers living with their children, with available child anthropometric data. The focus of the analysis is on two anthropometric indicators: height-for-age (HAZ) to indicate stunting; and BMI-for-age (BMIZ) to indicate overweight and obesity. Stunting and overweight are not mutually exclusive, they can coexist in the same environment, household or individual, particularly among countries experiencing rapid nutrition transition (Doak *et al.*, 2000; Varela-Silva *et al.*, 2012). This coexistence has been observed among the adult population of Brazil at higher rates than India, but rates of overweight are still low among young children in both countries (Monteiro, Conde and Popkin, 2002; Subramanian, Perkins and Khan, 2009).

Stunting was studied in both countries, due to their high prevalence of stunting for at least one period. Overweight was investigated only in Brazil. The reason for this is the higher prevalence of overweight among pre-school children , and data showing later stages of the nutrition transition in this country (IBGE, 2010a).

The plan of analyses consist in first contextualizing female work and child nutrition in Brazil and India, to generate further hypotheses on how maternal work may affect child nutrition in each country. These include specific hypotheses on how the different types of maternal work in each country affects the trade-off between income and time availability for childcare.

The analyses have to include a number of variables related to child nutrition and female work. The variables and types of statistical analyses used in this thesis are described in the next sections.

4.4 Variables

Data were obtained from the women's questionnaire, where women responded to question about themselves and their children. Additional information on sociodemographic and household characteristics were collected from the household questionnaire. Data on children who were not resident in the household were excluded, as were children who had no anthropometric measures available. Finally, children with anthropometric data who had mothers with no information about work were also excluded. The number of mothers and children in each data as well as the excluded children are shown in Table 4.1.

Table 4.1-Number of mothers, children and missing values in datasets for Brazil and India.

Country	Year	Number of children	Number of households	Children not resident	No anthro data available N (%)	No maternal work information
Brazil	1996	4,818	3,641	138	284(6.1)	10
	2006	5,044	4,138	NA	436 (8.7)	0
India	1998*	30,984	21,546	24	3,575 (11.5)	-
	2005	48679	38,254	436	4,134 (8.6)	66

Brazil conducted the PNDS and India, the NFHS – both DHS equivalent.
*The NFHS 1998 included children up to 3 years old
NA=Not available

4.4.1 Anthropometric Data

All datasets included in the study provided data on the weight, height and age of children. Some datasets contained z-scores based on the growth curves from the National Centre for Health Statistics [9], and others on the new WHO curves. To maintain the same pattern of z-scores, a recalculation was made for all datasets using the Stata igrowth package, which is based on the WHO Child Growth Standards (WHO, 2009a).

Once the z scores were computed, flagged values [10] were excluded from the analysis. Individuals with unfeasible simultaneous combinations of z-scores, particularly where height-for-age was less than -3.09 at the same time as weight-for-age was more than +3.09 (or the opposite), were considered invalid and excluded. The percentage of missing data and flagged cases are provided on Table 4.2. Brazil had small percentages of flagged cases in both years. India had up to 5% of flagged values, with a lower percentage in the second wave when compared with the first. Both countries had around 12% missing values.

[9] The growth curves from the National Centre for Health Statistics have been widely used since the late 1970s. However, the curves presented some limitations that called the attention of the WHO Working Group in 1993, such as: the data used to construct the curves were based only on infants of European descent residing in the United States; measurements were taken only every three months; the analytical methods for the development of the curves was inadequate; and inconsistencies such as poor growth of healthy breasted infants were found (Garza and de Onis, 2004). These limitations led to the decision to develop new standards using healthy breastfed infants, and a reference population from widely diverse ethnic backgrounds.

[10] Flagged values are cases with z-scores beyond specified lower or upper cut-offs established by the WHO growth standards (height for age beyond -6 and 6 SD; BMI-for-age between -5 and 5 SD). The purpose of flagging is to eliminate extreme values that are most probably due to measurement errors or data-entry errors.

Table 4.2- Missing and flagged anthropometric data for PNDS, NFHS and NIDS.

Country	Data	Classification	HAZ (%)	BMIZ (%)
Brazil	PNDS 1996	Flagged	36 (0.9)	47 (1.1)
		Not flagged	4,138 (99.1)	4,094(98.9)
		Missing	506	539
	PNDS 2006	Flagged	29 (0.6)	43 (0.9)
		Not flagged	4,486 (99.4)	4,457(99.1)
		Missing	529	544
India	NFHS 1998-99	Flagged	1,355 (5.0)	1,183(4.4)
		Not flagged	25,912(95.0)	25,971(95.6)
		Missing	3717	3830
	NFHS 2005-06	Flagged	1,504 (3.4)	1,739 (3.3)
		Not flagged	42,179(97.2)	41,924(96.7)
		Missing	4,376	4393

4.4.2 Independent variables (exposure and confounders)

<u>*Exposure: Working variables*</u>

The main independent variable used in this thesis is maternal work. For the DHS, the first question asked was broad and subject to what the individual understood by "work":

> "Aside from your own housework, have you done any work in the last seven days?"

The second question was more specific and included a broad conception of work:

> "Some women take up jobs for which they are paid in cash or kind. Others sell things, have a small business or work on the family farm or in the family business. In the last seven days, have you done any of these things or any other work?".

A new "work" variable was created as a combination of those who responded "yes" to either of these questions to identify women who were working at the time of data collection. Further questions that characterize work such as occupation, place of work and type of earnings were collected with slight differences between questionnaires (Table 4.3). Only two questions were common to all questionnaires, referring to the place of work and the decision on how to spend the money earned from work. The PNDS 2006 was the most distinct questionnaire, with more questions about the working history of women, and less questions characterizing female work. This data also provided more information on earnings and spending than the other questionnaires.

Table 4.3- Questions regarding work for each wave in the DHS

Questions from the DHS in India (NFHS 1998-99 and 2005-06) and Brazil (PNDS 1996 and 2006)	NFHS 98-99	NFHS 05-06	PNDS 1996	PNDS 2006
Have you ever worked?	-	-	✓	✓
Why have you never worked?	-	-	-	✓
Although you did not work in the last seven days, do you have any job or business from which you were absent for leave, illness, vacation, maternity leave or any other reason?	-	✓	-	✓
Have you done any work in the last 12 months?	✓	✓	✓	-
Why did you stop working?	-	-	✓	-
What is your occupation, that is, what kind of work do you mainly do?	✓	✓	✓	-
Do you work mainly on your own land, on family land, or on land that you rent from someone else, or do you work on someone else's land?	-	✓	-	-
Do you do this work for a member of your family, for someone else, or are you self-employed?	✓	✓	-	-
Are you employed or self-employed?	-	-	✓	-
Do you have a formal contract?	-	-	✓	✓
Do you usually work at home or away from home?	✓	✓	✓	✓
While you are working, do you usually have your child with you, sometimes have him/her with you, or never have him/her with you?	✓	-	-	-
Do you usually work throughout the year, or do you work seasonally, or only once in a while?	✓	✓	✓	-
Are you paid in cash or kind for this work, or are you not paid at all?	✓	✓	✓	-
How much did you earn from your work last month?	-	-	-	✓
Who decides how the money you earn will be used: mainly you, mainly your husband, or you and your husband jointly?	✓	✓	✓	✓
How much of the household expenses comes from your earnings from work? Almost nothing, less than half, half, more than half or everything?	-	-	-	✓
What was your gross income from work in the last month?	-	-	-	✓

The use of the variables that categorize female work are explained in detail in further chapters, where relevant for the analyses.

Control variables

Ideally, to have directly comparable results for the two countries, the questionnaire for all surveys should be the same. However, as mentioned above, questions varied between surveys. To ensure comparable results, control variables for statistical analyses were chosen, aiming for consistency across all datasets where possible. Variables were chosen based on what is reported in the literature to be associated with child nutritional status (CNS), and present in the majority of datasets. These variables were grouped in four main groups.

1. Child characteristics: sex and age of the child; birth order; reported birth size; reported recent disease (diarrhoea or fever); reported use of a health card; adequate vaccination for age;
2. Maternal characteristics: age; BMI; decision-making in the household, education;

3. Socio-economic/household characteristics: household wealth quintiles/tertiles; number of residents; religion; education of the husband; caste; family structure;
4. Country/region characteristics: area of residence (rural/urban)

For consistency of variables among countries, the variables were categorized in the same way, when possible, following standard classifications according to the literature (explained below). Some variables had to be classified differently due to different ways of measurement or small sample sizes. All the control variables included in this study, together with their categorization are shown in Appendix B. Some variables are explained in this chapter, while others are discussed later, where applicable.

Birth weight had a large number of missing values in the DHS data. This often happens in datasets from low and middle-income countries, where many infants are not weighed at birth, or the weight is not recorded properly. The DHS collects other information on birth weight, which is the mother's perception of the baby's size classified as very small, smaller than average, average, larger than average or very large. Channon (2011) showed a strong relationship between birth weight and mother's perception of size, concluding that this variable can be used as a proxy for birth weight when other variables, such as gender are taken into account. This variable was used for DHS data, categorized as "smaller", "average" or "larger".

Birth order and birth interval and are important variables associated with birth weight and health outcomes (see section 3.4.3). Birth order was included in the analyses as a continuous variable. The variable measuring preceding birth interval calculated the time in months from one birth to the other, and categorized according to the DHS reports in "7-17", "18-23", "24-35", "36-47", "48-59" and "60 or more"(IIPS, 2007).

Two questions were asked about the child having fever or diarrhoea in the last two weeks. The occurrence of fever or diarrhoea was combined, generating one variable measuring either illness in the last two weeks and categorized as "yes" or "no". Information regarding child vaccination was only provided for the Indian dataset, and the first wave of the Brazilian dataset used. Binary questions were asked about whether the child had different types of vaccination. These were re-categorized according to the vaccination schedule per child's age for each country. A new binary variable was created where children who missed at least one vaccination were categorized as "1", and those with all vaccinations up to date were classified as "0". The DHS asked whether the child had a health card, used to measure access to health care.

For maternal characteristics, age was categorized in groups (18 to 24, 25 to 34 and 35 to 49). Marital status was not included as a variable in the analyses because the DHS is particularly focused on married women, resulting in very small rates of single women. More information on rates of marital status are provided in Appendix D.3.

Anthropometric data on weight and height of women were collected, and used for the calculation of women's BMI. They were classified as thin if the BMI was lower than 18.5 Kg/m^2, normal if between 18.5 kg/m^2 and 24.9 kg/m^2, and overweight if the BMI was higher than 25.0 $kg/m^{2,}$ according to the international cut-off-points of the World Health Organization (WHO, 1995b).

Kishor and Subaiya (2005) investigated the best way of combining decision-making measures, and proposed creating two summary indicators that consisted of the count of the number of decisions made alone and jointly. All surveys collected data on female made decisions about purchases of daily household needs, major household purchases, and what to do with the money earned from women's work. Additionally, the DHS asked who had the final say on women's own health, child's health, and visits to relatives. Those questions were combined, generating an ordinal variable that goes from zero to four. Values of zero were categorized as low decision-making, 1 or 2 as medium and 3 or 4 as high decision-making (Appendix B.2).

Education was created based on the highest level of education. It was initially categorized as no education, primary, secondary, higher secondary and tertiary education, following the categorization used in a previous study of India using the NFHS (Subramanyam *et al.*, 2011).This variable was re-categorized in later analyses, due to the small number of individuals in a particular category and is explained accordingly in the methods section of further chapters.

Socioeconomic status can be directly measured by income, expenditure, or consumption, but when those measures are not available, a proxy measure can be constructed utilising household assets and alternative measures of welfare or living standards (O'Donnell and Wagstaff, 2008). The DHS survey constructs a wealth index based on the household ownership of durable goods and dwelling characteristics, types of water access, sanitation facilities, and cooking fuel. Durable goods include information on whether the household has electricity, a television, a telephone, a refrigerator, vehicles, and whether the family owns the dwelling. Dwelling characteristics include information on the type of material used for construction of floors, walls, roof and cooking stove. The wealth index is generated from principal component analysis, taking into account differences between rural and urban areas (Rutstein, 2008).

The latest version of the PNDS (2006) provided household income measured through questions about individual earnings from work, amount earned from government grants, donations, or extra income. All the other DHS data provided a calculated wealth index relative to their observations. To keep a consistent measure of socioeconomic status among countries, a wealth index was created for all datasets using the same variables and accounting for rural and urban areas. The newly created wealth index had high correlation with the previous index in the DHS datasets, varying from 0.954 to 0.985. Households were split into wealth quintiles or tertiles, varying from lowest values (poorest) to highest values (richest). Type of water consumed and sanitation were not included as covariates because they were included in the construction of the wealth index.

The household questionnaire collected information for all listed members of the household, including the relationship to the head of the household. This information enables understanding of who lives in each household and the establishment of the types of family structure. Since the focus of this research is on mothers and their children, a coding process was used to redefine the relationship of each member of the household with the mother of the child by using the definitions of who the mother and other individuals were for the household head. Families were categorized as monoparental (single mothers living alone, single mothers living with others, single mothers living with her family or in-laws), nuclear, nuclear living with parents, nuclear living with others, joint families with the family of the mother and joint families with in-laws. The types of family structure were re-categorized as single mothers, nuclear, joint families and couple living with others after analysis of sociodemographic characteristics.

Further variables regarding the child's diet were obtained from the PNDS 2006 and used in chapter 10. A set of binary variables (yes/no) provided information on the types of meals the child was used to have daily, such as breakfast, lunch, dinner, and snacks. A small food frequency questionnaire was used to assess child feeding during the week preceding the survey. In addition, children were classified as exclusively breastfed for six months or not. These variables are explained further in the corresponding chapter, and described in Appendix B.

4.5 Quality of Data

Quality of data is essential for producing meaningful and reliable results. Various important factors can affect the quality of data, such as representativeness of data, sample size, collection of all important covariates and missing data (Wang, Reddy and Kon, 1995; Mann, 2003; Gliklich RE, 2014). This section discusses the quality of data used in this study.

4.5.1 Sample size and representativeness of data

The DHS surveys are randomized and both are nationally representative, allowing results at a country level. However, the sample size varies greatly between the two countries. Table 4.1 shows NFHS 2005 has the highest sample size (38,254 households interviewed), while Brazil 1996 had a considerably lower number of people interviewed (3,641 households).

4.5.2 Missing data

Missing data are unavoidable in research for a variety of reasons and encompass nonresponse at unit and item level. Unit nonresponse happens when there is complete absence of an interview from a selected household. Item nonresponse refers to the absence of answers for specific questions asked of the individual (Yan and Curtin, 2010). This section refers to item nonresponse.

The reasons for missing data in surveys are mainly due to outright refusals, followed by neglecting a question, not knowing the answer or not having the information required, or due to errors from the interviewer. Missing data can affect the reliability of results (Allison, 2001). The cumulative effect of missing data for several variables in a study can lead not only to exclusion of a substantial proportion of the original sample, but also exclusion of individuals with particular characteristics. Missing data of participants who differ from those with complete data can lead to misinterpretation of the results, and a reduced dataset can decrease the statistical power of the sample (Sterne *et al.*, 2009).

The risk of bias due to missing data depends on the reason the data are missing. The reasons can be classified as missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR). MCAR means that there are no systematic differences between missing values and observed values. MAR means that any systematic difference between the missing values and observed values can be explained by differences in the observed data. And MNAR means that independently of the observed data, systematic differences between missing and observed values remain. When data are not MCAR, measures should be taken to guarantee the representativeness of the sample and avoid biased results (Sterne *et al.*, 2009).

The DHS had higher proportions of missing data for weight and height with no apparent reason given (Table 4.4). To investigate differences in sociodemographic characteristics of measured and unmeasured children, chi-square tests were conducted between these groups. The results, together with the discussion on the results are shown in Appendix C.

Table 4.4- Percentage of missing data for weight and height in each survey and possible reasons

Dataset	Number of children	Number of missing data (%)	Indicated causes for missing data
PNDS 1996	4,680	284 (6.0)	5.0% sick 13% refused 20.1% mother refused 44.1% not present 17.2% other reason (no explanation)
PNDS 2006	5,044	436 (8.6)	30.7% because child was absent 3 times 25.6% refused 31.8% other reason (no explanation) Other missing values: No conditions in the household, or impossibility of measure
NFHS 1998-99	30,984	3,575 (11.5)	3.5% sick 4.4% refused 10.0% mother refused 12.8% not present 72% other reason (no explanation)
NFHS 2005-06	48,031	4,134 (8.6)	25.5% other reason (no explanation) 28.7% not present 45.8% refused

Assuming that the data are MCAR, the probability of missing data for weight and height is unrelated to the values of any other variables, therefore, listwise deletion can be applied. This strong assumption cannot be proved only by testing sociodemographic differences between missing and non-missing data (Allison, 2001), but, considering that this is a particular set of the questionnaire with more missing data than other questions, it could be explained by difficulties in measuring a child who did not want to be measured or refusal by the mother.

4.5.3 Quality of anthropometric measures

The WHO technical report (WHO, 1995a) on the use and interpretation of anthropometric data described several sources of errors in anthropometric measures. Some can be attributed to the measurer, others may be instrumental, such as imprecise measurements, or instrument not calibrated before the measure is taken (Gupta and Zakaria, 2014). The DHS provided training and selected the same people to perform anthropometric data to minimize these errors. The survey team collected two reading measurements of weight and height in which measures should vary minimally, or else a third measure should be taken (Rutstein and Rojas, 2006; Leibbrandt, Woolard and de Villiers, 2009; Assaf, Korthari and Pullum, 2015).

Sources of error can also come from the individual being measured. Changes in posture during measurement can affect the results; time of the day can also introduce variability if measures are taken before or after a meal - or even by the clothes the person is wearing at the time of the measurement (Gupta and Zakaria, 2014). Information about clothing of children was not given.

Once the measurements are collected, and transformed into z-scores, another way to measure the quality of data is by testing the standard deviation (SD) of Z-scores. Mei and Grummer-Strawn (2007) have shown the SD of anthropometric indicators is reasonably constant across populations, irrespective of nutritional status. Table 4.5 compared the SD obtained from each dataset with the cut-offs recommended by Mei and Grummer-Strawn (2007). The value for HAZ in the PNDS 2006 was below the reference. Values beyond the limits established by Mei and Grummer-Strawn (2007) do not necessarily imply lower quality data, because may also be a measure of heterogeneity in the population with respect to factors that affect nutrition. Unlike the populations of emerging countries, the reference population used to compute the z-score was very homogeneous in terms of nutrition, based on healthy children living in an environment that favoured the achievement of their full genetic growth potential (WHO, 2009b; Assaf, Korthari and Pullum, 2015).

Table 4.5- Standard deviation of anthropometric measures compared with reference values from Mei (2007).

	HAZ	**BMIZ**
Reference range	**1.35-1.95**	**1.08-1.55**
PNDS 1996	1.43	1.19
PNDS 2006	1.29	1.12
NFHS 1998	1.84	1.52
NFHS 2005	1.66	1.36

HAZ height-for-age; BMIZ bmi-for-age

According to the DHS evaluation of quality of data, the average number of implausible z-scores for all DHS data was 3.6% (Assaf, Kothari and Pullum, 2015). Table 4.2 shows that most of the data used in this study had an acceptable percentage of implausible values, lower than the average estimated by the DHS. Values were slightly higher for the NFHS 1998-99, but the overall evaluation of the anthropometric data, including sample size, measurement methods, proportion of missing data, as well as the mean and SD of the z-scores, indicates this is a reliable dataset to be used for the purposes of this thesis.

4.5.4 Other considerations about quality of data

Comparative research is indeed important for the literature and for the understanding of the determinants of health between countries (Wrede *et al.*, 2006). Cross-country studies face methodological, conceptual and statistical problems (Levine and Renelt, 1991). The main problems arise because using observational secondary data, the researcher has no control over the variables available, and special attention must be given to discrepancies between the data (Peterson, 2005). Examples of discrepancies involve the way of measuring and classifying different variables; the different ways of choosing the sample; sampling procedures and the time of data collection (Peterson, 2005).

Although the data used in the thesis followed the DHS methodology, the differences in questionnaires from one wave to another, or from one country to the other, generates an issue with unequal questions and the interpretation of such questions in each context. For instance, the definitions of family structure, religion, and even female work are very different in the context of Brazil and India. Those differences were harmonized to become as comparable as possible. However, issues in the interpretation can still exist.

The time of data collection is another difference between surveys used in the thesis. Data from Brazil were provided for 1996 and 2006, or a 10 year interval; and for India, there was an interval of 7 years, from 1998-1999 to 2005-2006. The most recent data for both countries were collected approximately 10 years ago and major changes in sociodemographics, nutrition and the economy have since occurred. Still, these were the latest representative data available in both countries containing information about both child nutrition and maternal work.

A third important issue to be discussed is the data on female employment. This is generally recognised to be underestimated in developing countries, because women are considered economically inactive members of society when involved in non-paid work and agriculture, or women themselves misinterpret the key words used in questionnaire as meaning paid work only (Bardasi *et al.*, 2011). The DHS includes specific questions regarding agriculture, adding the term "non-paid work" in their question, in order to reach more women. Still, errors can happen due to biases towards socially accepted norms, where women tend to underreport labour force activity as well as due to biased proxy answers when the respondent is not available, and due to interviewers holding the preconception of women as housewives (Anker, 1983).

4.6 Data Analysis

The underlying statistical theories and formulas behind the main methods utilized in the analyses are explained in this section. A more applied explanation is given within the relevant chapters where the analyses are used. Descriptive and bivariate analyses were performed, and the differences between proportions were evaluated by the chi-square test. Standard techniques included linear regression and multilevel linear regression, logistic regression, multinomial logistic regression and multilevel logistic regression and structural equation modelling, which are explained below. The theories behind the propensity score method were explained in Chapter 8, where the method was conducted. The analyses were conducted with the use of the STATA software (version 15, STATA Corp., College Station, Texas).

4.6.1 Linear Regression

Linear regression is widely used to examine associations when the response variable is continuous and a linear relationship between response and explanatory variables is assumed. In this thesis, linear regression is used mainly to study height-for-age as the outcome variable and its association with variables measuring maternal work.

If *Y* is the dependent variable, and *x* the independent variable, the expected value of Y given x can be written as:

$$E(Y|x) = \beta_0 + \beta_1 x \tag{4.1}$$

where β_0 is the intercept parameter, which determines the precise height of the line, and β_1 is the slope parameter, which determines the steepness of the line. In terms of interpretation, β_0 is the predicted value of y when x is equal to zero, and β_1 indicates the average change in y associated with a unit change in x. This structural model says that for each value of x the population mean of Y can be predicted by this linear equation, and it has one unique value for each x.

Associations between variables are almost always inexact due to certain issues such as different sources, faulty measures and missing observations, therefore, an error term e has to be included in the formula to represent this inexact component, what is written as

$$E(Y|x) = \beta_0 + \beta_1 x + e \tag{4.2}$$

The error term acknowledges that every y value does not fall exactly on the line, and then, with a given x, there may occur more than one y, and more than one line to be fitted. A prediction error can be calculated as the difference between the observed y and the predicted ($e_i = y_i - \hat{y}_i$), and the calculation of β_0 and β_1 intends to find the line with the lowest prediction error, with minimum values of the sum of the squares of the prediction error (SSE):

$$SSE = \sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 \tag{4.3}$$

To make inferences about the population, some assumptions need to be met. The first is about the sample, which should be randomly selected in order to decrease bias and errors. Posterior assumptions are: the error term should have mean zero $E(\varepsilon_i) = 0$; the variance of the error is constant for all values of x_i , which is called homoscedasticity; and the error term is normally distributed.

There is disagreement in the statistical literature about how important these assumptions are, as some assumptions are more resistant to violation than others. While a random sample, and the choice of the explanatory variables is crucial for correct estimations, the normality assumption can be "less rigorous" if the sample size is large, due to the Central-Limit Theorem. Heteroscedasticity generates invalid standard errors (Lewis-Beck and Lewis-Beck, 2015).

The "goodness of fit" of the model can be evaluated using the coefficient of determination (R^2), which tells how well the regression equation accounts for variation in the dependent variable. R^2 is calculated as the share of the variation explained by the regression equation (RSS) by the total variation in the dependent variable (TSS),

$$R^2 = \frac{RSS}{TSS} = \frac{\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2} \tag{4.4}$$

The larger the RSS is relative to TSS, the better. The possible values of R^2 varies from 0 to 1, and the closer the value is to 1, the better the fit of the regression line, and more variation in y is explained by x (Lewis-Beck and Lewis-Beck, 2015).

4.6.2 Multilevel linear regression

Many epidemiological studies need to consider the impact of the context when examining associations with a response variable. When data are collected using cluster design, such as children nested in mothers, there is a chance that observations are not independent from one another. In this case, mothers represent another level of observation, and it is likely that children from the same mother are more similar to each other compared with children from different mothers. As independence is a major assumption for using Ordinary least square[11] (OLS) models, this can be violated when the multilevel structure is ignored.

[11] OLS is a method for estimating the unknown parameters through a linear regression model that aims to minimize the sum of the squares of the predicted error

In this study, children are nested in mothers, who are nested in regions of a country. Table 4.6 shows the percentage of mothers with more than one child in each survey to demonstrate the need for using multilevel analysis in this thesis

Table 4.6- Number of mothers with one, two or more children in the PNDS (Brazil 1996/2006) and NFHS (India 1998-99/2005-06)

	Mothers with 1 child N (%)	**Mothers with 2 children N (%)**	**Mothers with 3 or more children N (%)**
Brazil 1996	3,153 (77.2)	808 (19.8)	121 (2.96)
Brazil 2006	3,480 (82.8)	645 (15.3)	80 (1.91)
India 1998-99*	21,896 (89.2)	2,653 (10.8)	-
India 2005-06*	21,624 (89.3)	2,559 (10.6)	41 (0.2)

*These numbers are based on information of children from younger than 3 years old.

Considering children *i* nested in mother *j*, the level 1 model can be written as

$$Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + e_{ij} \tag{4.5}$$

In the first level, the model is similar to a typical OLS model, as described previously in the linear regression. However, the formula includes *j* , showing that a different level-1 model is estimated for each of the level-2 units. Using children and mothers as an example, each mother has children with different average measure (β_{0j}), and different effects of covariates in children's measure (β_{1j}), allowing the intercept and slope to vary across level-2 units.

Using a level two model, β_{0j} and β_{1j} need to be rewritten as functions of level-2 predictors and variability:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j} \tag{4.6}$$

in which γ_{00} is the mean value of the dependent variable, controlling for the level-2 predictor (W_j); γ_{01} is the effect (slope) of the level-2 predictor (W_j); and u_{0j} is the error, or variability for unit *j*.

$$\beta_{1j} = \gamma_{10} + \gamma_{11}W_j + u_{1j} \tag{4.7}$$

The interpretation of this formula is similar to formula 4.6, but the level-2 effects are modelled on the slope of X_{ij}. Then, γ_{10} is the mean value of the level-1 slope controlling for the level-2 predictor (W_j); γ_{11} is the effect of the level 2 predictor (W_j); and u_{1j} is the error for unit *j*.

Substituting equation 4.5 by the level-2 predictors, the following equation is obtained:

$$\gamma_{ij} = \underbrace{[\gamma_{00} + \gamma_{10}X_{ij} + \gamma_{01}W_j + \gamma_{11}W_jX_{ij}]}_{\textit{Fixed}} + \underbrace{[u_{0j} + u_1X_{ij} + e_{ij}]}_{\textit{random}} \tag{4.8}$$

The first part of the equation is fixed, while *u* and *e* are random effects, which is why the model is called a random intercept model. Random effects refer to additional error terms or sources of variability. e_{ij} is the traditional individual level error term, and u_{0j} and u_{1j} are two additional error terms, where u_{0j} is the variability of children's measures between mothers, and u_{1j} is the variability of the relationship of the independent variable to children's measures between mothers.

The final structure of the model will be dependent on how many levels are in the data, how many predictors at each level are considered, and whether the model is a random-intercept model or random-coefficient model. This study uses a random-intercept model, so all explanations are about this type of model.

The first step to build a multilevel model is to decide whether there is variance according to upper levels. This is provided by the intraclass correlation coefficient (ICC), which measures the proportion of variance in the dependent variable that is accounted by level 2 groups. It is written as:

$$\rho = \frac{\sigma_{u0}^2}{(\sigma_{u0}^2 + \sigma_e^2)} \tag{4.9}$$

Where σ_{u0}^2 and σ_e^2 are estimates of the level-2 and level-1 variances, respectively, and are obtained by fitting a null-model (with no covariates). In the case of this study, the ICC is calculated from the variability between mothers (u_{0j}) and the variability between children from the same mothers (e_{ij}).

One of the best ways of accessing the model fit is using the likelihood ratio statistic. This method measures the lack of fit between the data and the model, and is used to compare multiple models. The likelihood ratio is obtained by multiplying the natural log of the likelihood by minus two. The difference of the deviances from each model is distributed as a chi-square statistic with degrees of freedom equal to the difference in the number of parameters estimated in each model. A lower deviance always implies better fit, but noting that increasing the number of parameters will always lead to a lower deviance is important.

The model is first applied in chapter 7 to investigate height-for-age z scores and maternal work in Brazil.

4.6.3 Logistic Regression

This thesis includes dichotomous variables when defining a child as stunted or overweight. In these cases, ordinary least squares (OLS) cannot be applied. First, problems with the functional form comes from the fact that probabilities have a value ranging between a maximum of 1 and a minimum of 0, while linear regression can extend from negative to positive infinity. Negative or positive values as regression coefficients have no predictive use for dichotomous variables. The second problem implies a violation of assumptions of normality and homoscedasticity and, therefore, variance of the errors is not constant.

Logistic regression replaces OLS to overcome these limitations, proposing to transform the probability and model the transformation as a linear function of the covariates. The first is the transformation of the probability to the odds ($\pi_i/(1-\pi_i)$). Second, the logarithm of the result is taken, or log odds, what is referred to as the logit transformation shown below.

$$L_i = \ln[\tfrac{\pi_i}{1-\pi_i}] \tag{4.10}$$

This transformation eliminates the boundaries of zero and one. In addition, the logit transformation is symmetric around the probability 0.5, and the distance of the logit from 0 reflects the distance of the probability from 0.5.

The linear relationship between covariates and the logit response variable can be written as

$$\ln\left[\frac{\pi_i}{1-\pi_i}\right] = b_0 + b_1 X_i \tag{4.11}$$

The regression coefficient b_1 can be interpreted in the same way as in linear models, where the change in one unit in X represents a change in the logit of the probability equivalent to b_1, holding all other predictors constant.

The interpretation of the estimated coefficients on the log odds scale is complicated, because there is no linearity between the logit and the probability. Instead, a meaningful interpretation can be done in terms of odds, by simply taking the exponent or antilogarithm of the regression coefficients. The exponentiated coefficient represents an odds ratio, where a coefficient of 1 leaves the odds unchanged, greater than 1 increases the odds, and lower than 1 decreases the odds. The more distant the coefficient is from 1, the greater the effect in the odds. And the probability can be obtained by the inversed odds, as shown below.

$$\pi_i = \left(e^{b_0+b_1X_i}\right)/\left(1+e^{b_0+b_1X_i}\right) \tag{4.12}$$

The maximum likelihood estimation is used to find the maximum value for the likelihood function, or the likelihood of observing pattern of occurrences (Y=1) and no-occurrences (Y=0). It can be expressed by the following formula

$$LF = \prod \{\pi_i^{Y_i} * (1-\pi_i)^{1-Y_i}\} \tag{4.13}$$

Where LF refers to likelihood, Y_i refers to the observed value of the binary response variable for each case i, and π is determined by the unknown parameters β and independent variables. The likelihood function can be turned into a logged likelihood function by taking the natural log of both sides of the equations

$$lnLF = \sum \{[Y_i * ln\pi_i] + [(1-Y_i) * \ln(1-\pi_i)]\} \tag{4.14}$$

This transformation allows the function to vary from negative infinity to zero. The log likelihood function reflects the likelihood that the data would be observed given the parameters estimates, and it can be interpreted as the deviation from a perfect or saturated model in which the log likelihood is equivalent to zero. The log likelihood can be used to compare a model including covariates (full) to an initial model, assuming all β coefficients are equal to zero (reduced).

Taking the difference between the baseline log likelihood (reduced) and the full model log likelihood multiplied by -2 gives a chi-square value with degrees of freedom equivalent to the number of independent variables

$$LR = -2[logL(\hat{\beta}_r) - logL(\hat{\beta}_f)] \tag{4.15}$$

The chi-square tests whether all coefficients, except the constant, are zero, revealing if the change in the log likelihood due to the addition of covariates could have occurred by chance.

Logistic regression was applied several times in the thesis to identify associations with a binary response variable in the presence of control variables. For instance, it was applied in chapter 5, to investigate sociodemographic characteristics among groups of working women, and in chapter 8, to determine the probability of working based on maternal characteristics.

4.6.4 Multilevel logistic regression

The multilevel model, as described in section 4.5.2 can be extended for non-continuous dependent variables, using a generalized hierarchical linear model. Considering η=logit(Y), the traditional level-1 model can be written as

$$\eta = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k \tag{4.16}$$

for k predictor variables. No term is included for level-1 error variance because, for binary variables, the variance is completely determined by the mean.

Then, the level two models that predict the level-1 regression coefficients can be constructed as before (see section 4.4.2):

$$\text{If } \eta_{ij} = logit(Y_{ij});\ \ \eta_{ij} = \pi_{0j}$$
$$\text{Level 2: } \pi_{0j} = \beta_{00} + \beta_{01} X_j + u_{0j} \tag{4.17}$$

The model has only one random effect, which is the variability of level 2.

Because there is no variability in the level-1, the intraclass correlation is replaced by the conditional intraclass correlation or residual intraclass correlation, written as

$$\rho = \frac{\psi}{\psi + \pi^2/3} \tag{4.18}$$

in which the variance ψ is equal to Var(u_{0j}) (Snijders and Bosker, 1999).

The intraclass correlation has a difficult interpretation for a binary outcome, because it does not provide a clear distinction between individual level variance and area level variance. Furthermore, it is not comparable with the fixed effects interpretation, which is given in the odds ratio scale. Therefore, the literature suggests the median odds ratio (MOR) as a more appropriate measure to assess random effects in multilevel logistic regression (Larsen and Merlo, 2005; Merlo *et al.*, 2006).

The variation between clusters can be quantified by comparing two persons from two randomly chosen clusters. The MOR is the median odds ratio between the person with higher propensity of the outcome and the person with the lower propensity of the outcome. It can be conceptualised as the increased risk when moving from one cluster to the other.

MOR is a function of the cluster variance (ψ), written as:

$$MOR = \exp(\sqrt{2 * \psi^2} * \Phi^{-1}(0.75)) \tag{4.19}$$

where $\Phi(.)$ Is the cumulative distribution function of the normal distribution with mean 0 and variance 1, $\Phi^{-1}(0.75)$ is the 75th percentile, and exp is a exponential function. If the MOR is equal to 1, there is no variation between clusters, while if MOR is higher than 1, there is between-cluster variation.

This model was used in chapter 7 to investigate the effect of maternal work on the likelihood of having a stunted child in India, considering the multilevel structure of the data. Four different models were estimated, each including new variables as covariates. The maximum likelihood was used to evaluate the different models, as explained in section 4.5.3, in which an improvement of the model would be noticed by a reduction in the log likelihood, and a significant chi-square.

4.6.5 Multinomial Logistic Regression

Multinomial regression is used to analyse categorical variables with more than two categories that are not ordered. In this study, multinomial regression is used to compare sociodemographic and work characteristics of different groups of women, such as mothers of young children, mothers of older children, and non-mothers in Chapter 5.

Consider that a variable Y_i can take one of several discrete values {1,2,…,J}, the probability that the i-th response falls in the jth category can be written as

$$\pi_{ij=}\Pr\{Y_i = j\} \tag{4.20}$$

The probabilities for each category add up to one, generating J-1 parameters. One response category is defined as a baseline or reference cell, and all the log-odds for other categories are relative to the baseline π_{i1}/π_{iJ}.

In the multinomial logit model, it is assumed that the log-odds of each response follows a linear model

$$\eta_{ij} = log(\pi_{ij}/\pi_{iJ}) = \alpha_j + X'_j\beta_j, \tag{4.21}$$

where α_j is the constant, and X' is a vector of regression coefficients for j=1,2,…J-1. Although the model is similar to a logistic regression model, the distribution of the response is multinomial when J-1 is equal or higher than two. When J=2 , the multinomial logit model reduces to the normal logistic regression model, as the distribution becomes binomial. For instance, if J=3, and category 3 is the reference, results will compare "1 and 3" and "2 and 3". The missing comparison between categories 1 and 2 can be calculated in terms of the other two formulas, where $log(\pi_{i1}/\pi_{i2}) = log(\pi_{i1}/\pi_{i3}) - log(\pi_{i2}/\pi_{i3})$.

Instead of using log odds, the multinomial model can be written in terms of the original probability. For this, it is assumed that $\eta_{ij} = 0$,

$$\pi_{ij} = \frac{\exp\{\eta_{ij}\}}{\sum_{K=1}^{J} \exp\{\eta_{ik}\}} \tag{4.22}$$

A maximum likelihood estimation of the parameters is again used to examine the fit of the model and decide between selected models.

4.6.6 Structural Equation Modelling (SEM)

SEM is a statistical technique used to evaluate the mechanisms through which independent variables can affect a dependent variable by testing mediators between associations. This method has the advantage of allowing multiple causes and multiple outcomes to be tested at the same time, evaluating mediators of associations, as well as direct and indirect effects of variables. Additionally, SEM has the ability to address reliability of measurement instruments by explicitly addressing the issue of measurement error (Buhi, Goodson and Neilands, 2007).

SEM combines measurement models and structural models. The measurement model enables the use of multiple indicators (observed variables) to create latent variables [12], and it is equivalent to performing a confirmatory factor analysis. In this approach, the constructs are specified by the literature, and the model is fitted with two goals. The first goal is to obtain the parameters of the model (factor loadings, variances, covariances and residual error), and the second, to assess the fit of the model, or how well the scale measures the construct (Hox and Bechger, 2007).

Once the measurement model has been defined, the structural model consists of examining the paths between the latent variables and the other variables proposed in the theory. Using the path analysis, the direct effect can be established as the directional relationship between two variables,

[12] Latent variables are variables that cannot be directly measured or observed, but only inferred from the covariation and variation among a set of observed variables, or indicators.

while an indirect effect is the influence of one variable in another through one or more mediating variables (Buhi, Goodson and Neilands, 2007).

The method most widely used for the estimation of SEM is Maximum Likelihood estimation, which requires the assumption that the data follow a multivariate normal distribution, and the minimum number of observations is 200.

The goodness of fit of the model is evaluated according to the chi-square, the RMSEA (root mean squared error of approximation), CFI (Comparative fit index) and the SRMR (standardized root mean squared residual). The chi-square compares the model to a saturated model with no degrees of freedom, measuring whether the model reproduces the covariance matrix accordingly. A significant chi-square according to its degrees of freedom means the model is failing to significantly reproduce the covariance matrix. This measure is very sensitive to sample size, not always reflecting correctly the goodness of fit of the model (Maslowsky, 2015). Then, another proposed way to evaluate this is to report X2/df ratio, where a value between 2 and 5 represents a good fit of the data (Buhi, 2007).

The CFI compares the estimated model with a baseline model that assumes items are unrelated to each other, indicating how much better the estimated model does in comparison with a null model. This value is defined by

$$CFI = 1 - \frac{\max(chi - squared - df, 0)}{\max(chi - squared - def, baseline\ chi - squared - df)} \tag{4.23}$$

The recommended cut-off values for CFI are either 0.95, or 0.90 in less restricted models.

The RMSEA considers how much error there is for each degree of freedom. Considering that additional paths for loadings, correlated errors or other dimensions use additional degrees of freedom, unnecessary added complexity can penalize the model fit. The RMSEA is defined as

$$RMSEA = \sqrt{\frac{T/(N-1)}{df}} \tag{4.24}$$

Where T= max (model chi-squared-df,0), and N= sample size. The recommendation for best fit of the model is a value lower than 0.05.

The SRMR measures how close the estimated model reproduces each correlation, on average, with a recommended value of less than 0.08.

SEM was used in chapter 9 to investigate whether the association between maternal work and child's BMI was mediated by the child's diet. The measurement part of the model was used to define constructs of healthy and less healthy diet, while the structural part of the model tested the associations between independent, mediator, and response variables.

Chapter 5: Female labour force participation in Brazil and India

5.1 Introduction

India and Brazil have seen pronounced economic growth over the last two decades, which can lead to increases in FLFP. Several studies have explained the links between economic growth and changes in FLFP, when economic growth leads to increased work opportunities (Boserup, 1970; Goldin, 1994; Heath and Jayachandran, 2016), and decreases in gender gaps in education and employment (Blecker and Seguino, 2002; Klasen, 2002) (see section 3.2 for the theories behind changes in FLFP).

A woman's decision to join the labour force is complex and determined by the macro context as well as household and individual characteristics. While economic growth and culture influence the possibilities and types of work available for women, the individual decision depends on the context in which women live, and whether work is a necessity or a matter of personal fulfilment. Particularly for mothers of young children, the characteristics of the family, conditions of care for the child, and the amount paid when working are of great importance in the decision to work.

The whole context that influences a woman's decision to work can also influence child nutrition and whether work will create an environment that favours or prevents optimal child growth. In cases where economic growth is generating better work opportunities, it is likely that maternal work increases household income, affecting the child positively in many aspects. However, if maternal work is driven by necessity, not improving conditions for the child, it might have negative effects for child health and nutrition.

The understanding of how female work has changed over the years is important to contextualize maternal work in Brazil and India, serving as a base for further hypotheses of how maternal work affects child nutrition. This investigation has to take in account that, according to the theory of allocation of time proposed by Becker (1965) and Willis (1973), the decision to join the labour force is different for mothers and women with no children, and sociodemographic characteristics of women who work might not be the same as non-working women.

This chapter aims to answer questions 1, 2 and 3 of the thesis, contextualizing female work and the population of study (mothers of young children) among other women in each country. It investigates differences in characteristics of work for both periods, and whether there are observed differences in background characteristics and types of work undertaken by mothers of pre-school children compared with other women.

The use of data from only two data points - before and after the BRICS formation- is a limitation for a broader understanding of changes in the work force during this period. Still, the comparison of findings from one year to another provides a chance to discuss the apparent changes in FLFP in Brazil and India and characterize the population of study among national figures. The analyses show both a cross-country comparison aiming to verify differences between Brazil and India, and also a between waves comparison aiming to verify changes over the time in each country.

5.2 Methods

5.2.1 Working characteristics

The previous chapter described the variables referring to work in the surveys used in this study. Several questions were asked in each survey to characterize work (see Table 4.3, section 4.3.2), but the same variables were not provided for all countries. For instance, the questionnaire for Brazil 2006 was changed according to the interests of the Brazilian Ministry of Health and data on occupation and seasonal work were not provided. The definitions of types of work were also different between countries. In order to harmonize the data and make it as comparable as possible, changes to the data are reported below, and a summary of working variables provided by each country is shown in Table 5.1.

The question regarding the “type of work” was presented in different ways between waves (Table 5.1). The PNDS 1996 collected information on whether women were “employed” or “self-employed”. In Brazil 2006, it was asked whether individuals who worked had proof of employment or not, where those with no signed proof were considered self-employed. This was based on the fact that employed individuals in the formal sector are required by law to have a signed contract to receive the benefits and rights of employment and the fact that most informal jobs in Brazil are associated with self-employment, such as street vendors, door-to-door saleswomen, and commercial agents (Coletto, 2010).

Data in India was provided on whether the woman worked for the family, for other people, or for themselves. The majority of women working for the family were classified as unpaid work (91.7%), what according to the latest version of the International Conference of Labour

Statisticians (ICLS, 2013a) is considered self-employment. The distinction between paid and unpaid work, as well as the particularities of family work are important for the purposes of this study, with possible different outcomes for child nutrition. Therefore, the variable describing "type of work" was created with the categories "work for other", "work for the family", and "self-employed".

The variable "place of work" was created based on the information on whether the mother worked at home or outside of the home.

Data were provided on the type of activity performed at work, generating around 80 categories. Those 80 categories were classified into groups of occupation according to the International Standard Classification of Occupations, which defines ten major groups (ISCO, 2012). Due to the small number of people in each major group, these were combined in four groups according to the proximate level of knowledge needed for each occupation: 1) Managers, professionals, technicians and clerical support workers; 2) Services, sales workers and elementary occupations; 3) Agricultural, forestry and fishery workers; 4) Skilled occupation (includes craft and related trade workers). Data for occupation was not provided for Brazil 2006, and for 1996, there were very few women working in the skilled category (2.0%). These women were grouped together with those working in services, given their similarity in education and socioeconomic status.

Periodicity of work was defined as regular work or seasonal. The variable was used only for India, given that a great share of agriculture work is seasonal, and there was a high percentage of women in this type of work. In Brazil, this information was provided only in 1996, when the percentage of women in seasonal work was small.

Data were also provided on whether the women were paid or not. For India, the questionnaire asked about payment in cash, cash and kind or only kind. A dummy variable was created, in which those receiving any cash were classified as "1" and those earning only kind or not paid as "0". This variable was not considered for Brazil, because only 5.0% of women did not earn cash in 1996, and all were paid cash in 2006.

Another question asked whether, at the time of data collection, non-working women had worked in the previous 12 months. The PNDS 2006 had additional information on the reason for leaving work, and the reason for never working among those who reported so.

Table 5.1- Data collected on work characteristics in each country/wave.

	Brazil 1996	Brazil 2006	India 1998-99	India 2005-06
Type of work (Employed/ Self-employed)	-Self-employed -Employed	-Registered worker (employed) -Non registered worker (self-employed) -Civil servant (employed)	-Paid employee -Self-employed -Unpaid worker	Not provided, defined from the variable work for who
Work for who (for family member, for someone else, self-employed)	N/P	N/P	-For family member -For someone else -Self-employed	For family member -For someone else -Self-employed
Occupation (Professional, Services, Agriculture, Skilled)	1-Professionals (technicians, professionals, managers, clerical) 2- Services (sales, domestic, service, unskilled manual) 3- Agriculture 4- Skilled	N/P	1-Professionals (technicians, professionals, managers, clerical) 2- Services (sales, domestic, service, unskilled manual) 3- Agriculture 4- Skilled	1-Professionals (technicians, professionals, managers, clerical) 2- Services (sales, domestic, service, unskilled manual) 3- Agriculture 4- Skilled
Place of work (at home/ away)	At home away	At home Away	At home Away	At home away
Periodicity (regular/ seasonal)	-All year -Seasonal -Occasional	N/P	-All year -Seasonal -Occasional	All year -Seasonal -Occasional
Earnings (cash, non-cash)	Cash -Not cash	N/P	- Not paid -Cash only -Cash and kind Kind only	- Not paid -Cash only -Cash and kind Kind only
Additional information	-worked in the last 12 months	-worked in the last 12 months -worked anytime in life -Reason for never working -Reason for leaving work	-worked in the last 12 months	-worked in the last 12 months

5.2.2 Multinomial logistic regression

In view of Becker's theory suggesting that work is less attractive when women have to reconcile work and family, the decision to work can be influenced by whether there is a young child in the household. To provide a better understanding of differences in the prevalence of working between mothers and other women, women were divided in three categories: those with children younger than five years old, those with children above five years old and women without children. The number and percentage of women in each group is presented in table 5.2. Multinomial regression analysis was used to answer the second research question, exploring whether working mothers of young children were systematically different from other groups of working-women. This method is described in chapter four (see section 4.5.5), and applied to the context below.

Table 5.2 - Number and percentage of women in each group in Brazil and India.

	Brazil 1996 (%)	Brazil 2006 (%)	India 1998-99 (%)	India 2005-06 (%)
All women	8,828	11,489	86,938	96,130
Mothers <5	3,460 (39.2)	3,534 (30.8)	36,438 (41.9)	37,700 (39.2)
Mothers >5	4,772 (54.1)	6,582 (57.3)	41,873 (48.2)	49,469 (51.5)
No children	596 (6.8)	1,372 (12.0)	8,627 (9.9)	8,961 (9.3)

The reference category in this analysis was working mothers of older children, with the other groups of women generating two different logit equations: the first comparing working mothers of young children with working mothers of older children, and the second comparing working women with no children to working mothers of older children.

Let $\{\pi1, \pi2, \pi3\}$ denote the response probabilities. Considering 1 as working mothers of young children; 2 as working mothers of older children (reference); and 3 as working women with no children, the logit model uses *log*$(\pi1/\pi2)$ and *log*$(\pi3/\pi2)$.

For each logit model, independent variables included were age (categorized into groups 18 to 24, 25 to 34, and 35 or more), region (urban and rural), education, wealth, and religion. The last three variables were measured differently in Brazil and India. In India, education was categorized as "no education; primary education; secondary education; and higher secondary or more"; and wealth was divided in quintiles of wealth. For Brazil, due to small numbers of women with no education and a smaller dataset, education was categorized as "up to primary; secondary; and above secondary" and wealth was divided in tertiles of wealth. Religion in India was defined as "Hindu; Muslim, Other", while in Brazil, with majority of the population composed of Christians (either Catholic or Protestant), it was categorized as "Christians, or other". Interactions between education and wealth were tested, but due to non-significance, interactions were not included in the results.

5.3 Results

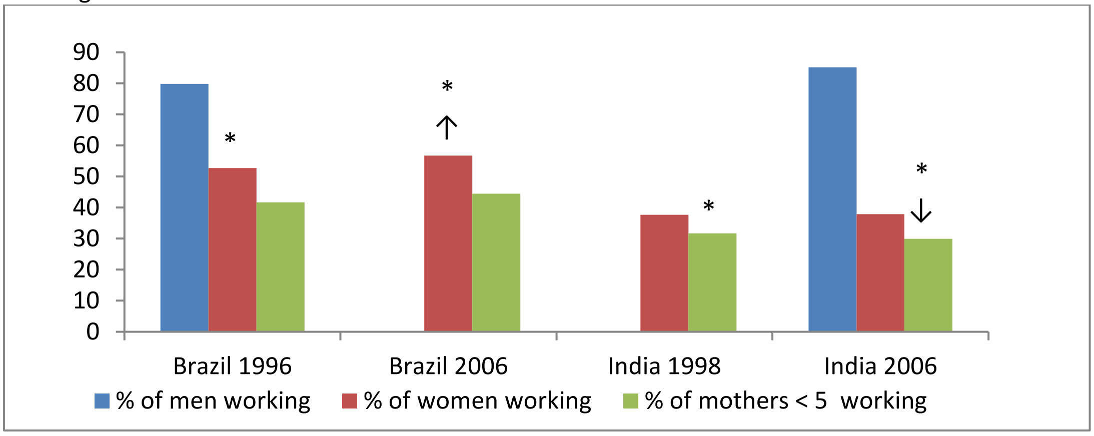
5.3.1 Female work before and after the BRICS formation

The percentage of individuals working, by gender, and of mothers of young children in Brazil and India in the DHS sample is shown in Figure 5.1. Information on men's work was not provided for

Brazil in 2006 and India in 1998-99, but estimates obtained from the World Bank data for similar years showed the rate of employment for men as 79.1% and 82.8%, respectively [13]. The figures for both countries show higher rates for males than females, and the gender gap is much greater in India than in Brazil.

For all women interviewed in each survey, there was a statistically significant increase in rates of women working in Brazil (from 52.7% in 1996 to 56.7% in 2006; p=0.001); while no changes were observed in India (37.7% in 1998 and 37.9% in 2006; p= 0.695). The percentage of working mothers of young children also increased slightly in Brazil between 1996 and 2006 (from 41.7% to 44.5%), while in India, numbers decreased from 31.7% in 1998-99 to 29.9% in 2005-06 (p=0.019).

Figure 5.1- . Percentage of men, all women and mothers of young children reporting to be currently working



Note: * Significant difference between waves.

Changes in rates of female work have not been uniform by socioeconomic status. Overall, changes in Brazil were observed mainly in the higher wealth quintiles, and the difference in the percentage of women working between the richest and the poorest has increased from 10.7% to 23.3% (Table 5.3). India saw opposing figures in comparison to Brazil, where higher rates of female work were found among poorer quintiles of wealth.

[13] Labour force participation rate, male (% of male population ages 15+). The World Bank data. Webpage: https://data.worldbank.org/indicator/SL.TLF.CACT.MA.ZS?end=2017&start=1996. Accessed on 15 January 2018.

Table 5.3- Percentage of working women according to wealth quintiles in Brazil (1996 and 2006) and India (1998-99 and 2005-06).

	Year	Q1	Q2	Q3	Q4	Q5	Q5-Q1	Overall
Brazil	1996	43.8	50.9	55.2	58.5	54.5	10.7	51.2
	2006	43.9	50.8	60.2	63.5	67.2	23.3	54.2
India	1998-99	47.1	43.5	44.7	29.0	20.6	-26.6	37.7
	2005-06	46.8	47.2	43.6	31.7	22.1	-24.7	37.9

Note: Further information on the percentage of female work according to wealth quintiles and other sociodemographic characteristics are provided in Appendix D.

Table 5.4 shows how rates of female work varied by groups of women in Brazil and India. Both countries had low rates of pregnant women and higher rates of mothers of older children within the labour force. In Brazil, about four in ten mothers of young children were working in both waves, and six out of ten mothers of older children and women with no children were working. A slight non-significant increase in rates of working women was observed for all groups between waves. In India, women with no children had lower rates of working, similar to mothers of young children, with three out of ten in the labour force, and mothers of older children were the ones most involved with economic activities. Between waves, mothers of older children had non-significant increase in rates of working, while significant decrease was observed among mothers of young children.

Table 5.4- Percentage of different groups of women considered to be currently working in Brazil and India.

	% all women working	% mothers <5 working	% mothers >5 working	% women with no children working
Brazil 1996	52.7	41.7	60.0	58.1
Brazil 2006	56.7	44.5	62.1	62.4
P value	***	*N/S*	*N/S*	*N/S*
India 1998-99	37.7	31.7	43.9	32.2
India 2005-06	37.9	29.9	45.2	30.8
P value	*N/S*	*	*N/S*	*N/S*

*<0.05; ** <0.01; *** <0.001; N/S Non significant

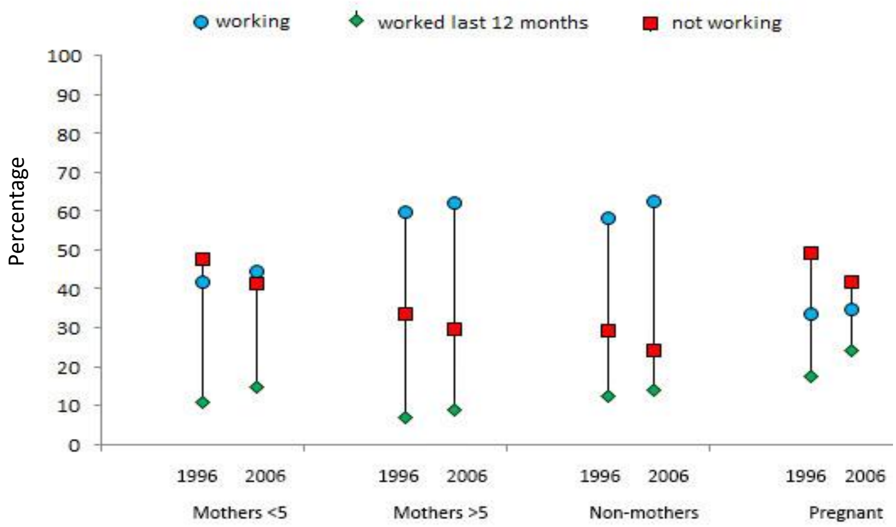
It is difficult to understand these women's trajectories of work with the use of cross-sectional data, since no information is provided on whether mothers of young children or pregnant women were on maternity leave or whether women changed their working status just before or after data collection. Data on non-working women who were working in the 12 months before data collection can provide insight into the trajectories of female work. In Brazil, the rates of women working in the 12 months prior to interview increased particularly for mothers of young children and pregnant women. For India, rates of mothers who worked in the previous year increased for all groups of women, alongside decrease in rates of working women.

The results so far suggest that economic growth resulted in significantly higher rates of female work in Brazil, with slight increases for all groups of women, affecting mainly those in higher socioeconomic status. In India, economic growth did not affect rates of female work, and a significant decrease was observed for mothers of young children. The highest rates of work for both waves were found among women with lower socioeconomic status.

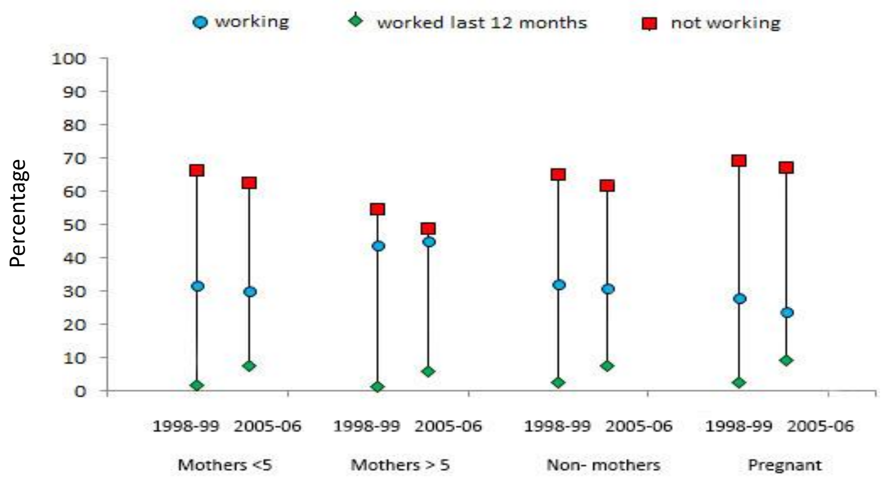
The next section investigates whether groups of women are systematically different, and whether such differences might explain the dissimilar rates of work between groups of women.

Figure 5.2- Percentage of female working status (currently working, not working, and working in the previous 12 months) by groups of women in Brazil 1996 and 2006 (A) and India 1998-99 and 2005-06 (B).

A)Brazil



B) India



Note: The group non-mothers refer to women with no children.

5.3.2 Sociodemographic characteristics of groups of women and working women

The main difference between women with no children, mothers of young children and mothers of older children is their age. The first two groups are expected to be younger, while mothers of older children are expected to be older. Differences in age are also related to other characteristics that can influence labour force participation and the type of work performed by these women such as education and work experience. Figure 5.3 A-D shows the age distribution for the two waves in each country. For both rounds, India had lower age of mothers compared with Brazil, showing that first pregnancy in India happens earlier. Note that neither countries experienced important changes in the age structure of these groups of women.

Examining the sociodemographic characteristics of each of the groups of women, Brazil had important changes in education, with increases in higher secondary and tertiary education. Women with no children, the youngest group, were the most affected by changes in the education system, with the highest increases in percentages of higher secondary and tertiary education from 1996 to 2006 (Table 5.5). Mothers of older children were a heterogeneous group, with the highest rates of women with no education or primary education in 1996 (49.1%), and better rates of women in tertiary education (6.0%) than mothers of young children (5.2%). Although the trends remained the same in 1996 and 2006, mothers of young children experienced greater increases in the prevalence of higher secondary education over the years (20.0% in 1996 and 38.7% in 2006) compared with mothers of older children (16.8% in 1996 and 28.1% in 2006). In 1996, mothers of young children were found among the poorest wealth quintiles (26.1%), and mothers of older children and women with no children had higher rates of women among the richest wealth quintiles (24.1% and 22.7%, respectively). In 2006, similar rates of mothers of young and older children were found in the poorest wealth quintile, but mothers of young children remained with the lowest percentage in the richest wealth quintile (14.9%).

India also experienced changes in education, with increases in secondary education for all groups of women. Small rises in tertiary education were observed, particularly for women with no children (6.5% in 1998-99 and 10.1% in 2005-06). For both years, there was a higher percentage of mothers of young children in the poorest wealth quintile, and in contrast to Brazil, mothers of older children were in an advantaged position, with the highest in the richest wealth quintile, despite their lower levels of education compared with other women.

Figure 5.3- Box plot of age for each group of women in Brazil and India across time (non-mothers refer to women with no children).

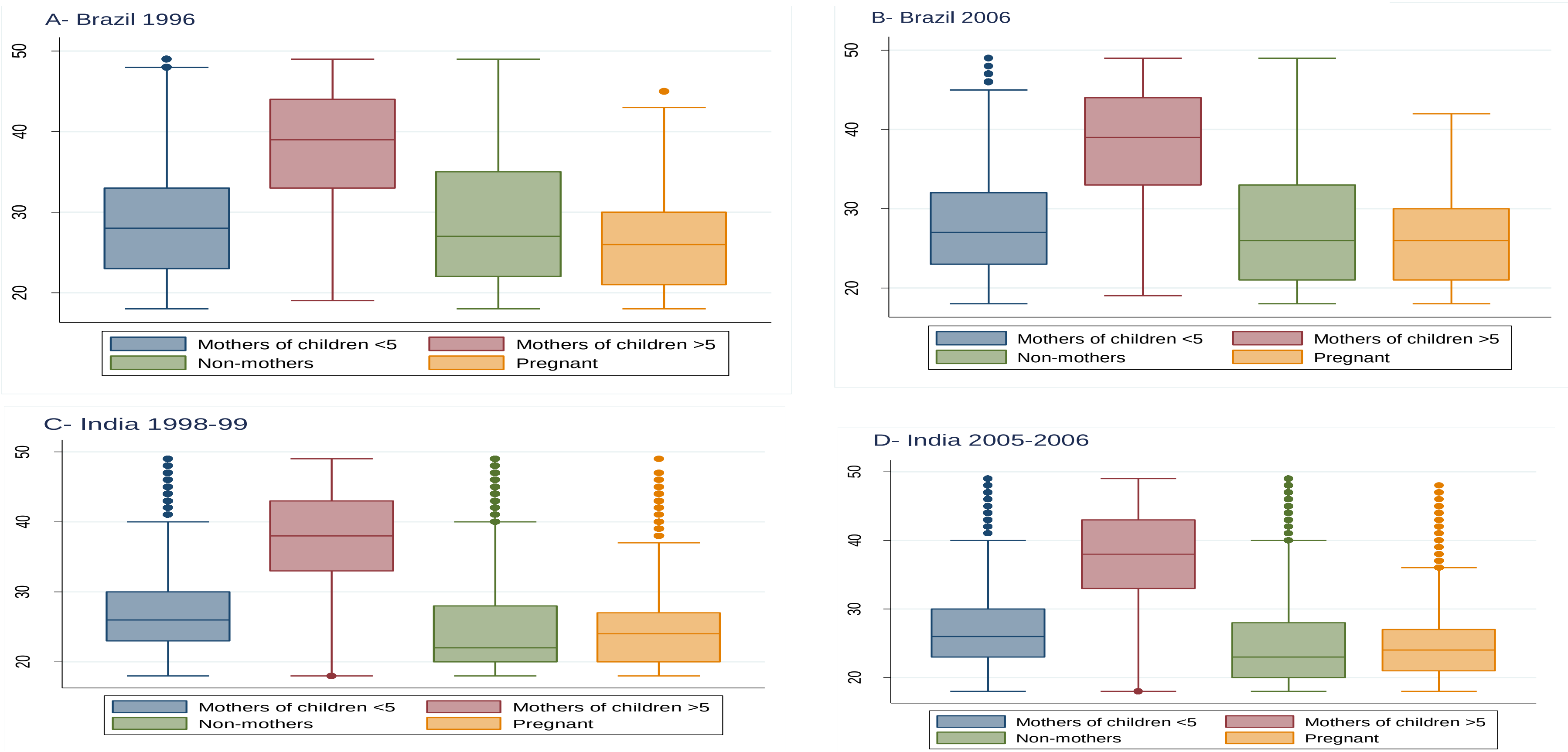


Table 5.5- Sociodemographic characteristics of groups of women in Brazil and India (M<5 mothers of young children; M>5 mothers older children; NC- women with no children; N/A non-applied).

	Brazil 1996				Brazil 2006				India 1998-99				India 2005-06			
	Overall	**M<5**	**M>5**	**NC**	**Overall**	**M<5**	**M>5**	**NC**	**Overall**	**M<5**	**M>5**	**NC**	**Overall**	**M<5**	**M>5**	**NC**
Age group																
18-24	15.3	30.7	1.6	36.3.	18.3	38.4	2.6	42.3	24.7	41.5	2.0	64.4	22.5	39.9	1.5	64.6
25-34	37.8	51.1	28.0	38.8	33.6	45.1	27.3	33.8	38.3	49.3	32.0	21.9	37.8	50.5	30.8	23.1
35+	46.9	18.2	70.4	25.4	48.1	16.4	70.1	23.9	37.0	9.2	66.1	13.7	39.7	9.6	67.7	12.3
p value		<0.001				<0.001				<0.001				<0.001		
Education																
No education	6.9	5.8	8.0	4.3	4.0	2.4	5.4	1.7	53.9	54.4	55.0	46.0	48.0	47.2	50.9	35.6
Primary	38.5	36.7	41.1	28.2	21.1	15.8	26.2	10.7	16.2	14.6	18.0	14.3	15.2	13.6	16.4	15.2
Secondary	29.6	32.2	28.1	26.0	29.7	34.5	29.4	19.2	21.8	22.1	20.3	27.2	26.0	27.4	23.9	31.4
Higher secondary	18.8	20.0	16.8	27.2	33.9	38.7	28.1	49.0	4.0	4.4	3.1	6.0	4.9	5.6	4.0	7.7
Tertiary	6.2	5.2	6.0	14.2	11.2	8.7	10.9	19.3	4.2	4.3	3.6	6.5	5.9	6.2	4.9	10.1
p value		<0.001				<0.001				<0.001				<0.001		
Wealth quintile																
Poorest	18.4	26.1	13.4	13.5	20.0	21.7	20.0	16.1	17.6	20.8	14.7	17.3	21.1	26.6	17.2	20.7
2nd	19.8	21.3	18.9	18.9	18.9	20.3	18.9	15.0	20.5	23.0	18.3	20.9	20.7	22.7	19.4	19.8
3rd	20.3	19.6	20.5	23.0	20.2	20.8	19.1	23.9	20.0	19.4	20.5	19.6	19.9	18.9	20.7	20.0
4th	20.6	17.0	23.0	21.9	21.4	22.4	20.6	22.5	20.7	19.4	21.8	20.6	19.4	16.6	21.3	20.2
Richest	20.8	15.9	24.1	22.7	19.6	14.9	21.5	22.5	21.3	17.5	24.5	21.7	18.9	15.2	21.5	19.3
p value		<0.001				<0.001				<0.001				<0.001		
Religion																
Hindu	N/A				N/A				81.8	79.7	83.4	82.4	81.5	78.9	83.2	82.4
Muslim	N/A				N/A				12.5	15.2	10.2	11.9	13.1	16.4	10.7	12.9
Christian	91.9	91.2	92.5	90.9	87.6	87.8	88.5	82.5	2.6	2.4	2.8	2.7	2.3	2.0	2.5	2.1
Other	8.1	8.8	7.5	9.1	12.4	12.2	11.5	17.5	3.2	2.7	3.6	3.0	3.2	2.7	3.6	2.6
p value		0.008				0.003				<0.001				<0.001		
Region																
Urban	81.0	77.9	83.2	81.4	82.8	81.7	83.0	85.1	26.8	23.6	29.5	27.0	31.3	27.2	34.4	31.4
Rural	19.0	22.1	16.8	18.6	17.2	18.3	17.0	14.9	73.2	76.4	70.5	73.0	68.7	72.8	65.6	68.6
p value		<0.001				0.188				<0.001				<0.001		

Brazil and India differed enormously in terms of religion and region of residence. Brazil had a majority of Christians in both years, but between 1996 and 2006, there was an important increase in the percentage of women with no children who reported to follow other religions. In India, the majority of women were Hindu, while the percentage of Muslims was higher among mothers of young children than other women. Brazil had a majority population living in urban areas in both years (82.8% in 2006), while in India, the majority of the population was living in rural areas (68.7% in 2005-06). Among groups of women, the percentage of mothers of young children living in rural areas in India was significantly higher than for other women.

The descriptive analysis so far has shown that the group under study in this thesis (mothers of young children) tended to be poorer than other groups of women in both countries and to have lower levels of tertiary education in Brazil. However, the figures are different when comparing groups of women who were working and not working. The differences in education and wealth for working and non-working women in Brazil and India are observed in Figures 5.4 and 5.5 (Tables with percentages are provided in Appendix D.2).

In Brazil, the percentage of women with more than higher secondary education was considerable greater among working women in 1996. This was particularly observed for women with no children, in which 23% of those who were working had tertiary education, compared with 2.1% of those not working. The overall improvement in educational levels in 2006 contributed to a reduction in the discrepancy in education between working and non-working women. Still, higher percentages of women with tertiary education were observed among working women in 2006. Working mothers of young children had similar rates of tertiary education as working mothers of older children in both years, but this group also had higher rates of women with higher secondary education.

Similarly, percentages of women in the richest wealth quintiles were higher among working women in both years, whereas working women with no children had the highest rates in the richest quintile of wealth. These results suggest that working women in Brazil were in an advantageous position in terms of schooling and wealth compared with non-working women.

Figure 5.4- Education according to working (W) and non-working (NW) groups of women in Brazil and India (NWW= non-working women; WW= working women. A) Brazil in 1996; B) Brazil in 2006; C) India 1998-99; D) India 2005-06

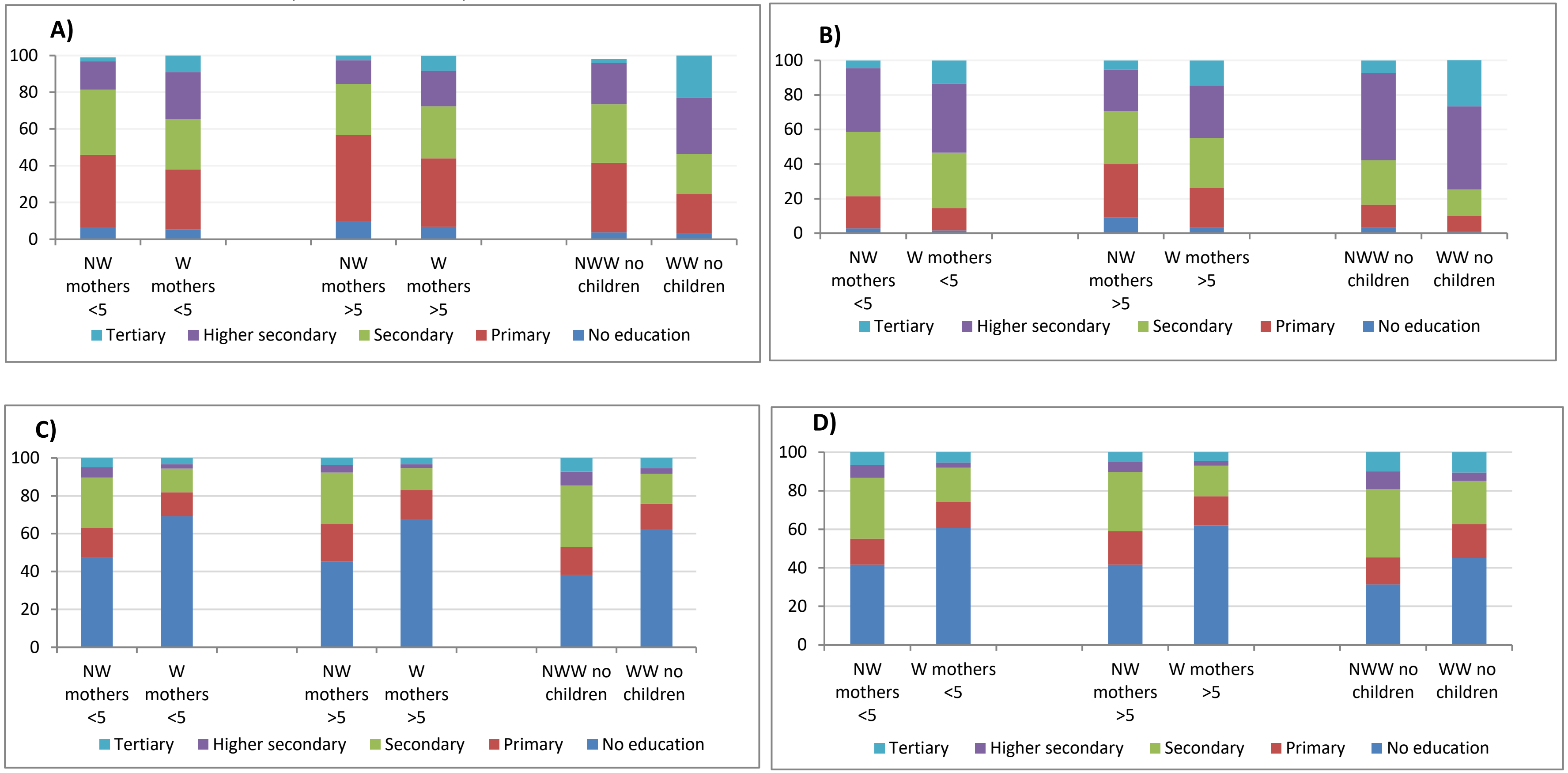
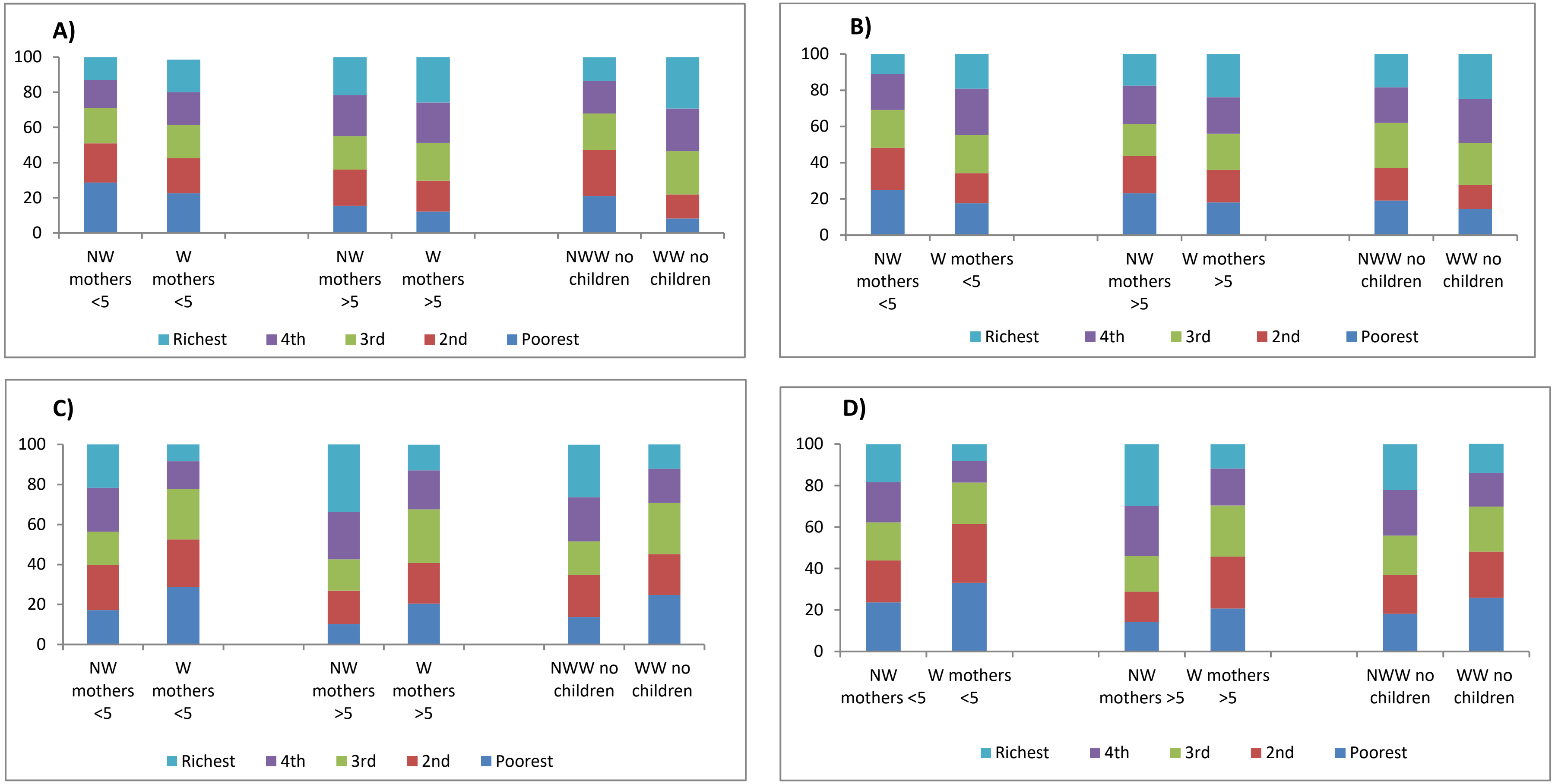


Figure 5.5- Wealth according to working (W) and non-working (NW) groups of women in Brazil and India (NWW= non-working women; WW= working women). A) Brazil in 1996; B) Brazil in 2006; C) India 1998-99; D) India 2005-06



In India, improvement in educational levels of working women were mainly observed among women with no children, who had similar rates of tertiary education as non-working women in the same group. For all groups of women, working women had higher rates of low education when compared with non-working women, whereas working mothers of young and older children had similar figures in both years. On the contrary, rates of working women in the highest wealth quintiles decreased for all mothers from 1998-99 to 2005-06, from which working mothers of young children were in the most disadvantageous position.

These initial descriptive analyses outline some important differences between the working and non-working groups of women in Brazil and India. A further step is to evaluate whether these differences are significant when controlling for covariates. Two questions that emerge from the initial analyses are: "Are there differences in sociodemographic characteristics of working mothers of young children compared with other working women?" and "Are there differences between working mothers of young children and non-working mothers of young children?". Both questions are important for the understanding of the population of study, and for the next chapters, where outcomes for children of working and non-working mothers are evaluated.

In order to answer the first question, a multinomial model was estimated comparing sociodemographic characteristics between groups of women who were working, with the reference category "working mothers of older children". For both countries, results followed the expected trend showed in the descriptive analysis. For working women in Brazil (Table 5.6), mothers of young children and women without children were significantly younger and better educated than mothers of older children, and women without children had the highest education among all groups. In 1996, mothers of young children were less likely to be in higher tertiles of wealth compared with mothers of older children, but no differences among these groups were found in 2006, while women without children had higher odds of belonging to richer tertiles of wealth. Both groups, mothers of young children and women without children, had higher likelihood of living in rural areas compared with mothers of older children in 1996, but no differences were found in 2006.

In India (Table 5.7), working mothers of young children and women without children were more likely to be younger and better educated compared with working mothers of older children in both waves, where the odds ratio of tertiary education for women without children was three times higher than for mothers of young children in 2005-06. Still, for both years, working mothers of young children and women without children were less likely to be found in higher quintiles of wealth when compared with working mothers of older children. Both groups of women had a higher likelihood of being Muslim in both waves, and mothers of young children were more likely to live in rural areas in 2005-06.

Table 5.6- Estimated odds ratio and 95%CI from multinomial logistic regression of sociodemographic characteristics of groups of women who worked in Brazil in 1996 and 2006 (reference group: working mothers of children>5).

	Brazil 1996		**Brazil 2006**	
	M<5	NC	M<5	NC
Age group				
15-24	1	1	1	1
25-34	**0.12(0.08-0.18)**	**0.06 (0.04-0.11)**	**0.14 (0.09-0.20)**	**0.08(0.05-0.13)**
35+	**0.02 (0.01-0.03)**	**0.02 (0.01-0.03)**	**0.02 (0.01-0.03)**	**0.03 (0.02-0.04)**
Religion				
Christian	1	1	1	1
Other	1.04 (0.77-1.42)	1.16 (0.74-1.81)	1.02 (0.75-1.38)	1.48 (0.99-2.20)
Education				
No education/primary	1	1	1	1
Secondary	1.00 (0.79-1.27)	1.02 (0.68-1.55)	**1.37 (1.01-1.84)**	0.98 (0.57-1.67)
Above sec	**1.90 (1.51-2.40)**	**3.61 (2.51-5.21)**	**1.59 (1.14-2.22)**	**3.19 (1.95-5.20)**
Wealth tertile				
Poorest	1	1	1	1
2nd	**0.45 (0.36-0.56)**	1.37 (0.92-2.04)	1.03 (0.81-1.31)	**1.54 (1.07-2.22)**
Richest	**0.44 (0.36-0.56)**	1.16 (0.76-1.76)	1.20 (0.90-1.61)	**1.49 (1.03-2.17)**
Region				
Urban	1	1	1	1
Rural	**1.34 (1.06-1.68)**	**2.07 (1.47-2.90)**	0.76 (0.59-0.99)	1.08 (0.71-1.65)

M<5 Mothers of young children; NC= women with no children. Bold= statistically significant

The next question tests the differences in sociodemographic characteristics of working and non-working mothers of young children, as they are the group of study for the next chapters. A logistic model was conducted to compare sociodemographic characteristics between these two groups of women, in which non-working mothers of young children was the reference category (Table 5.7 for Brazil and 5.8 for India).

Table 5.7- Estimated odds ratio and 95%CI from multinomial logistic regression of sociodemographic characteristics of groups of women who worked in India (reference group: working mothers children>5).

	India 1998-99		India 2005-06	
	M<5	NC	M<5	NC
Age group				
15-24	1	1	1	1
25-34	**0.08 (0.07-0.09)**	**0.03 (0.02-0.03)**	**0.08 (0.07-0.09)**	**0.02 (0.02-0.03)**
35+	**0.008 (0.007-0.01)**	**0.01 (0.01-0.02)**	**0.009 (0.008-0.01)**	**0.008 (0.007-0.01)**
Religion				
Hindu	1	1	1	1
Muslim	**1.86 (1.55-2.23)**	**1.40 (1.10-1.80)**	**1.98 (1.66-2.36)**	**1.42 (1.09-1.85)**
Other	1.12 (0.94-1.32)	1.21 (0.90-1.62)	**1.24 (1.04-1.48)**	1.18 (0.91-1.53)
Education				
No education	1	1	1	1
Primary education	**0.75 (0.67-0.84)**	**0.80 (0.66-0.96)**	**0.80 (0.71-0.90)**	**1.25 (1.04-1.50)**
Secondary	1.05 (0.93-1.19)	**1.28 (1.06-1.54)**	1.11 (0.99-1.23)	**1.52 (1.27-1.83)**
Higher secondary	**1.89 (1.53-2.32)**	**2.34 (1.64-3.33)**	**1.85 (1.48-2.31)**	**3.36 (2.44-4.62)**
Tertiary	**2.56 (2.05-3.19)**	**3.73 (2.75-5.07)**	**3.18 (2.62-3.87)**	**7.19 (5.48-9.43)**
Wealth quintile				
Poorest	1	1	1	1
2nd	**0.86 (0.77-0.95)**	**0.81 (0.69-0.95)**	**0.62 (0.56-0.70)**	**0.56 (0.47-0.67)**
3rd	**0.59 (0.54-0.65)**	**0.63 (0.52-0.76)**	**0.44 (0.39-0.50)**	**0.50 (0.42-0.61)**
4th	**0.50 (0.44-0.56)**	**0.62 (0.50-0.76)**	**0.32 (0.28-0.37)**	**0.47 (0.37-0.58)**
Richest	**0.46 (0.39-0.54)**	**0.56 (0.44-0.70)**	**0.34 (0.28-0.41)**	**0.42 (0.31-0.57)**
Region				
Urban	1	1	1	1
Rural	1.09 (0.95-1.24)	0.90 (0.76-1.07)	**1.17 (1.03-1.33)**	0.90 (0.75-1.08)

M<5 Mothers of young children; NC= women with no children. Bold= statistically significant

Table 5.8- Estimated odds ratio and 95% confidence interval for sociodemographic characteristics of working mothers of young children compared to non-working mothers of young children in Brazil in 1996 and 2006.

Variables	1996	2006
Age group(years)		
18-24	1	1
25-34	**1.50 (1.22-1.84)**	**1.59 (1.21-2.09)**
35-49	**2.36 (1.86-2.99)**	**2.09 (1.43-3.06)**
Education		
Up to primary	1	1
Secondary	1.03 (0.82-1.29)	1.27 (0.94-1.72)
Above sec	**2.31 (1.79-2.97)**	**1.66 (1.23-2.24)**
Youngest child's age (years)		
<1	1	1
1	**1.31 (1.04-1.66)**	**1.49 (1.05-2.11)**
2	**1.66 (1.32-2.07)**	**2.22 (1.52-3.24)**
3	**1.84 (1.41-2.40)**	**2.75 (1.96-3.86)**
4	**2.17 (1.64-2.86)**	**3.01 (2.00-4.53)**
Religion		
Christian	1	1
Other	0.88 (0.65-1.20)	1.01 (0.73-1.40)
Wealth tertile		
Poorest	1	1
2nd	0.91 (0.75-1.11)	1.07 (0.81-1.41)
Richest	0.98 (0.77-1.25)	**1.55 (1.13-2.11)**
Residence		
Urban	1	1
Rural	0.98 (0.79-1.24)	**0.56 (0.39-0.80)**

Models for both waves in Brazil showed that among mothers of young children, those who were working had a significantly higher likelihood of being older, having older children, and being better educated than those who were not working. Wealth and type of residence were not significantly different for working mothers in 1996, while in 2006, they were more likely to be in higher tertiles of wealth and less likely to be living in rural areas when compared with non-working mothers.

For India, working mothers of young children were more likely to be older, have older children and to be living in rural areas when compared with non-working mothers in both waves. They were also less likely to be Muslim, to have higher levels of education or to be in higher quintiles of wealth.

Table 5.9- Estimated odds ratio and 95% confidence interval for sociodemographic characteristics of working mothers of young children compared to non-working mothers of young children in India in 1998-99 and 2005-06.

	1998-99	**2005-06**
Age group		
18-24	1	1
25-34	1.09 (0.99-1.20)	**1.32 (1.22-1.43)**
35-49	**1.27 (1.09-1.48)**	**1.49 (1.31-1.69)**
Education		
None	1	1
Primary	**0.64 (0.57-0.71)**	**0.73 (0.65-0.81)**
Secondary	**0.42 (0.37-0.47)**	**0.51 (0.46-0.57)**
Higher sec	**0.44 (0.35-0.57)**	**0.43 (0.36-0.52)**
Tertiary	0.84 (0.64-1.11)	1.06 (0.88-1.28)
Youngest child's age		
<1	1	1
1	**1.39 (1.28-1.53)**	**1.57 (1.42-1.73)**
2	**1.61 (1.47-1.76)**	**1.75 (1.57-1.95)**
3		**2.11 (1.88-2.36)**
4		**2.58 (2.30-2.89)**
Religion		
Hindu	1	1
Muslim	**0.39 (0.33-0.47)**	**0.48 (0.40-0.57)**
Christian	**1.58 (1.29-1.92)**	**1.70 (1.41-2.05)**
other	**0.60 (0.44-0.80)**	0.85 (0.68-1.05)
Wealth quintile		
Poorest	1	1
2nd	**0.73 (0.65-0.82)**	**1.13 (1.00-1.27)**
3rd	1.12 (1.00-1.26)	1.01 (0.88-1.15)
4th	**0.65 (0.56-0.75)**	**0.61 (0.52-0.71)**
Richest	**0.45 (0.37-0.55)**	**0.50 (0.40-0.61)**
Residence		
Urban	1	1
Rural	**1.71 (1.45-2.03)**	**1.55 (1.35-1.79)**

*Data from 1998-99 was only provided for children younger than three years old.

5.3.3 Work characteristics of Brazil and India across waves

The previous section showed that working mothers of young children were significantly different from other groups of women, particularly with respect to age, education and wealth. These differences are likely to influence the working conditions and the opportunities of work available for women due to their influence on women's experiences and skills. This section intends to explore the differences in characteristics of work for groups of women in each country and wave. For this, given the high percentage of people living in rural areas of India, and the differences in the job market between those areas, descriptive analyses were conducted separately for rural and urban areas.

Table 5.10- Characteristics of work according to groups of working women in Brazil, 1996 and 2006.

	Brazil 1996 (%)				Brazil 2006 (%)			
	All	M <5	M>5	NC	All	M<5	M>5	NC
Type of work								
Employed	55.1	55.7	54.1	60.8	39.4	38.1	38.0	48.5
Self-employed	44.9	44.3	45.9	39.2	60.6	61.9	62.0	51.5
P value	-	0.140			-	0.002		
Occupation								
Prof.tech.	37.2	31.8	32.0	46.3				
Services	53.6	55.0	58.5	47.6			NP	
Agriculture	9.2	13.1	9.5	6.0				
P value	-	<0.001						
Where								
At home	26.4	23.6	28.3	22.6	21.2	23.1	22.1	13.7
out	73.6	76.4	71.7	77.4	78.8	76.9	77.9	86.3
P value	-	0.006			-	0.006		
Expenses decision*								
Women	69.5	66.2	72.0	62.9	75.3	76.8	76.7	65.9
Together	24.5	27.7	22.5	27.7	20.1	19.6	19.0	26.4
Someone else	6.0	6.1	5.5	9.3	4.6	3.6	4.3	7.7
P value	-	0.0005			-	0.002		

M<5 Mothers of young children; M>5 Mothers of older children NC= women with no children; NP= Not provided; NA= Not applicable

Table 5.11- Characteristics of work according to groups of women in rural and urban India, 1998-99 and 2005-06 (M<5 mothers of young children; M>5 mothers of older children; NC womenr with no children; NP=not provided; NA not applicable)

	Rural								Urban							
	India 1998-99 (%)				India 2005-06 (%)				India 1998-99 (%)				India 2005-06 (%)			
	All	M <5	M >5	NC	All	M <5	M >5	NC	All	M <5	M >5	NC	All	M <5	M >5	NC
Type of work																
Work for family	40.8	43.0	39.7	38.8	49.7	53.2	47.9	48.0	-				-			
Work for others	48.3	46.4	49.3	49.6	37.1	35.0	38.2	38.1	76.8	77.2	76.7	75.6	79.1	79.0	79.7	75.4
Self-employed	10.9	10.6	11.0	11.6	13.2	11.8	14.0	13.9	23.2	22.8	23.3	24.4	20.9	21.0	20.3	24.6
P value	-	*<0.001*			-	*<0.001*			-	*0.648*			-	*0.132*		
Occupation																
Professionals	3.0	2.8	3.1	3.4	3.7	3.5	3.6	5.6	23.1	23.5	22.1	29.5	21.0	21.8	18.8	37.1
Services	11.8	11.0	12.3	12.8	14.5	13.0	15.7	12.1	34.9	30.8	37.1	31.3	43.2	38.4	46.0	32.5
Agriculture	76.6	77.2	76.5	73.6	72.4	72.8	72.6	68.6	14.9	14.2	15.3	13.7	11.1	11.1	11.7	6.6
Skilled	8.6	8.9	8.1	10.2	9.4	10.7	8.1	13.7	27.1	31.6	25.5	25.5	24.7	28.7	23.4	23.8
P value	-	*0.016*			-	*<0.001*			-	*<0.001*			-	*<0.001*		
Periodicity																
Regular	65.4	63.7	66.8	63.2	62.0	58.6	64.3	59.0		NA				NA		
Seasonal	34.6	36.3	33.1	36.8	38.0	41.4	35.7	41.0								
P value	-	<0.001				<0.001										
Place of work																
At home	13.9	14.5	13.3	14.9	17.0	18.6	15.6	20.7	33.4	37.6	31.6	32.9	31.9	36.7	30.2	32.8
out	86.1	85.5	86.7	85.1	83.0	81.4	84.3	79.3	66.6	62.4	68.4	67.1	68.1	63.3	69.8	67.2
P value	-	*0.033*			-	*<0.001*			-	*0.003*			-	*0.001*		
Type of money																
Cash	62.8	60.2	64.5	64.0	62.4	57.8	65.0	62.2	89.0	87.7	89.6	88.3	93.1	92.3	93.3	93.0
Not-cash	37.1	39.8	35.5	36.0	37.6	42.1	34.9	37.8	11.0	12.3	10.4	11.7	6.9	7.7	6.7	7.0
P value	-	*<0.001*			-	*<0.001*			-	*0.281*			-	*0.504*		
Expenses decision																
Women	37.3	28.1	43.2	37.4	21.2	20.3	22.0	19.1	57.2	46.1	62.1	54.5	33.8	31.1	34.8	34.5
Together	28.6	29.5	28.1	27.6	58.1	56.4	59.6	52.9	26.9	33.0	23.9	30.6	56.7	59.0	56.1	54.1
Someone else	34.1	42.4	28.7	35.0	20.7	23.4	18.4	28.0	15.9	20.9	14.0	15.0	9.5	9.9	9.1	11.4
P value	-	*<0.001*			-	*<0.001*			-	*<0.001*			-	*0.185*		

Brazil has experienced increases in the number of self-employed women from 44.9% to 60.6%, and despite the increases across all groups of women, the highest percentage of employed women in both years was found among women with no children (Table 5.10). The majority of women were working in the services sector (53.6%), followed by professionals (37.2%). Among the groups of women, women with no children were mostly working as professionals (46.3%), and mothers of young children had higher percentages in agriculture (13.1%) when compared with the overall percentage (9.2%). The percentage of women working outside home increased from 73.6% to 78.8% between waves, mostly for women with no children (77.4% to 86.3% between waves). A small percentage of women did not have say on how to spend their money in both years (6.0% in 1996 and 4.6% in 2006). This prevalence was higher for women with no children in both years.

In India, different trends were observed in rural and urban areas from 1998-99 to 2005-06 (Table 5.11). In rural areas, a slight increase in the proportion of self-employed women was observed over the years, going from 10.9% to 13.2%. In addition, there was an increase in the rates of women working for the family (from 40.8% to 49.7%) for all groups of women. The percentage of women working in agriculture decreased from 76.6% to 72.4% over the years, while there was an increase in the services sector for mothers of young and older children. The percentage of women working as professionals increased particularly for women with no children (3.4% to 5.6%). Increases were also seen in rates of women working at home and in seasonal jobs for all groups of women. The percentage of women earning in cash remained similar in both years, with a slight decrease for mothers of young children (60.2% to 57.8%), and the highest prevalence among mothers of older children (around 65% in both years). There was a significant decrease in the percentage of women who did not have any say on decisions regarding their earnings (34.1% to 20.7%), particularly for mothers of young children (42.4% to 23.4%).

In urban areas (Table 5.11), the percentage of self-employed women was twice the one observed in rural areas, and a small decrease in this percentage was observed from 1998-99 to 2005-06 (23.2% to 20.9%), mainly for mothers of older children. The majority of women earned in cash, which increased over the years (89.0% to 93.1%). The number of women working in the services sector increased for mothers of young and older children, while women with no children, who were found to be better educated in previous analyses, had higher increases in the percentage of professionals from 29.5% to 37.1%. The number of women without say on her expenses in urban areas was lower than in rural areas in both years, decreasing from 15.9% to 9.5%.

The next analyses investigate the sociodemographic characteristics of types of work to contextualize the types of work in each country and evaluate changes in the pattern of work available for women. In Brazil 1996, a high percentage of employed women were also professionals (47.9%) or working in the services sector (42.6%), and most had either lower (37.3%) and higher education (37.4%). The majority of women working as self-employed were involved in the services sector (67.9%) with lower levels of education (45.5%). In 2006, the sociodemographic differences between types of employment were accentuated. Employed women and those working away from home had almost double percentages of women with higher education compared with 1996, and were from higher wealth quintiles (28.1% for employed and 24.5% for working away from home) compared with self-employed women (19.8%) and those working from home (17.7%, Table 5.12).

Table 5.12- Cross-tabulation characteristics of work for women in Brazil 1996 and 2006.

	Brazil 1996				**Brazil 2006**			
	Employed	**Self-employed**	**Home**	**Away**	**Employed**	**Self-employed**	**Home**	**Away**
Occupation								
Prof.tech.	47.9	11.9	14.5	39.5				
Services	42.6	67.9	78.6	48.7		NP	NP	
Agriculture	9.5	20.2	7.0	11.8				
P value	<0.001		<0.001					
Education								
Up to primary	37.3	45.5	45.8	39.3	11.1	28.1	27.0	19.9
Secondary	25.2	30.1	31.0	26.2	22.9	30.5	33.0	26.0
Above sec.	37.4	24.4	23.2	34.6	66.0	41.4	40.0	54.2
P value	<0.001		<0.001		<0.001		<0.001	
Wealth								
Poorest	12.6	18.4	12.0	16.3	11.6	21.4	21.2	16.5
2nd	19.6	16.9	17.7	18.5	15.2	18.0	17.0	16.9
3rd	22.9	18.5	21.9	20.6	20.8	20.4	21.4	20.4
4th	21.4	21.5	22.2	21.2	24.3	20.4	22.7	21.7
Richest	23.6	24.6	26.1	23.4	28.1	19.8	17.7	24.5
P value	<0.001		0.019		<0.001		0.026	

NP- Not provided
NA- Not applicable

Table 5.13- Cross-tabulation characteristics of work for women in rural India in 1998-99 and 2005-06

	India 1998-99							India 2005-06						
	Work/fam	**Work /others**	**Self-emp**	**Away**	**Home**	**Regular**	**Seasonal**	**Work /fam**	**Work/ others**	**Self-emp**	**Away**	**Home**	**Regular**	**Seasonal**
Occupation														
Prof.tech.	0.6	4.0	8.0	2.9	3.6	4.3	0.6	1.6	5.5	6.6	3.7	3.5	5.7	0.4
Services	4.7	15.4	22.9	11.6	13.3	13.2	9.2	9.2	20.8	17.0	13.9	17.9	17.0	10.5
Agriculture	90.3	73.3	38.8	83.1	35.1	72.8	83.5	84.3	60.3	61.5	79.8	36.2	65.5	83.6
Skilled	4.4	7.3	30.2	2.4	48.0	9.7	6.6	4.8	13.4	14.8	2.6	42.4	11.7	5.5
P value	*<0.001*			*<0.001*		*<0.001*		*<0.001*			*<0.001*		*<0.001*	
Periodicity														
Regular	67.5	62.0	72.5	66.4	65.2	-	-	59.7	62.7	68.6	60.1	71.3	-	-
Seasonal	32.5	38.0	27.5	33.6	34.8			40.3	37.3	31.3	39.9	28.7		
P value	*<0.001*			*0.37*				*<0.001*			*<0.001*			
Type of money														
Cash	20.2	93.9	85.0	61.7	70.0	62.8	62.9	38.8	93.5	62.2	60.6	71.2	67.2	54.6
Not-cash	79.8	6.1	15.0	38.3	30.0	37.2	37.1	61.2	6.5	37.8	39.4	28.8	32.8	45.4
P value	*<0.001*			*<0.001*		*0.981*		*<0.001*			*<0.001*		*<0.001*	
Education														
No education	72.7	76.5	64.4	76.2	57.8	73.2	74.4	68.1	67.5	65.0	70.0	55.3	64.5	72.4
Primary	14.7	13.3	13.5	13.1	18.9	13.7	14.3	14.7	15.3	12.5	14.0	17.8	15.0	14.1
Secondary	11.6	7.7	16.8	8.8	19.6	10.3	10.3	14.8	12.8	16.2	12.6	22.2	15.6	12.0
Higher sec	0.8	1.2	3.1	1.1	2.3	1.6	0.7	1.4	1.9	3.0	1.6	2.8	2.3	1.0
Tertiary	0.2	1.2	2.1	0.8	1.4	1.2	0.3	0.9	2.5	3.2	1.8	1.9	2.6	0.5
P value	*<0.001*			*<0.001*		*<0.001*		*<0.001*			*<0.001*		*<0.001*	
Wealth														
Poorest	20.0	33.1	33.2	28.6	22.4	27.1	29.0	30.7	31.4	32.0	31.5	29.6	27.4	37.4
2^{nd}	25.3	24.3	21.8	24.6	23.3	23.6	25.8	30.7	31.4	27.3	31.4	26.2	30.5	30.5
3^{rd}	28.8	29.8	20.6	29.0	24.4	29.0	27.3	24.9	24.9	23.0	24.9	23.3	25.8	22.7
4^{th}	19.6	9.8	16.7	13.6	20.7	14.9	14.0	10.7	9.8	12.5	9.6	15.7	12.2	7.9
Richest	6.3	3.0	7.7	4.1	9.3	5.4	3.9	3.0	2.5	5.1	2.7	5.1	4.0	1.5
P value	*<0.001*			*<0.001*		*<0.001*		*<0.001*			*<0.001*		*<0.001*	

Table 5.14- Cross-tabulation characteristics of work for women in urban India in 1998-99 and 2005-06.

	India 1998-99				India 2005-06			
	Employed	Self-employed	Home	Away	Employed	Self-employed	Home	Away
Occupation								
Prof.tech.	23.5	21.8	8.7	30.3	20.5	23.1	8.3	27.0
Services	35.2	33.7	24.4	40.0	43.6	41.5	31.1	48.8
Agriculture	18.3	3.5	4.9	19.9	12.8	4.9	2.5	15.2
Skilled	23.0	41.0	62.1	9.7	23.1	30.5	58.1	9.0
P value	*<0.001*		*<0.001*		*<0.001*		*<0.001*	
Type of money								
Cash	87.5	93.8	84.8	91.0	92.4	95.5	91.2	93.9
Not-cash	12.5	6.2	15.2	9.0	7.6	4.5	8.8	6.1
P value	*<0.001*		*<0.001*		*0.005*		*0.008*	
Education								
No education	42.3	29.7	34.4	41.8	38.9	24.0	28.9	39.1
Primary	16.7	16.5	21.2	14.3	15.8	12.0	18.2	13.5
Secondary	19.1	28.5	30.1	16.9	24.6	33.0	36.6	21.6
Higher sec	6.3	8.6	6.4	7.1	4.9	8.6	6.9	5.1
Tertiary	15.6	16.7	7.8	19.9	15.7	22.3	9.3	20.7
P value	*<0.001*		*<0.001*		*<0.001*		*<0.001*	
Wealth								
Poorest	5.1	2.5	1.4	6.0	3.4	1.8	1.7	3.8
2nd	8.6	5.7	5.6	9.1	11.0	5.3	6.5	11.4
3rd	17.0	10.3	13.5	16.5	19.0	13.4	15.1	19.0
4th	30.5	30.3	35.0	28.2	32.6	31.0	36.9	30.1
Richest	38.8	51.2	44.5	40.2	34.0	48.5	39.8	35.7
P value	*<0.001*		*<0.001*		*<0.001*		*<0.001*	

In rural India (Table 5.13), self-employed women tended to be better educated than employed women in 1998-99, but this group still had a high percentage of women with no education (64.4%). A high percentage of self-employed women were involved in occupations other than agriculture (61.1%), and in regular jobs (72.5%). In 2005-06, the differences in education among women working in different types of employment were attenuated, with increases overall in secondary and higher secondary educated women among other types of work. In the first wave, women working as self-employed had the highest percentages in the poorest (33.2%) and richest wealth quintile (7.7%) when compared with other types of work. In 2005-06, all groups of work had similar rates of women in the lowest wealth quintile, and self-employed women remained the group with the highest percentage of women in the richest wealth quintile. There was an important increase in the percentage of self-employed women in the agriculture sector from 1998-99 to 2005-06 (38.8% to 61.5%), while a decrease was observed in the other types of work.

The majority of women working for the family and working for others in rural areas were involved in the agricultural sector in 1998-99 (90.3% and 73.3%, respectively). This percentage has decreased in 2005-06 (84.3% and 60.3%, respectively), while increases were observed in the percentage of women working in the services sector. Among women who were working for the family, there was an increase in the percentage of seasonal work over the years (from 32.5% to 40.3%), as well as in the percentage of women earning cash (from 20.2% to 38.8%). Women working for the family had the lowest percentage in the poorest wealth quintile, which became similar to other types of work in 2005-06. Women working for others were the group with the highest percentage of cash payment (around 93% in both years), and the highest percentage in the poorest wealth quintiles in both years.

Women working from home tended to be better educated, with the majority involved in skilled activities and regular work, and from higher wealth quintiles in both years when compared with those working away from home. Similarly, regular work was associated with better education, higher wealth quintiles, and a higher percentage of women working in occupations other than agriculture, when compared with seasonal work.

In urban areas (Table 5.14), women working as self-employed were better educated, in higher quintiles of wealth, and involved in skilled jobs. Among those women, there was an increase in the percentage of women working in the services sector (33.7% to 41.5%) and with tertiary education (16.7% to 22.4%) between 1998-99 and 2005-06. Employed women were a more heterogeneous group, with high rates of women in the service sector (35.2% in 1998-99 and 43.6% in 2005-06), but also a considerable rate of women working as professionals (23.5% in 1998-99 and 20.5% in 2005-06). A higher percentage of employed women had lower education, and no changes in education were observed in tertiary education across years (16% in both years). For women working away from home, there was a high percentage of those working as professionals and in the service sector in both years, as well as a high percentages of women with low and high education.

In summary, work characteristics went in different directions in Brazil and India (Table 5.15). In Brazil, results suggested that being employed and working away from home were related with higher levels of education and richest wealth quintiles, where the differences were more noticeable in 2006. In India, self-employment was associated with better sociodemographic characteristics in rural and urban areas. In rural areas, working for the family, despite no payment in cash and lower levels of education, was associated with higher wealth quintiles, and differences were more noticeable in the first wave.

In both countries, women with no children were associated with higher educational levels, and professional occupations. Mothers of young children seemed to be in a lower work position, which in Brazil was related with self-employment, and in India, with the agriculture sector, working for the family or for others in rural areas, and services and skilled sector in urban areas.

5.4 Discussion

The understanding of the population of study (mothers of young children) in comparison to other women and the differences between working and non-working mothers are very important for the investigation of how maternal work affects child nutritional status. Chapter three provided a brief view of empirical evidence relating to child nutritional status and maternal employment, where the sociodemographic characteristics of the family, and the context of poverty had great influence on how the trade-off of income generated by work and lack of availability for childcare affected child nutrition. In this chapter, findings showed pronounced differences in sociodemographic characteristics of mothers of young children compared to other women in Brazil and India, as well as contrasting opportunities of work for women in each country.

Brazil had important improvements in female education and increased rates of female work, following the trend proposed by the feminization U-hypotheses. Other studies describing female work in Brazil also show high levels of education among working women, (Leone and Baltar, 2006; Bruschini, 2007), and a particular increase in the number of women working in the public sector, which is classified as a type of work that requires high levels of education, and has a hard entry process (IBGE, 2012b).

Despite the considerable growth in female education and work opportunities for educated women, the Brazilian work force is heterogeneous, and domestic workers and sellers are also reported as common occupations of women in Brazil in the informal market, associated with lower levels of education (IBGE, 2012b). This was shown in the previous analyses, where a marked prevalence of self-employed women working in the services sector and with lower levels of education was found in 1996, and increased in 2006. National data comparing the years of 1997 and 2003 also found a 10% increase in self-employment, composed by occupations that did require lower education, such as sellers, home services, repair and others (IBGE, 2003). This was explained by the fall in the value of the currency and poor performance of the labour market experienced in the late 1990s, leading to excess increase in non-formal jobs, particularly for women as domestic workers. After 2000, politicians started to speculate about improving conditions for domestic workers and regularizing it to formal employment (Leone and Baltar, 2006).

Table 5.15- Summary of findings from Brazil and India

	Brazil	**India**
Differences among groups of women	-Non-mothers –highest percentage of tertiary education and richer wealth quintiles -Mothers of young children - lowest level of tertiary education. Higher rates in the poorest wealth quintiles	- Non-mothers - highest percentage of tertiary education and richer wealth quintiles -Mothers of young children- higher percentages of tertiary education than mothers of older children, but they were in the poorest wealth quintiles
Changes in the prevalence of female work	-Significant increase overall from 52.7% to 56.7%. -Non-significant increase for mothers of young children (41.7% to 44.5%) - Increases were mainly observed among women in the highest wealth quintiles	-No changes overall (37.7% and 37.9%) -Significant decrease for mothers of young children (31.7% to 29.9%). - Increases were mainly observed among women in the lowest wealth quintiles
Differences between working and non-working women	-Working women - higher rates of tertiary education and richer wealth quintiles than non-working women -The differences between working and non-working women decreased over the years.	-The majority of working women had no education and were in the poorest wealth quintiles when compared with non-working women -Higher rates of working women in rural areas.
Working characteristics	-Self-employment increased from 44.9% to 60.6%	-Small increase in self-employment in rural areas, and a small decrease in agriculture work -The percentage of women working for the family increased -A high percentage of women in urban areas earned cash (around 90%) compared with rural areas (around 63%).
Sociodemographic characteristics of work	-Employed women- better education, working as professionals or in the services sector.	-Rural areas: Self-employed - better educated than employed women, with higher participations in other occupations other than agriculture -Women working for the family and others - mainly involved in the agriculture sector. -Women working for the family - richer wealth quintiles -Urban areas: Self-employment - better education, skilled work and higher quintiles of wealth -Employed women - higher rates of women working as professionals and in the services sector.

In contrast to Brazil, the rates of female employment in India were very low and did not change with economic growth, showing a very different pattern than expected. India has one of the lowest rates of FLFP in the World (Das *et al.*, 2015), placed at 120th of 131 countries in FLFP according to the International Organization's Global Employment Trends in 2013 (ILO, 2013), and it is reported that rates of FLFP are not only stagnant, but also decreasing in some geographical regions of India.

Some theories are proposed for this, such as factor endowments, historical contingencies of the country, tradition and religion that still reject the idea of women working outside home (Gaddis and Klasen, 2014). Boserup (1970) explains that countries that traditionally practiced plough agriculture are more likely to lead to lower levels of FLFP for many years. The main argument used by Boserup is that plough cultivation required manual strength, which not only favoured men over women in previous years, but also generated a mind-set of persistent gender inequality. The agricultural sector has been predominant for many years in India, and rural women have had very low rates of participation in the labour force compared to men (Chowdhury, 2011). Furthermore, the economy is still not following the expected trajectory of most developing countries, in which the agricultural sector declines and the manufacturing sector grows. Instead, although the value of the agricultural sector to the economy has decreased, there was no corresponding growth in manufacturing (Lahoti and Swaminathan, 2013) and the opportunities for women in the labour market did not grow according to the supply of female workers (Das *et al.*, 2015).

Another hypothesis for constraints against FLFP refers to religion. The two main religions in India are Hinduism and Islam, described by Weber (1905) as not supportive of female work. Mullatti (1995) reported that the large patriarchal structure of Hindu families, where elders and men are highly esteemed, contribute to the inequality between sexes and occupations (Mullatti, 1995). Similar to findings in this study, in which working mothers were less likely to be Muslim, Guiso, Sapienza and Zingales (2003) shows stronger conservative attitudes towards women's work in Islam compared with other religions.

Some particularities of the work in India are important to note. In this sample, women in rural areas working for the family or self-employed had better status than women employed by others. Unpaid family work on the family land or in family enterprises is common in India, where the woman serves as an important economic resource for maintaining the family. In this case, land ownership represents family's economic and social status, and even if the women is not paid, the household context where she works is better off than other landless agricultural wage labourers (Desai and Jain, 1994). Joint families that own land are often associated with better living conditions, higher castes and better socioeconomic status (Niranjan, Nair and Roy, 2005; Mberu, 2007), and therefore, the status of the family can bring more economic benefits than payment from work (Allendorf, 2013). Self-employed workers have higher status because this group is mainly composed of farmers, which again implies land ownership and better social status (Srivastava and Srivastava, 2010).

Paid work for others in India, although related to payment in cash, is commonly associated with lower social class (Desai and Jain, 1994; Dasgupta and Goldar, 2006). Casual workers in agriculture are in a more disadvantaged position, where wages tend to be lower than the minimum wage stipulated by the government, and the main activities performed by women in the agricultural sector, such as animal husbandry, weeding, transplanting, forestry and sowing contributes to gender segmentation in the workplace (Srivastava and Srivastava, 2010).

Results suggested that working women in urban areas of India were better off than working women in rural areas. In urban areas, there was a higher likelihood that working women had higher education compared with non-working women. This can be explained by better access to school and universities in urban areas, followed by more opportunities in the labour market outside of the agricultural sector (Klasen and Pieters, 2015). Some studies discuss that urban areas in India have followed a U-shape pattern, in which women with below primary education have a higher likelihood of being employed, and post-secondary education raises the chances of employment again (Das *et al.*, 2015; Klasen and Pieters, 2015). However, the supply of appropriate jobs for educated women has not grown adequately, resulting in the withdrawal of educated women from the labour market (Das *et al.*, 2015).

The low number of educated workers in India highlights the working conditions for women. The lack of education not only decreases the likelihood of women getting better jobs, it also reduces their bargaining power in the household and at work (Srivastava and Srivastava, 2010; Duflo, 2011). The literature has documented that although education was not a factor that attracted women to work in India, it was the most important determinant of better quality work for those already in the labour market (Srivastava and Srivastava, 2010).

Brazil and India both had different sociodemographic characteristics by groups of women, with a lower prevalence of workers among mothers of young children compared to mothers of older children or women with no children. This finding is consistent with Becker’s theory that working and parenting are less compatible for women (Becker, 1965), and it is supported by empirical evidence about the inverse relationship between labour force participation and fertility rate (Bloom *et al.*, 2009; Angeles Davia and Legazpe, 2013). In both countries, mothers of young children were in a disadvantaged situation compared with other groups of women. For instance, they had lower rates of tertiary education in Brazil and were in poorer quintiles of wealth in India. Still, in Brazil, working mothers of young children were better-off in terms of education and socioeconomic status than non-working mothers of young children.

Such sociodemographic differences between working women in Brazil and India suggest that in Brazil there is a higher number of women who go to work because income is attractive or for pursuing a career. In contrast, in India, the main reason behind the decision to work is the need of the money or some sort of payment to provide for the family (Desai and Jain, 1994).

When interpreting the results, some points are worth noting. The literature often discusses the fraught difficulties in measuring women's economic activity in developing and emerging countries, generating errors in measurements and uncertainties regarding international comparability of data (Anker, 1983; Bardasi *et al.*, 2011). Sources of errors were already discussed in the methodology, and although measures were taken to follow the ILO recommendations, the combination of wider groups of occupation due to the small number of observations, and the simple categorization of types of work can lead to errors.

Moreover, the use of cross-sectional data does not allow for the understanding of the working history of mothers, the reason why some mothers are not working, or information on maternity leave. It may be that mothers on maternity leave were included in the analysis as "not employed". This could be avoided in the NFHS 2006, where there was a question about whether the woman was on leave for some reason in the last seven days, which represented less than 1% of the sample. Those were included in the analysis as "working", but the same could not be done for other datasets. This information is important, as it is reported in the literature that women who were in the labour market when pregnant are more likely to go back to work in the child's first months of life (Baxter, 2009).

Despite difficulties with sample and measurement of work history, this chapter provides an overview of the sociodemographic characteristics of working and non-working mothers, differences between mothers of young children and other groups of women, as well as trends in work characteristics pre and post economic growth in Brazil and India. These results grounded the understanding of the population studied for the next analysis, which focuses only on mothers of young children and their child's nutrition.

Box 5.1 – Main findings for FLFP in Brazil and India

-Rates of female work increased in Brazil, particularly for higher socioeconomic status, but not for India;

-Mothers of young children, when compared with other groups of women, had lower education and were poorer in both countries, but when comparing mothers of young children who are working and not working, different patterns are observed in Brazil and India.

-In Brazil, working mothers of young children were better off than non-working mothers. In India, the opposite was observed.

-In Brazil, being employed was associated with better socioeconomic status and better-paid jobs than being self-employed.

-In India, being self-employed represented a better social status in both, rural and urban areas, while being employed in agriculture and in rural areas was negatively associated with socioeconomic status.

Chapter 6: Maternal work and child nutrition in the two different contexts: A preliminary analysis

6.1 Introduction

Brazil and India have both experienced great economic growth since 2000, but social development has not been equal between these countries, which is reflected in the rates of child malnutrition. Declines in stunting is a particular indicator of improvements in socioeconomic conditions of a country (de Onis and Blössner, 1997), since improvements in living conditions and alleviation of poverty provide a better environment for child growth. Studies examining child malnutrition globally have shown that the countries with the most gains in child nutrition and health outcomes were those with interventions that addressed population health, education, and social development (Bhutta, Salam and Das, 2013).

While the mother is an important figure when discussing child malnutrition due to her role as caregiver, her work is also seen as a way to improve living conditions by generation of income, resources for food security, care and health (Smith and Haddad, 2015). The macro aspects of a country determine the context within which options of maternal work and work conditions are offered, as well as the context for maternal decisions. Indirectly, by determining maternal experiences, the macro aspects also have some influence on whether maternal work will have positive or negative effects on child nutrition. The macro changes experienced by Brazil and India post economic growth show these countries have had contrasting outcomes for female work, suggesting they also experience opposite relationships between maternal work and child nutrition.

This chapter presents preliminary analysis showing the situation of Brazil and India in terms of social development and child nutrition before and after the BRICS entrance. This chapter also shows descriptive analyses for the associations between maternal work and child nutrition.

6.2 Socioeconomic disparities across waves in Brazil and India

This section will briefly discuss the context of Brazil and India in terms of social development and living conditions of the population, considering these are important determinants of child malnutrition. For this, the International Wealth Index, a comparable measure to evaluate household assets across country and over time was used.

6.2.1 The International Wealth Index

In the absence of measures of income, wealth indices based on household assets are effective indicators of socioeconomic position within the sample (O'Donnell and Wagstaff, 2008). However, they have the disadvantage of being very specific to each dataset, and not comparable between countries or time points (McKenzie, 2005).The comparison of the living conditions in Brazil and India, and between waves of each country, requires a comparable measure.

The International Wealth Index (IWI) is a measure created aiming to make this comparison possible across countries and time. It was constructed based on data derived from 165 household surveys, covering information on 2.1 million households (Smits and Steendijk, 2015). This is a general wealth index created by principal component analysis (PCA), in which the assets chosen should be the same in all households, and those should be weighted according to how much each asset influences the total household wealth. The IWI was closely correlated to the previous wealth index created in surveys, and it was associated with measures of welfare and poverty such as the Human Development Index, Gross National Income per capita, and Gini coefficient, demonstrating that it is a good indicator for measuring socioeconomic status in low and middle-income countries (Smits and Steendijk, 2015).

The assets chosen for this index were a combination of those more relevant for material need satisfaction, possession of goods, and access to commodities. They were divided into housing characteristics (type of floor material, toilet facility and number of rooms), consumer durables (television, refrigerator, phone, car, bicycle, a cheap utensil and an expensive utensil) and public utilities (water and electricity). Housing characteristics were classified in low/medium/high quality according to described standards, and rooms were classified in zero or one/ two/three or more. Consumer durables were classified as a dummy variable (yes or no). Lastly, public utilities included water source (low/medium/high facility) and access to electricity (yes or no).

For classification of toilet facilities, those with traditional pit latrine or no toilet facility were considered low quality. Middle quality was defined as either a public toilet and improved latrine. Any type of private flush toilet was considered high quality. Low quality of water supply was an unprotected well, borehole, spring or surface water. Middle quality included public tap, protected well and tanker truck. High quality was bottled water, or water piped into dwelling or premises (Smits and Steendijk, 2015).

After selecting the assets, two weighting processes were conducted to minimize the differences in country populations, and to acknowledge assets that contribute more to wealth than others. Countries were weighted by the square root of the population size, and PCA was conducted to estimate weights for the assets. The results from the PCA reflects the possibility that a household that owns one specific asset, also owns one of the other assets in the analysis (Smits and Steendijk, 2015).

The IWI has the range of 0 to 100, in which households with no assets are classified as zero, and those with all assets are classified as 100. Those with the same IWI value are assumed to have reached the same level of material need satisfaction, but this does not mean that they have the exact same assets. Following the methodology proposed by Smits & Steendijk (2015), the IWI was created for each wave of data in Brazil and India for comparisons between waves and countries.

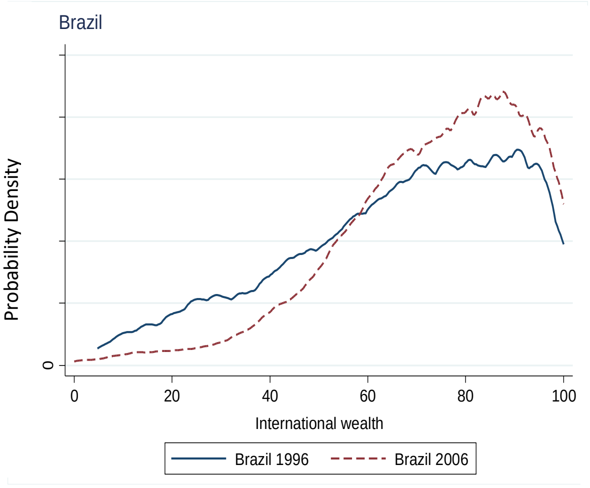
6.2.2 Comparisons of the IWI in Brazil and India

It is expected that economic growth in Brazil and India reduces socioeconomic inequality and improves access to goods and services for the poor. The evaluation of the IWI in both countries shows that this has happened in part. In Brazil, there were improvements mainly for those in lower socioeconomic status (Figure 6.1), whilst in India, there were improvements for all quintiles of wealth (Table 6.2). Inequality, however, persisted between quintiles of wealth in both countries.

In Brazil, the distribution of IWI was negatively skewed in both surveys, but in 2006, the number of people with lower levels of wealth decreased considerably, together with increase in the number of people with higher wealth (Figures 6.1 and 6.2). The mean IWI for all households went from 66.5 to 73.4, which represents a tangible increase in the living conditions of the general population in the country. Table 6.1 shows significant differences in the number of people with access to electricity, good quality water and a good quality toilet, with higher changes at the bottom of the distribution.

Figure 6.2-Distribution of International wealth for A) Brazil (1996 and 2006) and B) India (1998-99 and 2005-06).

A) B)



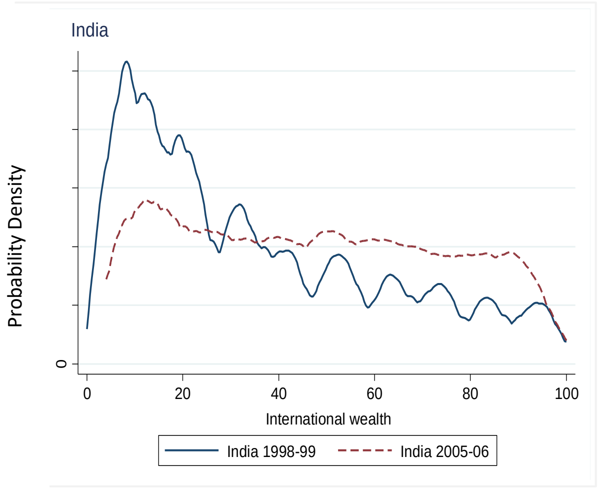
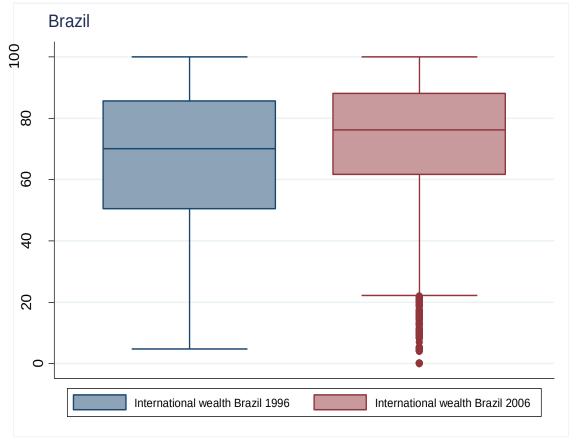


Figure 6.1- Box plot of International wealth for A) Brazil (1996 and 2006) and B) India (1998-99 and 2005-06).

A) B)



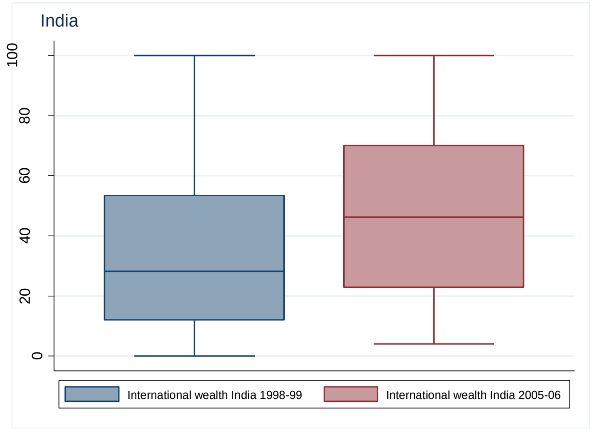


Table 6.1- Percentages of households with assets according to International wealth distribution in Brazil 1996 and 2006.

		All						Rural						Urban					
Assets	Years	Q1	Q2	Q3	Q4	Q5		Q1	Q2	Q3	Q4	Q5		Q1	Q2	Q3	Q4	Q5	
	1996	71.6	99.3	99.8	99.9	100.0	***	55.5	98.8	100.0	100.0	100.0	**	92.6	99.4	99.8	99.9	100.0	*
Eletricity	2006	94.2	99.7	100.0	100.0	100.0		90.1	100.0	100.0	100.0	100.0		98.1	99.7	100.0	100.0	100.0	
	1996	10.8	56.9	80.6	95.9	100.0	***	9.0	68.6	79.4	91.1	100.0	***	13.1	52.8	80.8	96.2	100.0	***
Television	2006	77.7	96.1	97.1	99.1	100.0		74.8	97.5	94.9	97.4	100.0		80.4	96.0	97.3	99.1	100.0	
	1996	21.3	79.7	93.1	98.7	100.0	***	19.9	86.3	91.8	98.0	100.0	***	23.2	77.4	93.1	98.8	100.0	***
Fridge	2006	59.8	90.5	97.7	99.5	100.0		61.0	93.2	96.4	99.7	100.0		58.7	89.9	97.8	99.5	100.0	
	1996	2.1	17.4	20.6	34.0	85.1	***	3.2	32.9	31.5	40.3	75.8	*	0.6	12.0	19.7	33.7	85.2	**
Car	2006	6.1	18.9	25.3	48.2	84.5		8.5	39.5	29.9	61.1	89.5		3.7	13.6	25.0	47.6	84.4	
High quality	1996	19.4	60.3	88.7	96.4	100.0	***	6.5	27.4	61.4	77.1	100.0	N/S	36.4	71.8	91.0	97.3	100.0	***
water	2006	36.5	75.7	94.6	99.5	100.0		16.2	50.3	93.3	100.0	100.0		55.9	82.3	94.7	99.4	100.0	
High quality	1996	0.4	4.6	17.1	37.1	40.7	***	0.8	3.1	22.8	53.0	61.3	N/S	1.1	11.7	36.9	71.2	97.9	***
toilet	2006	5.5	23.2	53.7	74.0	100.0		2.3	11.3	49.5	59.4	100.0		8.1	26.0	54.0	74.6	100.0	

* <0.05; ** <0.01; *** <0.001, N/S non-significant

Table 6.2- Percentages of households with assets according to International wealth distribution in India 1998-99 and 2005-06.

		All						Rural						Urban					
Assets	**Years**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**		**Q1**	**Q2**	**Q3**	**Q4**	**Q5**		**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	
Eletricity	1998-99	0	42.2	83.4	92.7	99.6	***	0	41.1	83.0	90.2	99.2	***	0	60.0	85.6	96.4	99.7	***
	2005-06	8.9	53.3	84.0	96.9	99.9		8.8	52.2	82.7	95.6	99.7		11.2	63.0	88.1	98.3	100.0	
Television	1998-99	0	0.9	18.7	64.6	93.6	***	0	0.8	17.3	67.4	92.0	***	0	2.4	25.5	60.4	94.1	***
	2005-06	0.1	7.5	44.0	74.5	97.2		0.1	7.2	45.6	77.5	96.4		0.3	9.6	38.7	71.7	97.5	
Fridge	1998-99	0	0.03	0.5	6.0	50.1	***	0	0	0.5	6.7	42.3	***	0	0.2	0.7	4.9	52.4	N/S
	2005-06	0.1	0.8	2.0	7.9	67.0		0.1	0.9	2.2	10.5	60.7		0	0.3	1.2	5.5	69.1	
Car	1998-99	0	0	0.1	0.6	8.1	N/S	0	0	0.1	0.8	7.6	N/S	0	0	0	0.3	8.2	N/S
	2005-06	0	0.03	0.2	0.7	12.5		0	0	0.3	1.1	10.8		0	0.1	0	0.3	13.1	
High quality water	1998-99	0	0	5.4	29.3	77.0	***	0	0	5.7	28.8	59.0	***	0	0	4.0	30.0	82.3	***
	2005-06	0	3.5	14.1	36.6	71.9		0	3.4	14.7	28.4	51.9		0	4.2	12.1	44.3	78.3	
High quality toilet	1998-99	0	0	3.2	35.6	88.5	***	0	0	2.3	23.8	76.6	***	0	0	7.7	53.2	92.0	***
	2005-06	0	2.3	24.0	70.5	93.4		0	2.0	19.4	58.2	92.3		0	5.8	39.1	82.2	93.7	

* <0.05; ** <0.01; *** <0.001, N/S non-significant

Generally, upwards from the third quintile of wealth, almost 100% of the population in Brazil had access to all assets in 2006, except for a car and access to a high quality toilet. The first is not a basic item in a household context, particularly in a majority urban population where public transport is available. The low number of people with high access to a high quality toilet might be showing areas where toilets are shared among people, and so, it is not considered high quality by the IWI index. Changes in the percentage of assets among those in the second and third quintiles of wealth suggest the upsurge of a middle class in Brazil (Ferreira *et al.*, 2012; Arnold and Jalles, 2014).

In India, where the distribution of IWI was positively skewed in the first wave, there were decreases in the number of people in the bottom tail of the distribution and increases from the middle to the top end of the distribution in 2005-06, resulting in a more uniform distribution. The mean IWI has significantly changed from 35.6 to 47.1 among the interviewed households, showing an important improvement in living conditions over the years.

Table 6.2 shows significant changes for all assets among 1998-99 and 2005-06, except for car ownership. However, even people in the highest quintile of wealth do not all have all essential assets, such as good quality of water (77.0%) and a fridge (67.0%). This is particularly important in rural areas, where the access to water and sanitation seems to be at a high disadvantage when compared to their urban counterparts. The first and second quintiles of wealth did not experience many changes between waves, and for those at the bottom of the distribution, access to high quality water and toilet was still zero.

So far, the results have shown that both countries have had improvements in living conditions by increased access to household assets. This has led to the expansion of a middle class, particularly observed in Brazil. Despite pronounced economic growth in India, social development was much slower than in Brazil, and those at the bottom distribution of wealth in India still had very low access to basic assets. Social development and improvement for the poor also affect child nutrition. The next sections look at the changes in child nutrition separately for Brazil and India.

6.3 Child nutrition in Brazil and India

This section explores the changes in rates of child malnutrition in Brazil and India, according to sociodemographic characteristics and maternal work (see section 4.3.2 for the definition of variables). In Brazil, both indicators were focused on: height-for-age (HAZ) and prevalence of stunting, and BMI-for-age (BMIZ) and the prevalence of overweight. In India, only HAZ and stunting are focused on, because of the low percentage of children classified as overweight in both years (4.6% in 1998-99 and 2.9% in 2005-06), which is not considered a public health concern.

For the purpose of this chapter, children of mothers younger than 18 years old were excluded, as well as all children from zero to three months. This decision was based on two facts. First, most mothers do not work during the first months after pregnancy (Hegewisch and Gornick, 2011). Mothers who are employed in the formal sector normally have the right to maternity leave, which varies by country. In Brazil, maternity leave covers from four to six months of full wage while in India, at the time of data collection, a full wage was offered for 3 months. When women work in the informal sector, legislation from most countries affords little or no protection (ILO, 1998), but due to time for recovery of the mother and greater demands from very young children, post-partum mothers are less likely to be working even in the informal sector. A second factor in which this decision is grounded is the assumption that child nutrition from zero to three months would suffer more impact from factors and environmental conditions before birth, and not necessarily from characteristics of the environment related with maternal work (Karlberg *et al.*, 1997).

The number of mothers and children excluded from the analysis, as well as the total number of mothers and children are provided in Table 6.3. The percentage of children and mothers excluded was about the same in both waves, with about 3% of mothers and 4% of children excluded in each wave.

Table 6.3- Number of children and mother excluded from the analysis (mothers younger than 18 years old and children 0-3 months) and remaining number of mothers and children in each wave and country.

	N (%) of mothers 15-17 years old	N (%) of children from 0-3 months	Total number of mothers	Total number of children
Brazil 1996	138 (3.63)	194 (4.42)	3,153	4,082
Brazil 2006	113 (2.98)	218 (4.82)	3,480	4,205
India 1998-99	821 (3.00)	2146 (7.83)	21896	24549
India 2005-06	444 (1.01)	1675 (3.82)	31038	41831

6.3.1 Child nutrition in Brazil

Table 6.4 shows summary statistics for both anthropometric indices (HAZ and BMIZ) as well as the prevalence of stunting and overweight. Brazil had a statistically significant increase in the mean height-for-age, as well as considerable decrease in the percentage of children under five considered stunted. For overweight, no changes were found in this age group, although steep increases were observed in adults, adolescents and school-aged children over this time period (CEBRAP, 2009; IBGE, 2014b).

Table 6.4- Descriptive analyses of HAZ and BMIZ in Brazil, 1996 and 2006

Indicator	Index	Brazil 1996	Brazil 2006
HAZ	N	3833	4104
	Mean	-0.54	-0.19
	SD	1.44	1.23
	P value*	<0.001	
	% stunting	13.4	5.9
	P value	<0.001	
BMIZ	N	3779	4065
	Mean	0.38	0.46
	SD	1.19	1.09
	P value	0.001	
	% overweight	7.3	7.4
	P value*	0.309	

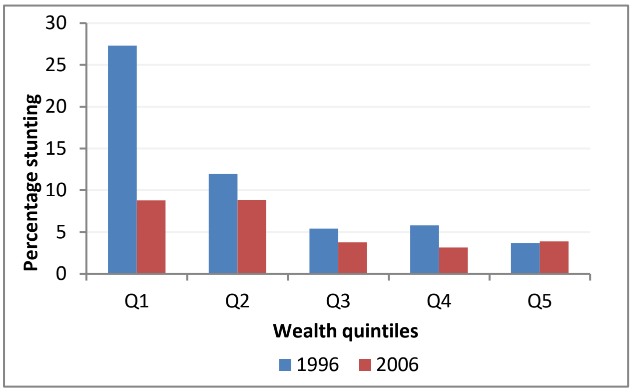
All estimates were weighted
*P value refers to the test of differences between the two waves

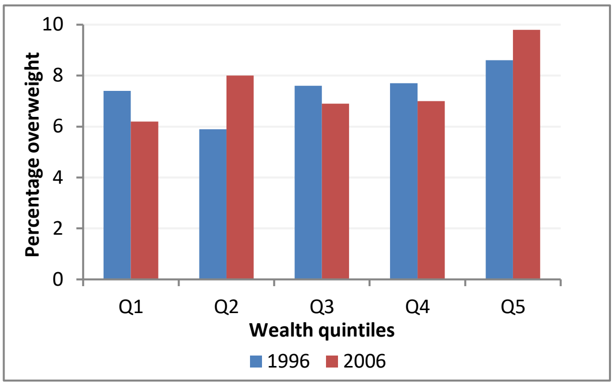
Analyses testing differences in the percentage of stunting across the wealth quintiles (Figure 6.3) suggest a great health disparity according to socioeconomic strata in 1996, in which the poorest quintile had the highest percentage of stunted children, seven times higher than the percentage of stunted children in the richest wealth quintile (p<0.001). From the third to fifth wealth quintile, the percentage of stunting did not vary. In 2006, differences between socioeconomic status decreased considerably, and the poorest wealth quintile had 2.3 times more stunting than the richest wealth quintile (p=0.044). Conversely, the percentage of overweight increased slightly with wealth in both years, but the increase was not statistically significant (p=0.568 for 1996 and p=0.625 for 2006).

The contributions of maternal education on child nutrition (Desai and Alva, 1998) as well as the effect of education on better job prospects drive the investigation of whether different maternal education is associated with reductions on child stunting. Due to the small number of people with no education and small number of stunted children when mothers have higher education, the education variable was categorized into “up to primary education”, “secondary education” and “above secondary”.

Figure 6.4 shows reduced prevalence of stunting between 1996 and 2006, with a narrower gap when mothers had higher education. For overweight, similar rates were observed by maternal education in 1996, followed by a slight decrease for higher educational levels in 2006.

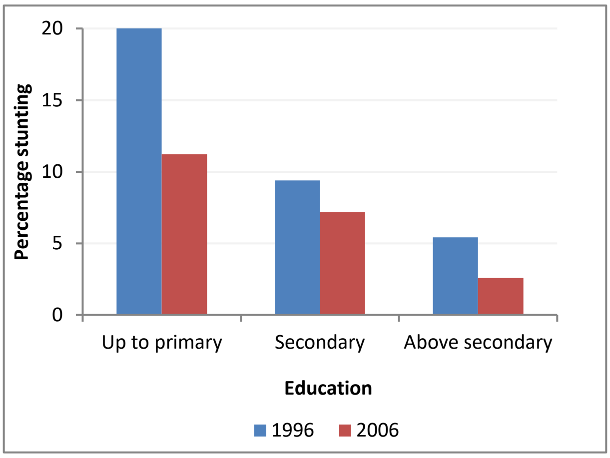
Figure 6.3- Percentage of stunting and overweight according to wealth quintiles in Brazil.

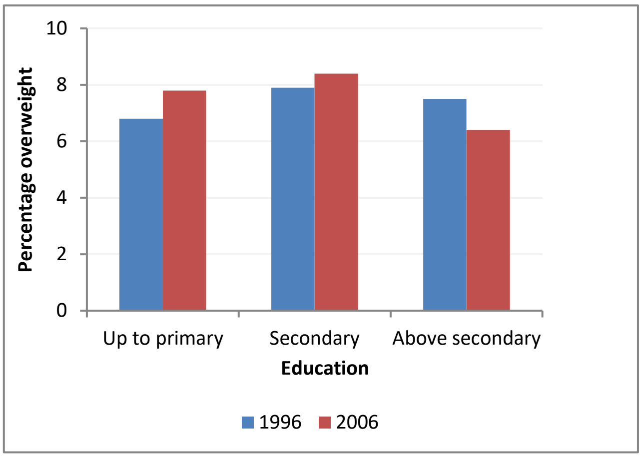




Note: These analyses use the standard wealth calculated separately for each wave and country.

Figure 6.4- Percentage of stunting and overweight according to maternal education in Brazil





Analysis of child nutrition by maternal work shows in 1996, the mean HAZ (-0.48) as well as the prevalence of stunted children (11.5%) were significantly lower for children of working mothers than for non-working mothers (-0.60 and 14.6%, respectively). However, no statistical difference was observed in 2006 (Table 6.5). Conversely, no significant differences were observed between working status for mean BMIZ or the percentage of overweight in 1996, while in 2006 working mothers had higher values compared with non-working mothers. The HAZ and BMIZ distribution by maternal work are provided in Appendix E.

Table 6.5-Mean (SD) children's height-for-age /stunting prevalence and BMI-for-age/overweight prevalence according to maternal work in Brazil.

		Brazil 1996	Brazil 2006
		Means (SD)	
HAZ	NWM	-0.60 (1.47)	-0.19 (1.23)
	WM	-0.48 (1.43)	-0.19 (1.22)
	Sig	**	N/S
		Percentages	
Stunting	NWM	14.6	6.2
	WM	11.5	5.4
	Sig	***	N/S
		Means (SD)	
BMI	NWM	0.38 (1.20)	0.40 (1.11)
	WM	0.37 (1.20)	0.56 (1.06)
	Sig	N/S	**
		Percentages	
Overweight	NWM	7.4	6.2
	WM	7.1	9.0
	Sig	N/S	*

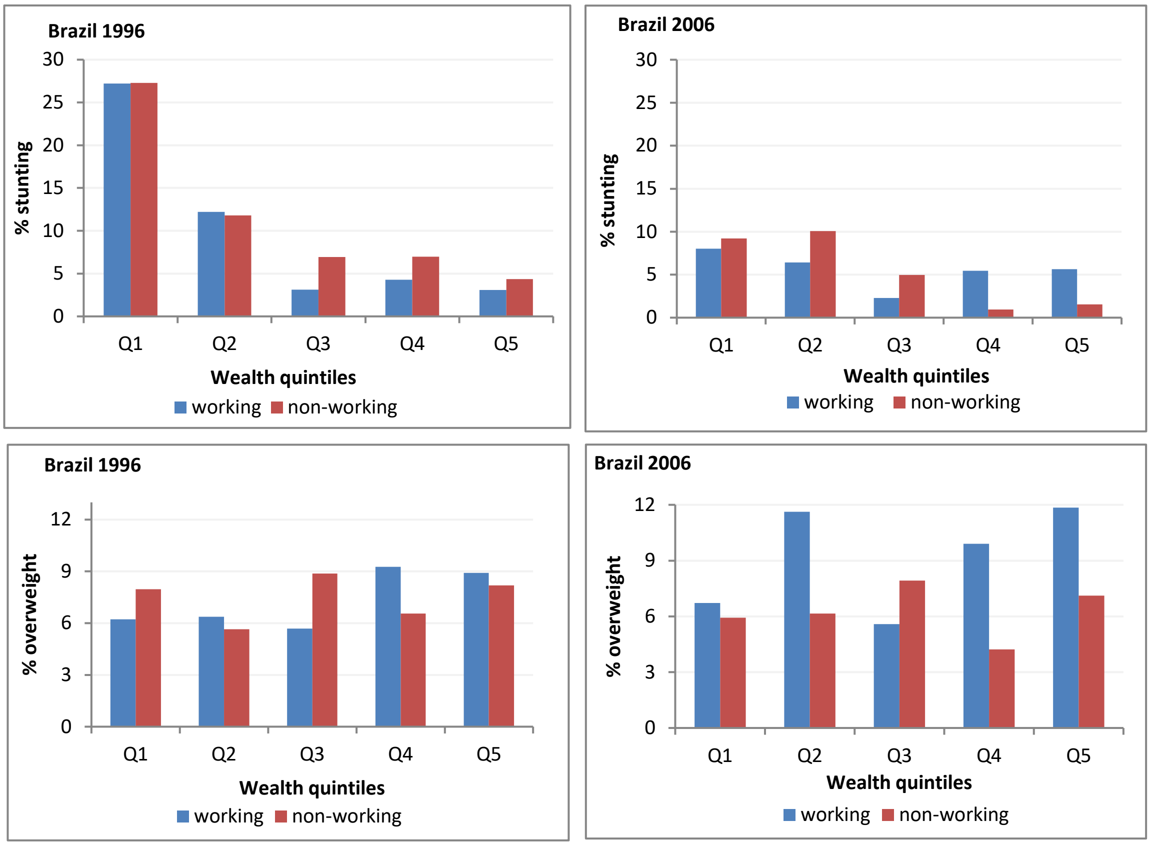
*<0.05 **<0.01 ***<0.001 N/S=non significant
NWM=non-working mothers; WM= working mothers
SD=standard deviation

The effect of maternal work on child stunting varied according to socioeconomic status. Figure 6.5 shows decreased child stunting for working mothers only from the third to the richest quintile in 1996 (not significant). In 2006, this pattern changed, where the second and third quintiles of wealth had statistically lower rates of stunting when mothers were working, while the fourth and richest quintiles of wealth had higher rates of stunting for working mothers (p<0.001).

For overweight, a higher prevalence was observed in 1996 for children of working mothers in the richest wealth quintiles (p<0.001). In 2006, higher rates of overweight were observed among working mothers for almost all quintiles of wealth (p<0.001; Figure 6.5).

No significant differences were observed in levels of child stunting between working and non-working mothers by maternal education, although Figure 6.6 indicates a lower prevalence of stunting for working mothers in 1996. For overweight, higher levels of maternal education were associated with higher prevalence of overweight for working mothers (p<0.001), where in 1996 this was only observed for those with more than secondary education, and in 2006, this was also observed for those with secondary education (p=0.023).

Figure 6.5- Effect of maternal work on percentage of child stunting and overweight according to wealth quintiles in Brazil, 1996 and 2006

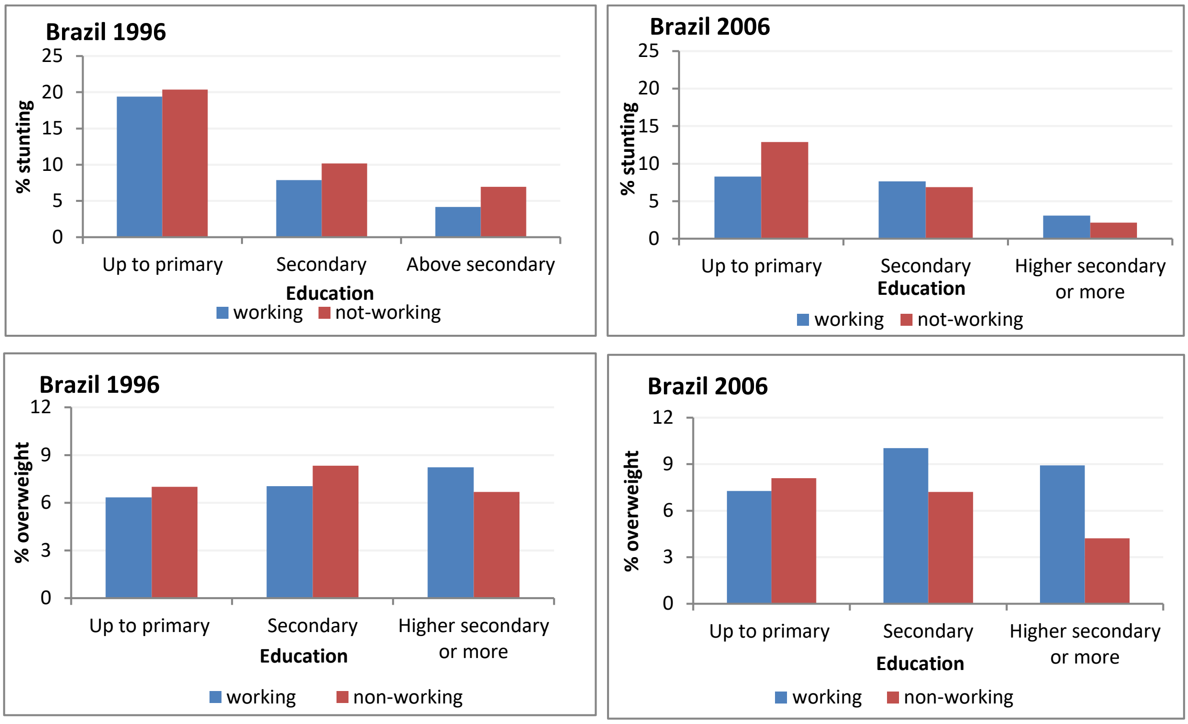


Note: These analyses use the standard wealth calculated separately for each wave and country

Results so far have agreed with the improvements observed in household living conditions in Brazil, since levels of stunting not only decreased significantly between waves, but discrepancies in levels of stunting by socioeconomic status have also decreased greatly. Simultaneously, levels of overweight increased with wealth and education in both waves.

Overall, maternal work was associated with improved rates of stunting, what can be related to the previous assumptions that increased income from work leads to better resources for the child, including improvements in child feeding. The same factors explain the higher levels of overweight among working mothers in 2006. However, patterns of changes when the mother works by wealth quintiles and maternal education were different from 1996 to 2006, and although not significant, suggest that changes in the child’s diet and health behaviours when the mother works were leading to the coexistence of malnutrition, particularly among those better-off.

Figure 6.6- Effect of maternal work on percentage of child stunting and overweight according to maternal education in Brazil, 1996-2006



The last analysis in Brazil consists of examining whether HAZ and BMIZ differ according to the types of maternal work for each wave. Results from Table 6.6 show that in 1996, being employed, and being a professional/technician were associated with better height-for-age. In 2006, being employed was also associated with better linear growth. Those types of jobs were described in Chapter 5 as associated with better security, and better income. No differences were found between BMIZ and work characteristics.

Table 6.6-Mean height-for-age and bmi-for-age according to characteristics of maternal work in Brazil, 1996-2006.

	Brazil 1996				Brazil 2006			
	HAZ		BMIZ		HAZ		BMIZ	
	Mean	p-value	Mean	p-value	Mean	p-value	Mean	p-value
Type of work								
Self-employed	-0.58		0.34		-0.32		0.51	
Employed	-0.33	0.001	0.38	0.670	0.04	0.006	0.62	0.241
Occupation								
Prof.tech.	-0.15		0.45		N/P		N/P	
Services	-0.39	0.004	0.34	0.148				
Agriculture	-1.18	<0.001	0.30	0.220				
Skilled	-0.53	0.141	0.38	0.675				
Where								
At home	-0.41		0.43		-0.27		0.56	
away	-0.45	0.667	0.51	0.342	-0.17	0.456	0.56	0.958

NP=not provided; N/A = not applicable
Note: The p-values show whether the mean HAZ is statistically different from the category of reference.

6.3.2 Child nutrition in India

These analyses follow the same format as for Brazil, with focus only on HAZ and stunting.

Table 6.7 shows the mean height-for-age and the prevalence of stunting for both waves of data in India. Although the differences between waves suggest improvement in child linear growth, mean values of HAZ in 2005-06 are still very low, and almost reaching the cut-off point for stunting (-2 SD). The prevalence of stunted children had an important decrease between waves, but it was still high in 2005-06, accounting for almost half of the population from this sample (46.3%).

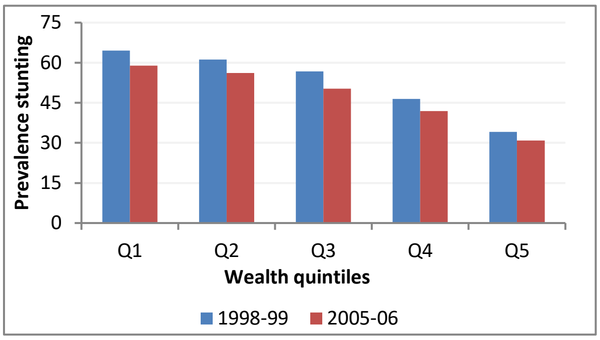
Table 6.7- Descriptive analysis of HAZ in India (1998-99 and 2005-06)

	India 1998-99	**India 2005-06**
Number	23246	23297
Mean	-2.07	-1.76
SD	1.80	1.78
P value	0.000	
% stunting	53.1	46.3
P value	<0.001	

SD= standard deviation
P value refers to the test of differences between the two waves

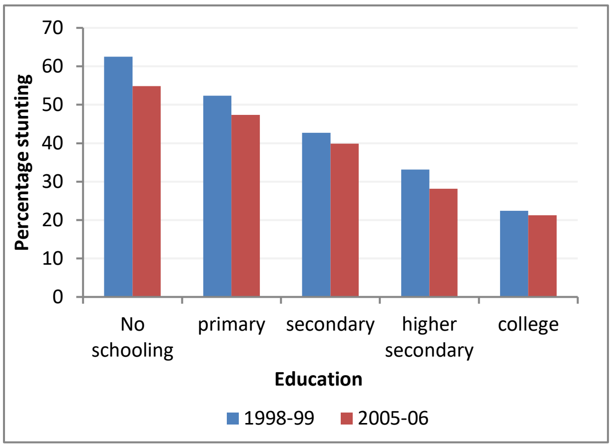
Analyses testing differences in the percentage of stunting across the wealth quintiles (Figure 6.7) shows the majority of children in the poorest wealth quintiles from both waves were stunted (p<0.001 for both waves). The poorest wealth quintile had a 1.83 times higher percentage of stunting than the highest wealth quintile in 1998-99 and although rates of stunting decreased in 2005-06, the differences between the poorest and richest wealth quintiles remained the same.

Figure 6.7- Percentage of stunting according to wealth quintiles in India, 1998-99 and 2005-06



Note: These analyses use the standard wealth calculated separately for each wave and country.

Figure 6.8- Percentage of stunting according to education in India, 1998-99 and 2005-06.



The findings according to maternal education were very similar, where despite observed decreased levels of stunting in 2005-06, the difference in rates of stunting between lower and higher education remained the same over the years ($p<0.001$ for both waves, Figure 6.8).

Table 6.8 provides the mean height-for-age and prevalence of stunting according to maternal work in India. Both values show a negative effect of maternal work on children's linear growth, where levels of stunting were significantly higher among working mothers. The distribution of HAZ by maternal work is shown in Appendix E.

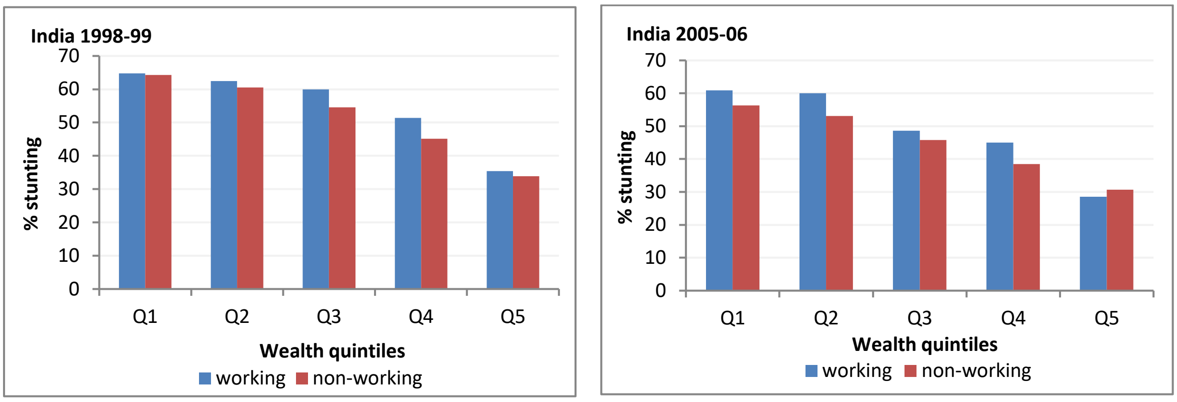
Table 6.8- Mean (SD) height-for-age and prevalence of stunting according to maternal work in India, 1998-99 and 2005-06

	India 1998-99	India 2005-06
Means		
HAZ (NWM)	-1.98 (1.8)	-1.68 (1.8)
HAZ (WM)	-2.29 (1.9) ***	-1.97 (1.8) ***
Percentages		
Stunting (NWM)	50.7	44.1
Stunting (WM)	58.7 ***	52.5 ***

NWM= non-working mothers; WM = working mothers
SD= standard deviation

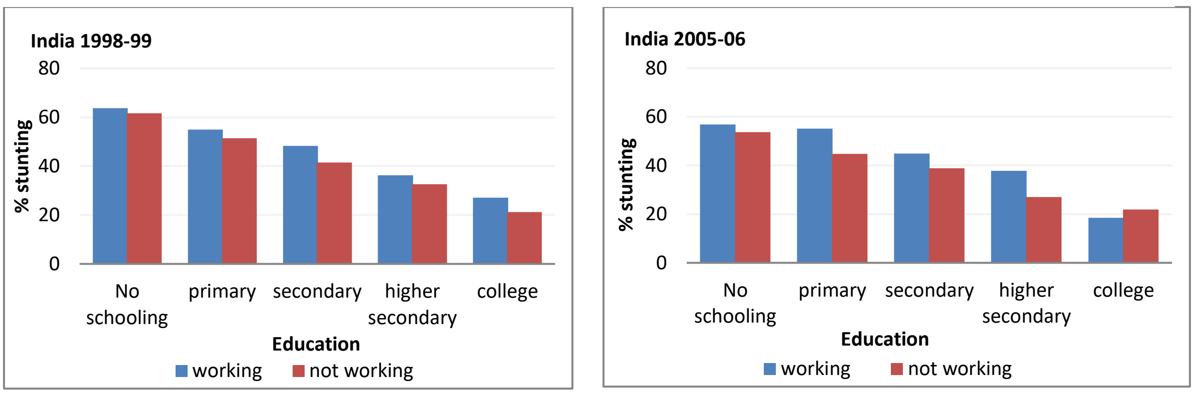
The effect of maternal work on child stunting was similar according to socioeconomic status. Figure 6.9 shows higher levels of child stunting for working mothers for all wealth quintiles (p<0.001), and very similar rates on the top quintile. Similarly, rates of child stunting were higher for working mothers for all levels of maternal education in both waves, with similar rates for those with tertiary education in 2005-06 (Figure 6.10).

Figure 6.9- Percentage of stunting by maternal work status according to wealth quintiles in India.



Note: These analyses use the standard wealth calculated separately for each wave and country.

Figure 6.10 - Percentage of stunting by maternal work status according to maternal education in India.



So far, results in India have shown slow improvements in child nutrition, which coincide with the small improvements in the population living conditions. A high inequality in levels of stunting among wealth quintiles and maternal education was also observed. Maternal work was associated with higher levels of stunting, with no differences between socioeconomic characteristics. Reflecting on the concept of maternal work affecting the child nutrition through a trade-off between time and income, this finding is supported by results in Chapter 5 that show a high percentage of women in unpaid work, and also supported by literature that suggests low paid jobs for women.

The last analyses examine the effect of characteristics of work on child HAZ (Table 6.9). It suggests that being a professional, self-employed and working at home were associated with better height-for-age when compared to their counterparts. Again, these were the type of jobs described in Chapter 5 as related to better working conditions and better payment.

Table 6.9- Changes on mean height-for-age according to characteristics of maternal work in India, 1998-99 and 2005-06.

	India 1998-99		India 2005-06	
	Mean	**p-value**	**Mean**	**p-value**
Occupation				
Prof.tech.	-1.41		-1.14	
Services	**-2.33**	**<0.001**	**-2.01**	**<0.001**
Agriculture	**-2.39**	**<0.001**	**-2.07**	**<0.001**
Skilled	**-2.06**	**<0.001**	**-1.78**	**<0.001**
work for who				
family member	-2.34		-1.98	
someone else	-2.26	0.241	-2.00	0.662
self-employed	**-2.18**	**0.042**	-1.88	0.282
Where				
At home	-1.85		-1.79	
away	**-2.09**	**0.001**	**-2.02**	**0.003**
Type of money				
Not-cash	-2.36		-2.00	
Cash	**-2.24**	**0.048**	-1.95	0.464
Who decides about money				
Women	-2.11		-1.90	
Together	-2.15	0.606	-1.94	0.606
Someone else	**-2.40**	**<0.001**	-1.96	0.602
Time of the year working				
all year	-2.26		-1.89	
seasonal	-2.35	0.119	**-2.11**	**<0.001**
occasional	-2.24	0.849	-1.94	0.701

Note: The p-values show whether the mean HAZ is statistically different from the category of reference.

6.4 Discussion

This chapter aimed to contextualize Brazil and India in terms of social development and living conditions of the population, and to offer some preliminary analyses on the changes in rates of child malnutrition across the years, as well as the associations between child nutrition, socioeconomic conditions and maternal work.

Both countries experienced changes in socioeconomic status, living conditions and levels of child malnutrition. However, in Brazil, changes were more successful in reducing inequalities and malnutrition than in India. These were the consequence of economic growth and a combination of policies, such as the conditional cash transfers programme, and increases in the minimum wage, that changed the living conditions of the population (Paim *et al.*, 2011). India had higher economic growth than Brazil (Stuenkel, 2015), with substantial improvement in the percentage of the population with basic assets, and pronounced increase in access to education (NSSO, 2011). However, these changes were slow, and not enough to reduce disparities between socioeconomic strata. The gap in rates of stunting between the poorest and richest remained the same, and the prevalence of stunting among children was still almost half of this population.

Poverty and malnutrition are closely associated as optimal child nutritional status depends on a comprehensive range of human basic conditions that include not only food availability, but also housing conditions, hygiene, access to education and health services (Monteiro, 2003). Therefore, from the results obtained in this chapter, it is expected that Brazil experienced greater reductions in child stunting when compared with India. The sample from Brazil has shown changes in maternal education, coverage of water and sanitation services, and improved access to assets, all documented elsewhere as associated with the decline in rates of stunting in the country (Monteiro *et al.*, 2009; Monteiro *et al.*, 2010).

There was no evidence of an increase in rates of overweight among children under five in Brazil, but national data on other age groups have shown substantial increase in overweight for children older than 5 years old as well as in adults (IBGE, 2010a; IBGE, 2014b). The slow increase in overweight levels among preschool children has been reported in other Latin American countries (Kain, Vio and Albala, 2003; de Mola *et al.*, 2014). At the same time, improvements in living conditions and increased access to food and commodities have been related to the nutrition transition and higher rates of overweight among schoolchildren in these countries (Popkin, Richards and Monteiro, 1996; BRASIL, 2016), suggesting that preschool children are the latest age group to be affected by changes in nutrition and physical activity patterns (De Onis, Blössner and Borghi, 2010). Despite the low levels of overweight found in the population of study, it is noticeable that rates of overweight for children under five started to vary according to sociodemographic characteristics in 2006.

Rates of malnutrition according to maternal work also went in different directions for Brazil and India. In Brazil, the prevalence of stunting decreased with maternal work in 1996, but no changes were observed in 2006. This finding suggests that the income from maternal work was important for providing for the child when rates of stunting were high in Brazil, but not so important after social changes and decreases in rates of child malnutrition. Still, maternal work had some influence in stunting in 2006, where descriptive analyses by wealth showed higher levels of stunting for working mothers in the highest quintiles of wealth. A possible explanation for this is the nature of maternal work in 2006 compared with 1996. With more educated women in the labour market as development progressed, jobs may have become more demanding and required more hours of dedication (Bruschini, 2007). The decreased time available for the child is associated with both stunting and overweight in the literature, and in Brazil, rates of overweight were higher for working mothers irrespective of wealth, and for those with better education.

In India, for both years, maternal work was associated with significant higher levels of stunting when compared with children from non-working mothers, irrespective of wealth. This can be explained by the overall working conditions for women in India, described in the previous chapter. Economic growth in India was not associated with the training of the population to engage in higher skills jobs, nor with modernization of other sectors of the economy (Ravallion and Datt, 2002). This is particularly true for women, who suffer cultural constraints against work outside home, and for whom opportunities and working conditions are still poor (Bhalla and Kaur, 2011).

Differences in findings from one country to the other show the importance of country macro characteristics for the association between maternal work and child nutrition, where income and time available for childcare, as the main mechanisms for this association, are also determined by the context. For instance, in India, where poor sanitation, household conditions and lower educational levels are associated with child stunting, the income/production factor is crucial for the positive effect of maternal work on child nutrition if it implies improvements in household resources, food availability and health care. However, if economic growth is not translated into better working conditions for women, and instead, mothers are subject to unpaid or low paid work, and poor employment rights, no positive effect can be expected.

On the other hand, where the environment allows better child nutrition due to improved sanitation, food availability and health care, the income generated by maternal work can be used for the benefit of the child. In the case of Brazil, the context of social development had already led to improvements in child nutrition and favoured the nutrition transition in the country (Monteiro *et al.*, 2009; Monteiro *et al.*, 2010). Then, the income generated by maternal work can affect the child in different ways depending on decisions made by parents in terms of food, habits, and behaviours. Such decisions can be related to the decreased time the mother spends doing household tasks, where the money can be used to purchase poor nutritional-quality meals, which is then associated with increased rates of overweight.

Because it is clear that the trade-offs between income and time availability for childcare operate in different ways in Brazil and India due to their contextual differences, new conceptual frameworks were proposed for each country, aiming to show the mechanisms by which maternal work affects child nutrition in each context.

The proposed conceptual framework for Brazil (Figure 6.11), suggests that:

1- The income generated by maternal work increases the access to both healthy and unhealthy habits that can affect child nutrition in different ways. If the local environment provides the basic needs for child growth, the decisions of parents on how to spend their earnings are the main determinants of whether the child can develop stunting and/or overweight.
2- The time constraints generated by work can result in decreased breastfeeding duration and decreased child supervision. Both can contribute to child stunting or overweight depending on the local environment.
3- Family structure can affect this association by increasing income in the household and by sharing the responsibilities of childcare with other adults.

For India, the following hypotheses are proposed (Figure 6.12):

1- Due to the high percentage of women in non-paid work, male earnings from work can be more important to provide for the household, and confound the association between maternal work and child nutrition, while the positive effect of maternal work due to income is only observed when the mother has better working conditions and better paid work.
2- When women have low or unpaid work, the positive effect of maternal work is more determined by the status of the family (property of land, caste) than earnings from work.
3- Family structure can affect this association by increasing income in the household and by sharing the responsibilities of childcare with other adults.

The third hypothesis, regarding the effect of family structure on how maternal work affects child nutrition is similar between countries, as additional working members within the family/household can increase household resources, and reduce the mother work-family conflict.

However, the context is still different in Brazil and India, where in Brazil, nuclear families are the majority (de Mesquita Samara, 2002), compared to India, where the traditional society prefers joint families (Niranjan, Nair and Roy, 2005).

There is a broad discussion in the literature about the characteristics of joint families in India, where a slightly higher proportion of joint families have been found among Hindus, in higher castes and/or families that own properties (Shah, 1996; Niranjan, Nair and Roy, 2005). Still, the patriarchal or matriarchal structure of joint families can influence maternal autonomy in the household and therefore, influence how maternal work relates to child nutrition (Sonawat, 2001; Allendorf, 2013).

Although the frameworks are focused on mothers, they do not intend to exclude the responsibility of the father on childcare and child's well-being. The inputs of the father are important for both income and childcare, shown in the framework by the generation of income from male work, and the effect of family structure on childcare. The effect of the father's behaviours and their involvement in raising the child has not been the focus of academic literature, and there is a lack of appropriate data to investigate this association. Still, the further analyses intend to bring this discussion to light through the examination of family structure.

The next chapters aim to test the hypotheses proposed in the conceptual framework using the data described in chapter 4. However, the data has several limitations for this study because no information is provided on female earnings from work, nor on the type of substitute childcare used when the mother works. Furthermore, the cross-sectional nature of the data does not allow for the understanding of changes in the household or in the child's lifestyle due to maternal work. Therefore, some of the hypotheses cannot be directly tested, and instead, they are tested using assumptions on how different types of maternal work affect the trade-off between income and time availability for childcare in each context. Those are discussed in more detail in the subsequent chapters.

Figure 6.11- Conceptual framework for the association between maternal work and child nutrition in Brazil.

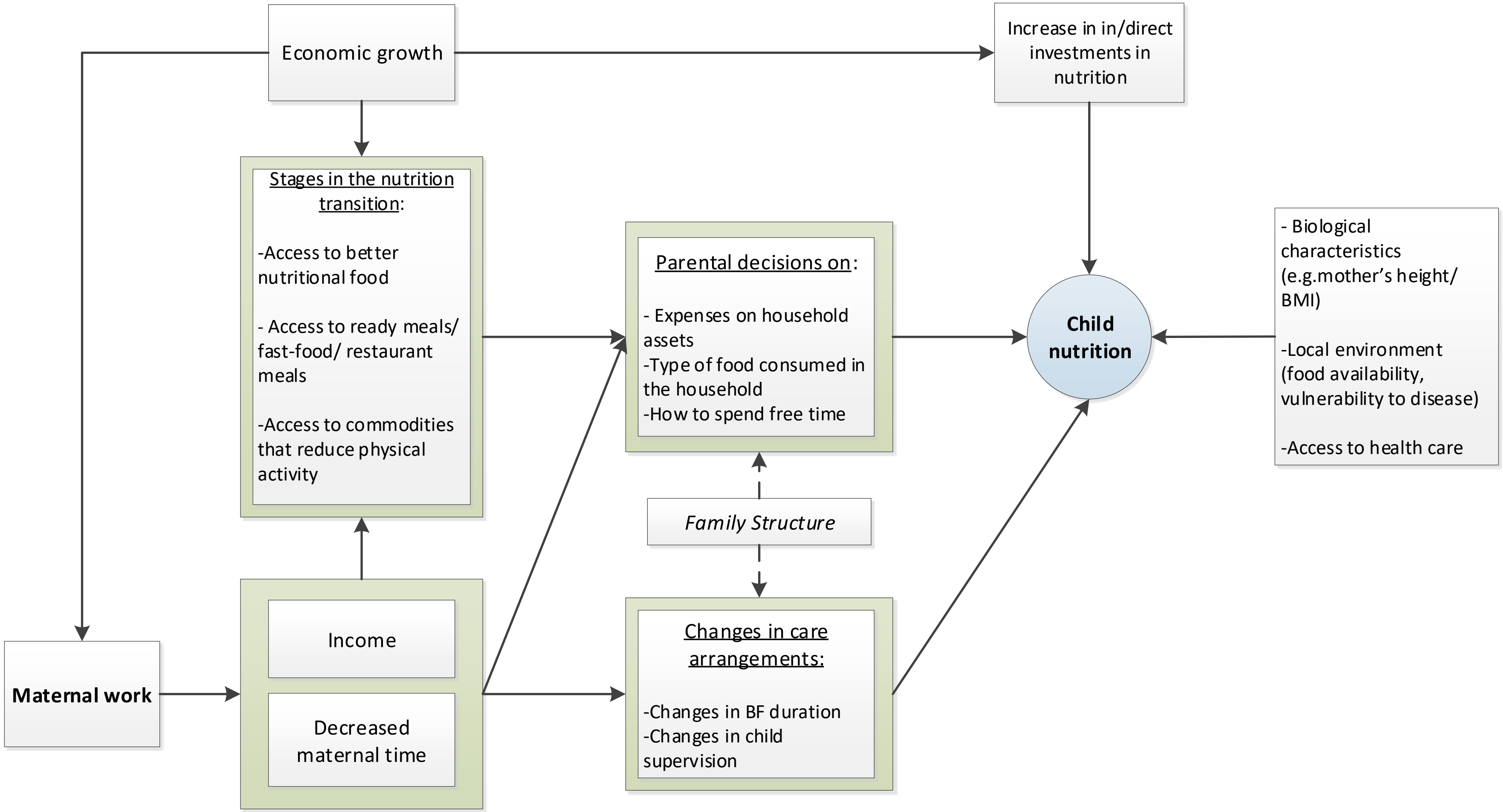
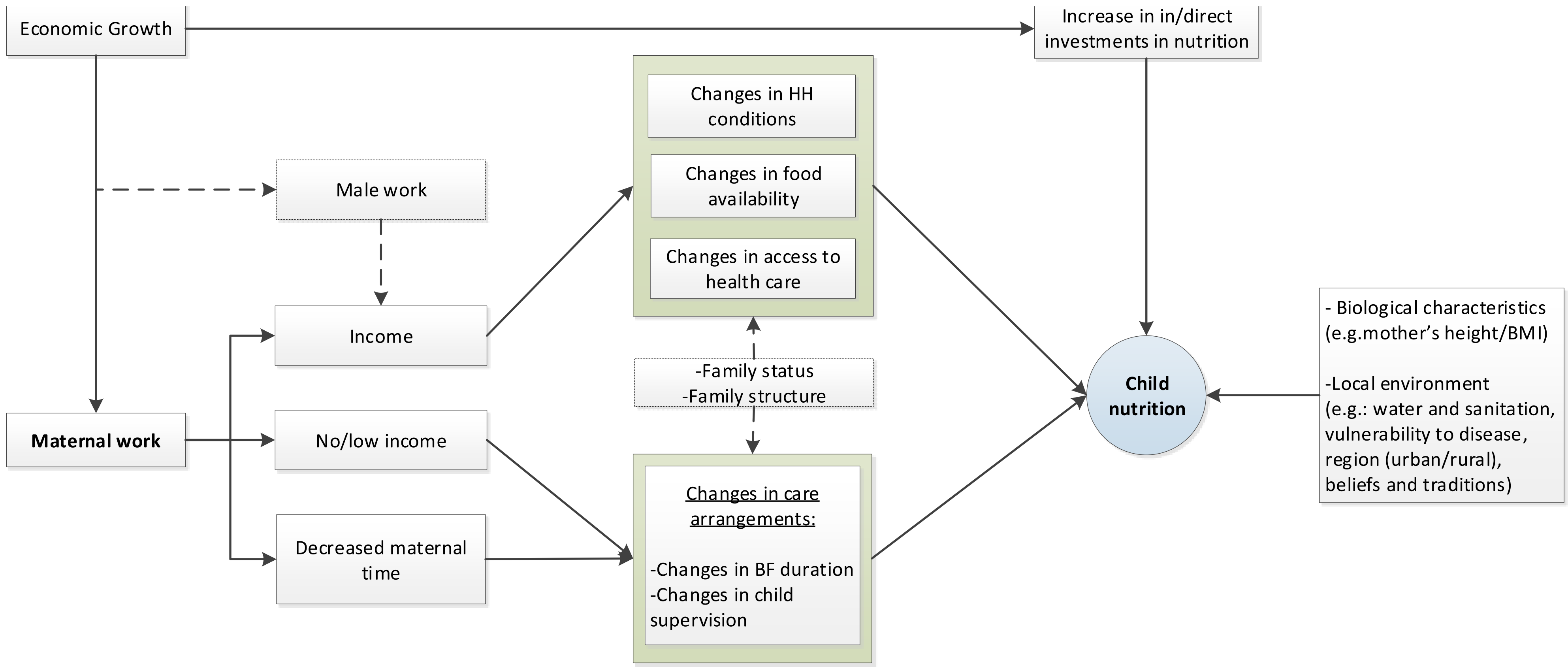


Figure 6.12-Conceptual framework for the association between maternal work and child nutrition in India



Box 6.1 – Main findings for child nutrition in Brazil and India

-Social development was higher for Brazil than for India, translating into a sharp decline in rates of stunting from 1996 to 2006;

-Rates of overweight did not increase in Brazil, but in 2006, higher rates of overweight were observed among higher socioeconomic strata;

-In India, there was improvement in the access to assets for the poor, but rates of stunting remained high;

-The association between maternal work and child nutrition went on opposite directions for Brazil and India: Maternal work was associated with lower rates of stunting and higher rates of overweight in Brazil, and higher rates of stunting in India.

Chapter 7: Exploring the effects of the type of work on child stunting in Brazil and India

7.1 Introduction

Findings from the last chapters showed women who work are significantly different from those who do not work in both Brazil and India. In Brazil, women who work were in an advantageous position, with better education and in higher wealth quintiles, while in India, they were poorer and less educated. Additionally, descriptive analyses showed that in Brazil, children from working mothers had lower rates of stunting, while in India, the opposite was found.

Critiques of previous studies that evaluate the association between maternal work and child nutritional status (CNS) included the lack of multivariate analysis, and the fact that most studies simply categorized women as employed or not employed, ignoring the many different types of work that women may do (Leslie, 1988). The type of work is important because it can affect child nutrition in different ways through how much compensation it offers (in terms of income) and how much time it demands from the mother.

The data used in this study does not provide information on time and income, but assumptions about how each type of work is associated with CNS can be made, based on the literature and based on results from descriptive analyses of female work (section 5.3.3). This chapter explores these assumptions according to each country's individualities, aiming to answer question 4, on how the different types of maternal work are associated with child linear growth/stunting in Brazil and India.

7.2 Methods

The investigation of the association between maternal work and child nutrition using covariates requires the use of variables that are at different levels of hierarchical structure. Children, as individuals are influenced by maternal characteristics, which are influenced by the characteristics of the environment in which they live. A proposal of multilevel analysis intended to consider maternal characteristics as a second level, and geographic states as the societal context, where children *i* were nested in mothers *j,* who are nested in states *k*.

Since Brazil and India have very different rates of stunting, different methods were used for each country. Brazil had lower levels of stunting than India in both waves, with the lowest prevalence in 2006 (5.9%). Therefore, the understanding of the effect of maternal work on child linear growth, instead of on stunting is more appropriate and more meaningful in terms of conclusions and policy recommendations. The equation for the multilevel linear regression analysis controlling by covariates can be written as:

(1) $HAZ_{ijk} = \beta_1 + \beta_2 W_{ijk} + \beta_3 X_{ijk} + \mu_{jk} + \delta_k + \epsilon_{ijk},$

Where HAZ_{ijk} refers to children's height-for-age, W_{ijk} represents maternal work, and X_{ijk} is a set of controlling variables including child, maternal and household characteristics (covariates X_{ijk} were specified in chapter four, section 4.3.2). The error components are represented by μ_{jk} , as a random intercept for mother *j* and state *k*, δ_k as the random intercept for state k, and ϵ_{ijk} as specific to each child *i* from mother *j* and state *k*.

A null model (Table 7.1) was estimated to check the variation at the maternal and state levels in Brazil. The likelihood ratio test comparing the three-level model with a single-level model (no maternal and state effects) shows that the three-level model offers a significantly better fit to the data. The intraclass correlation coefficient (ICC) shows the correlation of HAZ between two children from the same state and the correlation between two children from the same mother. HAZ for children in the same states of Brazil had a small correlation, estimated as 0.04, while HAZ among children from the same mothers was higher, estimated as 0.35 and 0.27 for 1996 and 2006, respectively. The highest variance was attributed to individual differences among children.

This indicates that for both waves in Brazil, children from the same mother and living in the same state tend to have a more similar height-for-age when compared with children from different mothers and different states. Such similarity can be explained by genetics, environmental characteristics, habits, or regional policies and legislation regarding maternal and child health, which justify the use of a multilevel model in this study.

Table 7.1- Variation on height-for-age at maternal and state levels in Brazil

	Brazil 1996	**Brazil 2006**
Number of states	7	10
Number of mothers	3050	3427
State variance (SE)	0.09 (0.052)	0.06 (0.03)
Maternal variance (SE)	0.64 (0.059)	0.37 (0.05)
Individual variance (SE)	1.33 (0.057)	1.17
Likelihood ratio (p-value)*	281.73 (p<0.001)	168.39 (p<0.001)
ICC state level	0.04	0.04
ICC maternal level	0.35	0.27

Note: *Comparison with a two-level model also showed a better fit to the data for the three-level model (LR test chi2(1) =129.70, p<0.001 for 1996 and 101.99, p<0.001 for 2006).

In India, where higher rates of stunting were found for both years, the response variable was categorized as “0” for normal growth and “1” for stunted, and multilevel logistic regression was used. The three level model followed the formula below (2), in which two error components were generated (μjk and δk).

(2) $Yijk = \beta 1 + \beta 2Wijk + \beta 3Xijk + \mu jk + \delta k$

Due to the high percentage of people in India living in rural areas (around 70% in both years) and the great variability in the types of work in urban and rural areas, the analyses in India were stratified by place of residence. Table 7.2 shows variation at the maternal and states levels for both areas.

Table 7.2- Variation on stunting at maternal and state levels in India

	Rural 1998-99	**Urban 1998-99**	**Rural 2005-06**	**Urban 2005-06**
Number of states	26	26	29	29
Number of mothers	15,525	5,863	13,382	7,896
State variance (SE)	0.24 (0.07)	0.15 (0.06)	0.14 (0.04)	0.11(0.04)
Maternal variance (SE)	0.50 (0.16)	0.66 (0.29)	0.69 (0.20)	1.24 (0.35)
Likelihood ratio (p-value)*	585.7 (p<0.001)	99.9 (p<0.001)	319.9 (p<0.001)	140.0 (p<0.001)
ICC state level	0.06	0.04	0.03	0.02
ICC maternal level	0.18	0.20	0.21	0.29

Note: *Comparison with a two-level model also showed a better fit to the data for the three-level model (LR test equal to 566.5 for rural areas and 91.1 for urban areas in 1998-99; and 289.6 for rural areas and 107.8 for urban areas in 2005-06).
-Analyses only took into account children younger than 36 months to allow comparison between the two waves of data.

The likelihood test comparing the three-level model with a single-level model for rural and urban areas of India was favourable toward the three-level model. The ICC was slightly higher for states in the first wave, and in both years, the ICC for children from the same mothers was higher indicating that children from the same mothers had similar probabilities of being stunted comparing with children of different mothers.

Maternal work can affect child nutrition mainly through changes on household income and time available for childcare, as proposed in the conceptual framework (see **Figure 6.11** for Brazil and **Figure 6.12** for India, section 6.4). Different types of work can affect the trade-off between these variables in various ways, leading to different outcomes for child nutrition. If the positive effect of income is very high, it can outweigh the negative effect of lack of time availability, and the opposite is also true, in which low quality of childcare can result in an overall negative effect of maternal work on CNS.

Then, CNS can be written in a simplified model as:

$$(1.1)\ CNS_{ijk} = X_{ijk} + C_{ijk} + I_{ijk} + u_i$$

in which CNS for the *ith* child is a sum of its biological/behavioural determinants and environmental characteristics such as family education and wealth (X_{ijk} – controlling characteristics) plus the availability of the mother for childcare (C_{ijk}) and the additional income from maternal work (I_{ijk}) – all for each mother and each state. *ui* represents all the error terms in the multilevel model (μjk, δk, ϵijk), accounting for unobserved individual, household or state characteristics that might affect child nutrition.

Assumptions on how different types of work affect C_{ijk} and I_{ijk} were made, based on the literature and previous analysis of characteristics of work, and tested using multilevel models. Each type of work was compared with children from non-working mothers: hence, "not working" is the reference category for the independent variable in most of the subsequent models.

The results were presented according to the inclusion of different covariates. The first result shows the univariate analysis, including only the variable related to maternal work (W_{ijk}) and the error components (Model 1). The second result shows the model with child characteristics added (Model 2), followed by the model with maternal characteristics added (Model 3) and finally, with household characteristics added (Model 4). Results were provided as coefficients for Brazil (multilevel linear regression) and as odds ratio for India (multilevel logistic regression). The full models can be found in the Appendix F. Analyses were conducted for the two waves, for comparison in two periods of time. Interactions between work and education, wealth, and caste were tested separately, but those were not significant, and therefore, they are not reported here.

7.3 Results for the effects of maternal work on child linear growth in Brazil

The first model (Table 7.3) compares child height-for-age for working mothers with non-working mothers. Results suggest that maternal work had a positive effect on linear growth in 1996, which remained statistically significant in the full model. In 2006, no associations were observed. The variance decreased when adding covariates, showing that the initial state variance was largely explained by sociodemographic differences between children in both models (77% in the final model in 1996, and 67% in the final model in 2006). The first wave had a higher variance in HAZ between mothers, which was partially explained by child characteristics such as age, birthweight, and vaccination. In 2006, the highest drop in the maternal variance happened when adding maternal characteristics.

Table 7.3- Results from multilevel modelling on the impact of maternal work on child's height for age in Brazil in 1996 and 2006.

	1996			
	Model 1	**Model 2**	**Model 3**	**Full model**
Intercept	-0.49	-1.05	-1.12	-0.90
Working	**0.15*** **	**0.19*** **	**0.12***	**0.12***
CI	**(0.06,0.25)**	**(0.08,0.30)**	**(0.01,0.24)**	**(0.002,0.24)**
Variance state (SE)	0.09 (0.05)	0.04 (0.03)	0.04 (0.02)	0.02 (0.01)
Variance mother (SE)	0.64 (0.06)	0.49 (0.07)	0.45 (0.07)	0.44 (0.07)
Variance children (SE)	1.33 (0.06)	1.29 (0.07)	1.26 (0.07)	1.25 (0.07)
Log likelihood	-6697.4	-4412.6	-4284.2	-3952.8
	2006			
Intercept	-0.29	-0.15	-0.24	-0.13
Working	0.05	0.04	0.001	0.01
CI	(-0.03,0.13)	(-0.06,0.14)	(-0.10,0.10)	(-0.10,0.09)
Variance state (SE)	0.06 (0.03)	0.03 (0.02)	0.02 (0.01)	0.02 (0.01)
Variance mother (SE)	0.37 (0.05)	0.30 (0.06)	0.27 (0.06)	0.25 (0.06)
Variance children (SE)	1.17 (0.05)	1.07 (0.06)	1.07 (0.06)	1.07 (0.07)
Log likelihood	-6699.2	-4038.0	-3984.1	-3792.2

* <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

This analysis suggests that maternal work had an overall positive effect on child linear growth in 1996, but it was no longer important after decreases in the rates of stunting in 2006, consistent with the descriptive results from section 6.3.1. The coefficients for the covariates in each model are shown in Appendix F.1. All the child characteristics were significantly associated with child linear growth in both waves. For maternal characteristics, only education and older maternal age were significant in the first wave. In the second wave, older maternal age and education were positively associated with child growth, while mixed ethnicity was negatively associated with child growth. Wealth tertiles were positively associated with child linear growth in both waves, while a negative association was observed with the number of household members in the first wave. The next models test the assumptions on how each type of work affects child linear growth.

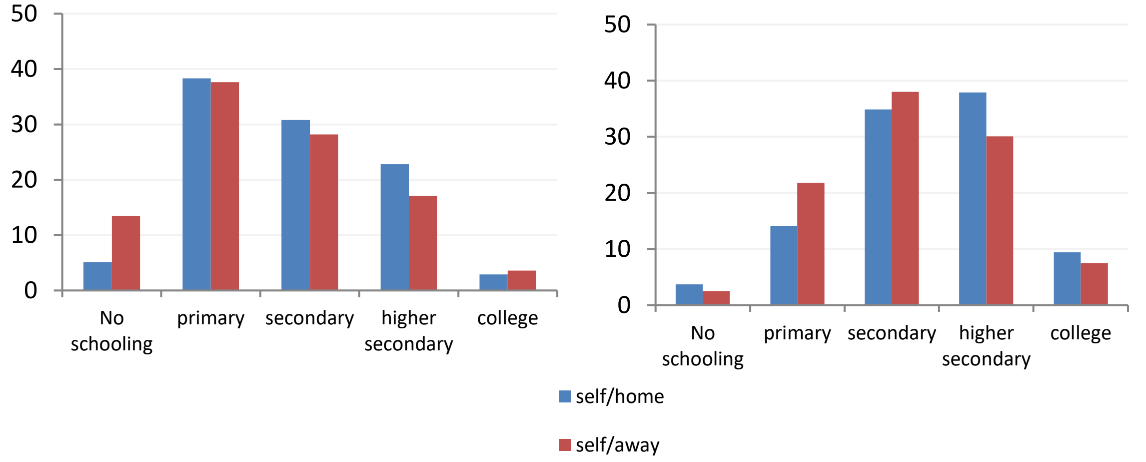
Employed or self-employed

Studies show a positive association between fertility and self-employment, arguing that this type of employment offers greater flexibility in the organization and quantity of work that enable women to reconcile childcare and work (Bianchi and Casper, 2000; Wellington, 2006). Yet, this relationship can differ across different types of self-employment (professional versus non-professional occupations) (Budig, 2006).

In the previous chapter, children from self-employed mothers had lower HAZ than children from employed mothers (Table 6.6, section 6.3). Initially, this was an unexpected result when considering that this type of work should allow for more time available for childcare, together with increased income, and should have a positive effect on HAZ. However, as previously discussed (section 5.4), a number of self-employed women are involved in activities away from home, that require lower levels of education/training, such as itinerant business, vendors, and domestic workers (Wajnman, Queiroz and Liberato, 1998).

In fact, in this data, self-employed women working away from home had lower educational levels than those working from home (Figure 7.1). Furthermore, more than half of mothers characterized as self-employed were working away from home (53.5% in 1996 and 64.2% in 2006), which decreases the time available for childcare, and is often related with lower job security and lower financial stability.

Figure 7.1- Education according to whether self-employed mothers work at home or away from home in Brazil.



Therefore, a distinction was made between self-employed mothers who were working at home and away from home, leading to the following assumptions for each type of work:

(1.2) CNS self-employed/home = X_{ijk} +(C_{ijk}+I_{ijk}) + u_i

For self-employed mothers working at home, women have more time with the child. Therefore, the extra income and time availability for childcare complement each other resulting in a positive effect for the child.

(1.3) CNS self-employed/away= X_{ijk} + I_{ijk} – C_{ijk} + u_i

For those working away from home, the negative effect of lack of time for the child can nullify or outbalance the positive impact from income, because the effect of income is small.

(1.4) CNS employed = X_{ijk} + I_{ijk} x (I_{ijk}- C_{ijk}) +u_i

For employed mothers, the benefits provided by a secure job (e.g. regular income, access to health care and unemployment insurance) can enhance the effect of income, even when time available for childcare is reduced.

Although it is not possible to measure what type of childcare the child received during the absence of the mother, nor the amount of time the mother was absent in each category of work, this analysis provides an idea of the effect of type of work on child's health.

Univariate analysis on Table 7.4 confirms the assumptions. For 1996, results suggest that the positive effect of income was null for self-employed mothers working away from home, and no differences in HAZ were found when compared with non-working mothers. In 2006, self-employed mothers working away had a negative effect on child nutrition, which was no longer significant when covariates were added. For self-employed mothers working from home, the effect was positive and significant in Models 1 and 2 for both waves.

Table 7.4- Results from multilevel modelling on type of work (employed/self-employed) on child's HAZ compared to non-working mothers in Brazil in 1996 and 2006.

	1996			
	Model 1	**Model 2**	**Model 3**	**Full model**
Intercept	-0.49	-1.02	-1.09	-0.86
Self-employed/away	-0.05	0.10	0.09	0.12
CI	(-0.21,0.11)	(-0.08,0.28)	(-0.09,0.28)	(-0.06,0.31)
Self-employed/home	**0.18***	**0.25****	0.16	0.12
CI	**(0.01,0.35)**	**(0.06,0.44)**	(-0.03,0.35)	(-0.07,0.32)
Employed	**0.23*****	**0.21*****	0.12	0.12
CI	**(0.11,0.35)**	**(0.07,0.35)**	(-0.03,0.27)	(-0.03,0.27)
Variance state (SE)	0.09 (0.05)	0.04 (0.01)	0.04 (0.02)	0.01 (0.01)
Variance mother (SE)	0.63 (0.06)	0.48 (0.07)	0.47 (0.07)	0.48 (0.07)
Variance children (SE)	1.33 (0.06)	1.29 (0.07)	1.29 (0.07)	1.26 (0.07)
Log likelihood	-6640	-4381.9	-4254.1	-3924
	2006			
Intercept	-0.29	-0.15	-0.22	-0.11
Self-employed /away	**-0.12***	-0.10	-0.11	-0.11
CI	**(-0.23,-0.02)**	(-0.22,0.02)	(-0.24,0.01)	(-0.24,0.01)
Self-employed /home	**0.14***	0.11	0.08	0.08
CI	**(0.005,0.28)**	(-0.04,0.28)	(-0.08,0.24)	(0.08,0.23)
Employed	**0.23*****	**0.22****	0.14	0.11
CI	**(0.11,0.36)**	**(0.07,0.38)**	(-0.02,0.29)	(-0.05,0.27)
Variance state (SE)	0.05 (0.03)	0.03 (0.02)	0.02 (0.01)	0.02 (0.01)
Variance mother (SE)	0.36 (0.05)	0.29 (0.06)	0.26 (0.06)	0.25 (0.06)
Variance children (SE)	1.17 (0.05)	1.08 (0.06)	1.08 (0.06)	1.07 (0.07)
Log likelihood	-6677	-4036.8	-3975.5	-3784.4

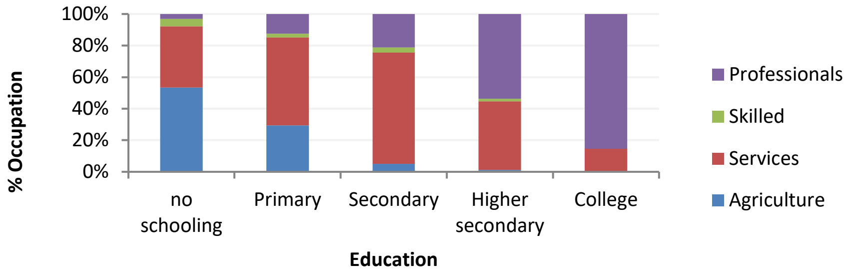
* <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 – univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

None of the models remained significant after including maternal characteristics, and among covariates, only education and age of the mother were significantly associated with HAZ among all of the included maternal characteristics in 1996 (Appendix F.1). Changes in the state and maternal variance were similar to the first model (Table 7.3), as well as the direction of covariates, and hence, those are not further discussed. The next model investigates maternal occupation, which provides a better idea of work measuring maternal education.

Occupation

This model was only estimated for 1996 as data on maternal occupation was not provided for 2006. Figure 7.2 shows a simple cross tabulation between occupation and maternal education, where the similarity between these variables suggest that occupation may be a proxy for educational level. The majority of women working in agriculture had no education or only primary education, and professionals had mostly higher secondary or tertiary education. Women working in services and skilled occupations had similar rates of participation in almost all groups of education.

Figure 7.2- Cross tabulation between education and occupation for Brazil 1996.



Due to the low number of women working in skilled jobs, this category of work was combined with services. However, services is a very heterogeneous group, including the group of self-employed women working away from home, such as domestic workers and vendors, and jobs that demand extra training or better education, such as employment in administration, industries, communications and technology. Therefore, services were divided into services with up to primary education, and services with more than primary education, and occupation was used as a proxy for maternal level of education in the analyses.

Using the same formula provided in 1.1, the assumption behind this model is that jobs that require better education provide better income, increasing the positive effect of maternal work on child nutrition, which outweighs the negative effect of lack of time for childcare.

Results for the univariate analysis (Table 7.5) show agriculture was negatively associated with child HAZ, no longer significant when adding covariates. Services with better education and professionals were positively associated with child growth, and remained significant when household characteristics were added. However, the effect of occupation on HAZ decreased.

Table 7.5- Multilevel linear regression for the impact of maternal occupation on children's HAZ compared to non-working mothers in Brazil, 1996.

	Model 1	Model 2	Model 3	Full model
Intercept	-0.51	-1.07	-0.99	-0.85
Agriculture	**-0.48*****	-0.12	-0.13	-0.04
(CI)	**(-0.68,-0.28)**	(-0.33, 0.09)	(-0.35,0.09)	(-0.27,0.18)
Services/LE	-0.14	0.06	0.08	0.11
(CI)	(-0.30, 0.02)	(-0.12,0.24)	(-0.10,0.27)	(-0.09,0.30)
Services/HE	**0.34*****	**0.25****	**0.25****	0.16'
(CI)	**(0.19, 0.49)**	**(0.07,0.42)**	**(0.07,0.43)**	**(-0.03,0.34)**
Professionals	**0.49*****	**0.44*****	**0.41*****	**0.29****
(CI)	**(0.35-0.64)**	**(0.27,0.62)**	**(0.23-0.59)**	**(0.10-0.48)**
Variance state (SE)	0.09 (0.04)	0.04 (0.03)	0.04 (0.03)	0.01 (0.01)
Variance mother (SE)	0.59 (0.06)	0.48 (0.07)	0.47 (0.07)	0.48 (0.07)
Variance children (SE)	1.32 (0.06)	1.29 (0.07)	1.29 (0.07)	1.25 (0.07)
Log likelihood	-6652	-4402.5	-4290.8	-3953.3

* <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

The shortcoming of the model consisted of grouping working mothers using a proxy for education, while non-working mothers were grouped all together. Non-working mothers are also a heterogeneous group, which can contain women with both high and low education, with difference in time available for childcare, and quality of childcare. The next model was estimated trying to address this issue, taking into account educational differences among working and non-working mothers.

Combined effect of work and education

A variable was created to combine education and work. First, maternal education was re-categorized into simply lower education and higher education. Women with up to primary education were categorized as having a low level of education, and higher education if otherwise.

The assumptions for this model are that for non-working mothers with lower education, the income and education effect disappears, and child nutrition is a combination of all the identified and non-identified covariates related to child nutrition and more time available for childcare. For working mothers with lower education, the small income effect cannot outweigh the negative effect of the lack of time available for childcare. Among those with high education, for non-working mothers, there is a positive effect of quality of time available for childcare summed with the effect of better education. However, for those working, income and education can overcome the negative effect of lack of time of the mother. This is because work that demands better education is likely to pay more, and improve living conditions and child feeding, and even pay for better childcare in the mother's absence, although this cannot be tested using this data.

Table 7.6- Results for multilevel regression model on the combined effect of work and education on child's HAZ in Brazil 1996 and 2006.

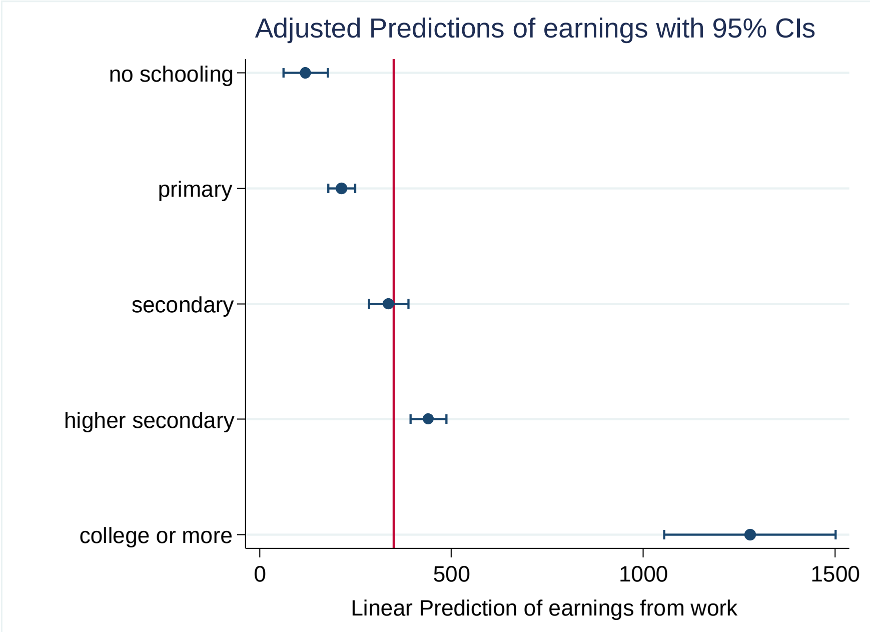
	Model 1	Model 2	Model 3	Full model
1996				
Intercept	-0.78	-1.18	-1.10	-0.88
W/LE	-0.02	0.04	0.04	0.06
(CI)	(-0.16,0.12)	(-0.11,0.19)	(-0.12,0.19)	(-0.10,0.22)
NW/HE	**0.51*** **	**0.21** **	**0.20** **	0.10
(CI)	**(0.39,0.63)**	**(0.06,0.36)**	**(0.05,0.35)**	(-0.06,0.27)
W/HE	**0.71*** **	**0.49*** **	**0.47*** **	**0.31** **
(CI)	**(0.58,0.83)**	**(0.33,0.64)**	**(0.31,0.62)**	**(0.13,0.48)**
Variance state	0.07 (0.04)	0.04 (0.03)	0.04 (0.02)	0.01 (0.01)
Variance mother	0.57 (0.06)	0.47 (0.07)	0.47 (0.07)	0.48 (0.07)
Variance children	1.31 (0.06)	1.25 (0.07)	1.29 (0.07)	1.25 (0.07)
Log likelihood	-6619.6	-4397.3	-4286	-3952.9
2006				
Intercept	-0.60	-0.44	-0.23	-0.12
W/LE	-0.001	0.002	0.003	-0.02
(CI)	(-0.16,0.16)	(-0.16,0.17)	(-0.16,0.17)	(-0.19,0.15)
NW/HE	**0.45*** **	**0.32*** **	**0.32*** **	**0.26*** **
(CI)	**(0.33,0.56)**	**(0.19,0.47)**	**(0.19,0.45)**	**(0.12,0.40)**
W/HE	**0.47*** **	**0.35*** **	**0.32*** **	**0.27*** **
(CI)	**(0.35,0.59)**	**(0.21,0.49)**	**(0.18,0.47)**	**(0.12,0.41)**
Variance state	0.04 (0.02)	0.03 (0.01)	0.02 (0.01)	0.02 (0.01)
Variance mother	0.32 (0.05)	0.28 (0.06)	0.27 (0.06)	0.26 (0.06)
Variance children	1.18 (0.05)	1.08 (0.06)	1.07 (0.06)	1.07 (0.07)
Log likelihood	-6652	-4019.9	-3985.2	-3792.8

* <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

Results for this model (Table 7.6) agree with the proposed assumptions. Results show that better education had an important positive effect on child nutrition, regardless of the work status of the mother. Moreover, the combination of both work and education had a higher effect on child linear growth in 1996, which remained significant even when controlling for household wealth.

Going back to the trade-off between income and time availability for childcare, the positive effect of the combination of work and education on child linear growth may be related to increased earnings from work when the mother is better educated. This model could not test the income effect of work, but further analysis studied the association between maternal earnings from work and education in 2006 [14]. There was an association between education and better earnings (Figure 7.3), in which those with higher education earned much more than those with higher secondary education.

Figure 7.3- Earning predictions for mothers inserted in the labour force according to education in Brazil, 2006.



Vertical line = minimum wage (R$350.00)

7.3.1 Discussion of findings in Brazil

Overall, maternal work had a positive effect on child linear growth in Brazil. However, this effect was rather small, and wiped out when other important determinants of child nutrition (e.g. maternal education and household wealth) were included in the models. This has been reported elsewhere in the investigation of maternal work on child's development (Ukwuani and Suchindran, 2003; Bernal, 2008), where the estimates were upwardly biased in univariate models. The addition of explanatory variables corrected for endogeneity, showing the importance of socioeconomic factors for child development.

The findings were more significant in 1996 than in 2006, which might be explained by the higher rates of stunting in the first wave, when changes provided by maternal work would have a more important effect on household conditions and child feeding. From 2000 to 2006, the country has progressed through social development, with decreased inequality between lower and higher

[14] Data on maternal earnings were collected only in 2006. This was not used in further analysis due to the number of missing values (N= 566).

socioeconomic strata and facilitated improvement in living conditions (Paim *et al.*, 2011). The conceptual framework proposed for Brazil (Figure 6.11) acknowledges that after social development, if the local environment provided the basic needs for child growth, the impact of income from maternal work on the household could have minor effects on child linear growth. Instead, the parental decisions on the type of food consumed, household expenses, and the type of childcare offered would have a higher impact on child nutrition.

The results from the models agreed with the proposed assumptions, in which maternal education seemed to be an important determinant of the effect of work on child nutrition, particularly in 1996. Types of work that required better education (self-employed at home, employed, being a professional or working in roles in the services sector that require better education) were all positively associated with child linear growth at some point in the analysis. Furthermore, the variables that strongly defined maternal education, such as "services with higher education" and "working with higher education" remained significant in the full models.

Maternal education is indeed a very important determinant of child nutrition, as it has a direct effect on choices and behaviours of the mother regarding childcare that is then reflected in better child nutrition. Although there is an expected gradient of education among these types of work, working variables might not capture maternal behavioural choices as well as maternal education. Moreover, education increases the chances of having better wages, increasing the effect of income over the effect of decreased maternal time for childcare. Studies of patterns of work in Brazil showed in 2004 that women with more than 15 years of study, and working as a professional earned more than 7.5 times the minimum wage, compared to technicians who earned 5.5 to 7.0 times the minimum wage, and those with lower education who earned less than four times the minimum wage (Leone & Baltar, 2006).

Although the literature on types of work and child nutrition is scarce, this study's results has some similarities with previous studies investigating the effect of maternal work on child's wellbeing or child's cognitive behaviour. The Longitudinal Study of Australian Children (LSAC) (Baxter *et al.*, 2007) that investigates the impact of parental employment on child's wellbeing showed that self-employment was associated with poorer quality relationships and more detrimental effects on family due to its pressure on mother's wellbeing. It is important to consider the types of self-employment performed by women in each country, since it can vary, but it seems to be the same case in Brazil. The slow progress of Brazil towards women's participation in the formal labour force encouraged women to be included in the informal sector for many years, mainly working as domestic workers and sales. FLFP increased in Brazil, but self-employment is higher for women than men and among those, there are still high rates of women working in these low paid sectors (Leone & Baltar, 2008). On the other side, being employed should ensure better and regular wages, as well as protection against unemployment, medical assistance and maternity leave.

In conclusion, the results for Brazil advocate for a positive effect of maternal work on child linear growth when the work is related to better education and higher earnings.

7.4 Results for the effect of maternal work on stunting in India

The first model (Table 7.7) compares child stunting for working mothers and non-working mothers in a logistic multilevel model. The results (shown as odds ratios) showed that maternal work had a negative effect on child nutrition, where the odds of having a stunted child when the mother was working was 42% higher in 1998-99 when compared with children of non-working mothers. The effect was no longer significant when maternal covariates were added to the model in the first wave, but had borderline significance in 2005-06, where working mothers had 10% higher odds of having a stunted child.

The ICC shows that the propensity of stunting between two children from the same state had a small correlation, decreasing when added of control variables. Children from the same mothers had a higher correlation that varied when adding covariates. The median odds ratio (MOR)[15] calculated for state shows that the residual heterogeneity between states increased the odds of a child of being stunted by 1.58 times in the first wave and 1.36 times in the second wave when randomly picking two children in different areas. The heterogeneity between areas was higher in the first wave and it has increased when adding child characteristics.

The coefficients for each control variable are shown in Appendix F2. Most variables related to child characteristics were significant in both models, in which the likelihood of stunting increased with child's age and decreased with larger birth intervals. In the first wave, the likelihood of stunting was higher for girls when compared with boys, but no difference was observed in the second wave. For maternal characteristics, increased maternal BMI and education were associated with lower likelihood of having a stunted child. In comparison with Hindu religion, not being a Muslim was associated with lower likelihood of stunting in the first wave, and maternal

[15] In a multilevel logistic regression, the variances are rescaled, what makes it inviable to compare changes in variance components across models (Hox, Moerbeek and van de Schoot, 2017). Similarly, the interpretation of ICC is not ideal because it does not convey information regarding variation between clusters, nor is comparable with the fixed effects given in odds-ratio.
Therefore, the interpretation of the context was provided for the median odds ratio (MOR), explained in detail in section 4.5.4. It compares the median odds ratio between an individual from an area with a higher propensity of the outcome and an individual in a different state, with the same values for covariates.

age was not associated with child stunting. Belonging to a scheduled caste was associated with higher likelihood of child stunting, while the opposite was observed for higher wealth quintiles.

Table 7.7- Results from multilevel modelling on the effect of maternal work on stunting in India in 1998-99 and 2005-06 (Odds ratio provided, reference category: not working).

	1998-99			
	Model 1	**Model 2**	**Model 3**	**Full model**
Working	**1.42*** **	**1.19*** **	1.07	0.94
CI	**(1.32,1.52)**	**(1.08,1.32)**	(0.97,1.19)	(0.85,1.05)
Variance state (SE)	0.23 (0.07)	0.31 (0.10)	0.20 (0.06)	0.21 (0.07)
ICC state (SE)	0.06 (0.01)	0.05 (0.02)	0.04 (0.01)	0.04 (0.01)
MOR state	1.58	1.96	1.53	1.55
Variance mother (SE)	0.55 (0.14)	1.65 (0.35)	1.61 (0.34)	1.52 (0.33)
ICC mother (SE)	0.19 (0.03)	0.37 (0.04)	0.35 (0.05)	0.34 (0.05)
Log likelihood	-15671	-10381	-10160	-9933
	2005-06			
Working	**1.50*** **	**1.29*** **	**1.18*** **	1.10’
CI	**(1.39,1.62)**	**(1.61,1.41)**	**(1.07,1.30)**	(1.0,1.21)
Variance state (SE)	0.11 (0.03)	0.11 (0.04)	0.08 (0.02)	0.09 (0.02)
ICC state (SE)	0.03 (0.007)	0.02 (0.007)	0.02 (0.005)	0.02 (0.006)
MOR state	1.36	1.36	1.31	1.33
Variance mother (SE)	0.90 (0.18)	1.35 (0.31)	1.32 (0.31)	1.20 (0.30)
ICC mother (SE)	0.24 (0.03)	0.31 (0.05)	0.30 (0.05)	0.28 (0.05)
Log likelihood	-15535	-10016	-9843	-9656

‘<0.10; * <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

As discussed earlier, a binary variable for whether the mother was working or not is not enough to understand how work affects CNS, and further models should take into consideration work characteristics. As shown in chapter five, the nature of work in rural and urban areas varies widely in India (section 5.3.3) and analyses were conducted separately by type of residence.

Again, equation 1.1 was used to investigate whether working was positive or negative for child stunting based on assumptions regarding income and time availability for childcare. However, this evaluation comes with some issues. The first issue is that assumptions regarding work earnings are very difficult to make when about a third of women in rural areas do not earn cash (section 5.3.3). To account for this, I_{ijk} was also related to in-kind earnings, such as food production, that can directly provide food to the household. Second, although rural work can be demanding (Srivastava and Srivastava, 2010) and decrease time available for childcare, a number of women work seasonally, which can result in more days spent at home and more time available for childcare. A separate model considered seasonal work in comparison to regular work, but no conclusions can be taken about the time and duration of maternal work in other models.

7.4.1 Effects of maternal work on child stunting in rural areas of India

Employed/self-employed

A high percentage of women in the agricultural sector work for their families. Among those, descriptive analyses showed that in this dataset, only 7.5% were paid in cash in 1998-99 and 32.8% in 2005-06. Some of these women are paid in kind, or agreements are made with the household head (Srivastava and Srivastava, 2010; Das *et al.*, 2015). In this situation, it is not possible to know how much the mother gains in kind, nor how much this benefits the child. However, in many cases, the family has ownership of land, which implies a higher status of the family. Additionally, these families tend to be extended, resulting in more adults to share childcare responsibilities, and greater income/production when pooling male earnings in the household (Niranjan, Nair and Roy, 2005).

Women working for others are mainly paid in cash (92.8% in 1998-99 and 90.2% in 2005-06), but they might be under worse conditions than those working for their families. Studies describe those working in paid agriculture as poorer and belonging to scheduled castes, earning poorer wages because of lower bargaining power (Desai and Jain, 1994; Srivastava and Srivastava, 2010).

Self-employment in agriculture is mainly undertaken by farmers, which suggests higher status due to land ownership. However, women working in these conditions have low support from society and legislation, are not seen as the principal producer, or have low control over their assets (Nceus, 2012). Outside of agriculture, self-employed women are not a homogeneous group. They can be working on their own account, which again includes roles such as street vendors and manufactures, associated with lower status and lower wages or, they can be classified as employers, associated with higher status.

The trade-off between income and time available for the child could only be applied to women earning cash, which is mainly composed of women working for others, and self-employers on their own account. However, both of these types of work are considered low paid jobs, and then, the income effect cannot outweigh the time constraints generated by work. Other work arrangements, when belonging to a high status family, may have more positive effects on the child, when women's work guarantee the functioning of the land, while allowing men to work for wages.

Table 7.8- Results from multilevel modelling on the impact of being self-employed/employed on stunting in India in 1998-99 and 2005-06

	Model 1	Model 2	Model 3	Full model
1998-99				
Employed family	**1.25*** **	1.02	0.97	0.92
CI	**(1.13,1.39)**	(0.89,1.18)	(0.84,1.11)	(0.79,1.06)
Employed others	**1.52*** **	**1.26** **	1.16’	1.00
CI	**(1.36,1.70)**	**(1.08,1.47)**	(1.0,1.36)	(0.86,1.17)
Self-employed	1.09	1.06	1.05	1.01
CI	(0.91,1.32)	(0.82,1.39)	(0.81,1.38)	(0.78,1.32)
Variance state (SE)	0.24 (0.07)	0.38 (0.12)	0.25 (0.09)	0.26 (0.09)
Variance mother (SE)	0.49 (0.16)	1.56 (0.38)	1.56 (0.38)	1.49 (0.37)
Log likelihood	-11302	-7711	-7591	-7435
2005-06				
Employed family	**1.38*** **	**1.17***	1.10	1.07
CI	**(1.24,1.53)**	**(1.02,1.34)**	(0.96,1.26)	(0.93,1.23)
Employed others	**1.58*** **	**1.37*** **	**1.29** **	1.17’
CI	**(1.38,1.81)**	**(1.15,1.62)**	**(1.08,1.54)**	(0.98,1.39)
Self-employed	**1.28***	1.11	1.08	1.05
CI	**(1.06,1.55)**	(0.86,1.42)	(0.83,1.39)	(0.81,1.35)
Variance state (SE)	0.12 (0.04)	0.13 (0.04)	0.09 (0.03)	0.09 (0.03)
Variance mother (SE)	0.72 (0.20)	1.31 (0.36)	1.33 (0.36)	1.23 (0.35)
Log likelihood	-9901	-6686	-6599	-6473

’ <0.10; * <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

Table 7.8 shows that being employed by family or others increased the chances of having a stunted child, but the odds were greatest for those working for others, with borderline significance after controlling for covariates in 2005-06. Self-employment did not affect the likelihood of having a stunted child when compared with non-working mothers in the first wave, while in the second wave the odds ratio was no longer significant after including child characteristics as covariates. Changes in the variance after the introduction of covariates were similar to the observed in Table 7.7, as well as the direction of associations between control variables. Therefore, the changes in the variance and control variables will no longer be discussed.

<u>Regular/Seasonal or Occasional</u>

It is very common that among women working in agriculture, some jobs are offered only for a few months of the year for seasonal or casual jobs in times of transplanting, weeding and sowing. All these activities are paid very low wages when compared to men (Srivastava and Srivastava, 2010; Bhalla and Kaur, 2011). In terms of childcare, seasonal work may allow the woman to spend more days per year out of working, which gives more time to care for children, but it can also require intense work during working seasons, that affect childcare negatively.

The assumption for regular workers is that they have the benefit of cash/in-kind earnings coming regularly to the house, at the same time as experiencing the negative effect of lack of time for the child. If mother's earnings are low, it can lead to a negative effect of work on child stunting, but, if earnings are higher, the trade-off could be null or positive. Seasonal workers can have lower wages, but may also have fewer days of the year where they leave their child under other people's care.

Table 7.9- Results from multilevel modelling on the impact of periodicity of work on stunting in India in 1998-99 and 2005-06.

		1998-99		
	Model 1	**Model 2**	**Model 3**	**Full model**
Regular	**1.36*****	**1.15***	1.09	1.00
CI	**(1.24,1.50)**	**(1.01,1.31)**	(0.96,1.24)	(0.88,1.15)
Seasonal	**1.28*****	1.06	0.97	0.88
CI	**(1.15,1.43)**	(0.91,1.24)	(0.83,1.14)	(0.75,1.03)
Variance state (SE)	0.24 (0.07)	0.38 (0.12)	0.25 (0.09)	0.26 (0.09)
Variance mother (SE)	0.49 (0.16)	1.54 (0.38)	1.54 (0.38)	1.47 (0.37)
Log likelihood	-11308	-7712	-7591	-7434
		2005-06		
Regular	**1.34*****	1.13'	1.08	1.04
CI	**(1.22,1.50)**	(0.98,1.29)	(0.94,1.24)	(0.91,1.19)
Seasonal	**1.54*****	**1.35*****	**1.26*****	**1.18***
CI	**(1.36,1.73)**	**(1.16,1.57)**	**(1.08,1.46)**	**(1.01,1.37)**
Variance state (SE)	0.12 (0.04)	0.13 (0.04)	0.09 (0.03)	0.09 (0.03)
Variance mother (SE)	0.72 (0.72)	1.32 (0.36)	1.34 (0.36)	1.24 (0.35)
Log likelihood	-9901	-6686	-6598	-6471

' <0.10; * <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

Both types of work had significantly increased odds of stunting when compared to non-working mothers, but results were different between waves (Table 7.9). Initially, in 1998-99 working regularly had higher odds of stunting, but the effect was lost after entering maternal covariates to the model. For the more recent wave, having seasonal work was associated with higher odds of stunting, which remained significant after adding covariates.

Agriculture/non-agriculture

In rural areas, 78.0% and 72.8% of working mothers reported being in the agricultural sector in 1998-99 and 2005-06 respectively. Jobs outside agriculture are heterogeneous, and can require better training or education, such as jobs in manufacturing, teachers in lower grades, paramedics, and work in public administration (Nceus, 2012). It suggests that non-agricultural workers in rural areas would have better effect on child nutrition when compared to those in agriculture.

Table 7.10 shows that working in agriculture increased the odds of stunting for both waves, and it remained borderline significant in the full model in 2005-06.

Table 7.10- Results from multilevel modelling on the impact of the agricultural sector on child stunting in India in 1998-99 and 2005-06.

	1998-99			
	Model 1	**Model 2**	**Model 3**	**Full model**
Agriculture	**1.42*** **	**1.16***	1.06	0.96
CI	**(1.30,1.55)**	**(1.03,1.32)**	(0.93,1.19)	(0.84,1.08)
Non-agriculture	1.11	1.00	1.04	0.98
CI	(0.98,1.27)	(0.83,1.21)	(0.86,1.26)	(0.80,1.19)
Variance state (SE)	0.24 (0.07)	0.38 (0.12)	0.25 (0.09)	0.26 (0.09)
Variance mother (SE)	0.50 (0.16)	1.56 (0.38)	1.55 (0.38)	1.48 (0.37)
Log likelihood	-11289	-7703	-7583	-7426
	2005-06			
Agriculture	**1.54*** **	**1.29*** **	**1.19** **	1.12'
CI	**(1.40,1.70)**	**(1.14,1.46)**	**(1.05,1.35)**	(0.99,1.27)
Non-agriculture	**1.17***	1.04	1.06	1.04
CI	**(1.02,1.34)**	(0.86,1.25)	(0.88,1.27)	(0.86,1.25)
Variance state (SE)	0.12 (0.03)	0.12 (0.04)	0.09 (0.03)	0.08 (0.03)
Variance mother (SE)	0.71 (0.20)	1.31 (0.36)	1.33 (0.36)	1.24 (0.35)
Log likelihood	-9883	-6678	-6593	-6466

' <0.10; * <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

The trade-off between income and time for childcare could not be fully understood in these models. Further tests were made with the intention of strengthening assumptions on the trade-off, considering that family structure can have some effect on the type of childcare received. The same analyses conducted in this section were conducted separately by nuclear and joint family structure. Results are provided in Appendix F.3.

7.4.2 Effects of maternal work on child stunting in urban areas of India

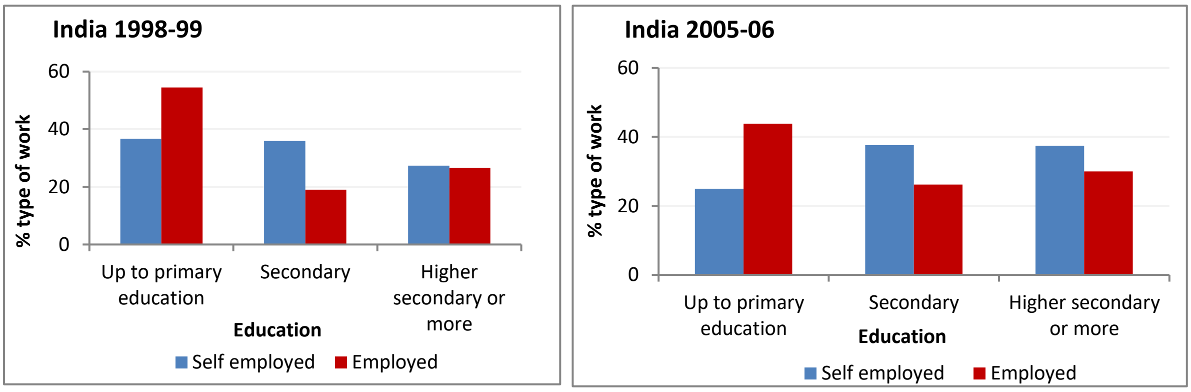
As observed in this sample, urban areas have a low number of women within the labour force (11.8% in 1998-99 and 15.9% in 2005-06). This is unexpected and of interest to researchers, due to the increasing educational levels of women in urban areas, which contrasts with the low rates of FLFP (Klasen and Pieters, 2015). Two characteristics of work investigated here are the type of work (self-employed/ employed) and occupation. Urban areas have higher rates of women earning in cash than rural areas (around 90% for both waves), and the evaluation of these associations considering the trade-off between time available for childcare and income is suitable.

Self-employed/employed

Self-employed women in urban areas are a smaller group compared with employed women (22.7% in 2005-06). It comprises employers, own account workers and family helpers, where the majority of workers are concentrated on manufacturing and trade (Nceus, 2012). A high percentage of them are found to be working at home (65.5% in 1998-99 and 60.3% in 2005-06), suggesting that this group could have both the benefits from time at home and income.

For those who are employed, which comprises the majority of women involved in the labour force in urban areas, there are also differences according to socioeconomic status and education. Those with lower education are found in low-skilled jobs, while highly educated women have the opportunity to enter white collar jobs (Klasen and Pieters, 2015). Descriptive analyses presenting the frequency of employed mothers according to educational level show a large percentage of employed mothers with lower education alongside increasing rates of education (Figure 7.5). Employed mothers were, therefore, divided into employed with lower education (up to primary education) and employed with better education (secondary or more).

Figure 7.4 - Type of work according to maternal education in India 1998-99 and 2005-06.



Considering that most of these mothers work away from home, lack of time for childcare could bring a negative impact for child nutrition, while the sector in which the mother is employed helps determine the income effect on the child.

Table 7.11- Results from multilevel modelling on the impact of employment/self-employment on stunting in urban areas of India in 1998-99 and 2005-06.

	Model 1	Model 2	Model 3	Full model
	1998-99			
Self-employed	0.91	0.76	0.75	0.76
CI	(0.67,1.24)	(0.48,1.20)	(0.47,1.20)	(0.47,1.21)
Employed (LE)	**2.08*** **	**1.47***	1.29	0.95
CI	**(1.63,2.65)**	**(1.05,2.05)**	(0.93,1.80)	(0.68,1.34)
Employed (HE)	0.77’	**0.54****	**0.62***	0.71
CI	(0.60,1.00)	**(0.35,0.83)**	**(0.41,0.97)**	(0.46,1.10)
Variance state (SE)	0.14 (0.05)	0.10 (0.05)	0.07 (0.04)	0.12
Variance mother (SE)	0.63 (0.29)	1.69 (0.74)	1.67 (0.75)	1.05
Log likelihood	-4275	-2611	2560	-2483
	2005-06			
Self-employed	1.12	1.12	1.22	1.19
CI	(0.82,1.50)	(0.76,1.64)	(0.82,1.80)	(0.81,1.74)
Employed (LE)	**2.06*** **	**1.42***	**1.35***	1.09
CI	**(1.61,2.65)**	**(1.07,1.87)**	**(1.01,1.79)**	(0.82,1.43)
Employed (HE)	**0.77***	0.81	0.89	0.99
CI	**(0.62,0.97)**	(0.60,1.09)	(0.66,1.22)	(0.74,1.34)
Variance state (SE)	0.10 (0.03)	0.09 (0.04)	0.07 (0.03)	0.08 (0.03)
Variance mother (SE)	1.22 (0.34)	1.15 (0.55)	1.22 (0.56)	0.92 (0.51)
Log likelihood	-5530	-3289	-3237	-3164

‘ <0.10; * <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

In both years, being employed with lower education increased the chances of having a stunted child in the univariate model, while being employed with better education was associated with lower odds of having a stunted child (Table 7.11). The effect disappeared when controlling for covariates.

Occupation

In these surveys, occupation can be seen as a proxy for education, with the hypothesis that the better the education and maternal earnings, the better the influence on child nutrition.

Table 7.12- Results from multilevel modelling on the impact of employment/self-employment on stunting in urban areas of India in 1998-99 and 2005-06.

	Model 1	Model 2	Model 3	Full model
1998-99				
Services	1.92***	1.35	1.10	1.02
CI	**(1.47,2.51)**	(0.92,1.97)	(0.75,1.62)	(0.69,1.51)
Skilled	1.31’	1.03	0.85	0.74
CI	(0.98,1.75)	(0.67,1.57)	(0.54,1.31)	(0.47,1.16)
Professionals	**0.42*** **	**0.31*** **	**0.55***	**0.54***
CI	**(0.30,0.59)**	**(0.18,0.54)**	**(0.31,0.97**	**(0.31,0.95)**
Variance state (SE)	0.13 (0.05)	0.09 (0.04)	0.08 (0.04)	0.09 (0.04)
Variance mother (SE)	0.63 (0.29)	1.85 (0.81)	1.86 (0.82)	1.76 (0.81)
Log likelihood	-4153	-2529	-2464	-2409
2005-06				
Services	**1.77*** **	**1.35***	**1.34***	1.17
CI	**(1.40,2.23)**	**(1.02,1.78)**	**(1.01,1.78)**	(0.88,1.56)
Skilled	**1.64** **	1.29	1.28	1.17
CI	**(1.22,2.18)**	(0.91,1.83)	(0.89,1.82)	(0.82,1.66)
Professionals	**0.38*** **	**0.51** **	0.66	0.87
CI	**(0.27,0.53)**	**(0.33,0.81)**	(0.42,1.04)	(0.54,1.38)
Variance state (SE)	0.10 (0.03)	0.08 (0.03)	0.06 (0.03)	0.07 (0.03)
Variance mother (SE)	1.20 (0.35)	1.14 (0.55)	1.18 (0.56)	1.03 (0.54)
Log likelihood	-5391	-3194	-3148	-2949

’ <0.10; * <0.05; **<0.01; ***<0.001 CI=confidence interval; SE= standard error
Model 1 - univariate model of mother working or not
Model 2 – Model 1 + child characteristics
Model 3 – Model 2 + maternal characteristics
Full model – Model 3 + household characteristics

Results for this model (Table 7.12) show that, in the univariate models, being a professional was the only category of work with lower chances of having a stunted child, which remained significant in the first wave, but not in the second.

The analyses were also estimated by family structure, and results are found in Appendix F.3.

7.4.3 Discussion of findings in India

Overall, maternal work in India was associated with higher odds of child stunting. Univariate results confirmed the hypothesis that working for others and working in the agricultural sector was negative for child nutritional status, as these characteristics are related to lower wages, and mostly involve women in lower socioeconomic strata, scheduled castes, and lower education (Srivastava and Srivastava, 2010). Most models remained significant or with borderline significance after controlling for covariates in the second wave, suggesting that the effect of maternal work on CNS was intensified post-economic growth.

This finding can be explained by the various changes in the labour force, as well as the stagnation of FLFP that exacerbated sociodemographic inequalities for working women. Data from the National Office Statistics in India show the proportion of males working in agriculture declining gradually with economic growth, increasing their participation in other sectors of the economy, as well as migration to urban and semi-urban areas (NSS, 2006). The increased male migration to other areas implied women being left behind in rural areas to tend the land, decreasing their chances of improving income at the same time as reducing her time available for childcare (Rao, 2006). In addition, the increased opportunities for male employment alongside improved household income were accompanied by the withdrawal of women from the labour market due to increased stigma (Klasen and Pieters, 2015; Das and Zumbyte, 2016). Such changes suggest that women who continued working for money in agriculture in 2005-06 were driven by economic necessity and had poorer conditions for maintaining child's health and nutrition than in the previous wave.

The differences in results for seasonal work and regular work between 1996 and 2006 are worth noting. The former previous wave had regular work relating to worse odds for child stunting, while in 2005-06, it was better than seasonal work. Descriptive analyses in chapter five showed slight increases in the percentage of women working in the services sector alongside decreases in the agricultural sector. The shift from regular employment in agriculture to other sectors can be responsible for the change in the effects on child nutrition, since wages are better in other sectors of rural areas when compared with agricultural work (Srivastava and Srivastava, 2010).

Working for family members, despite being unpaid was more advantageous than paid work for others. Studies in India show that extended families, with ownership of the land have greater economic status, own more assets, and have better living conditions, which benefit the child despite the lack of income from maternal work (Niranjan, Nair and Roy, 2005; Allendorf, 2013). Furthermore, although the data did not allow for further investigation of childcare options, having more adults in the household may help with childcare responsibilities.

While results in rural areas showed higher odds of stunting or no association, results for urban areas showed opposite results, where work that required better education was associated with lower odds of stunting. The literature in urban areas show expansion of education for females, declines in the education gender gap, and increases in labour market returns to education in the past two decades (Pieters, 2010). The improved education is important not only for household wages, but also for higher decision-making power and better choices for the child.

In most models for both urban and rural areas, maternal education was positively associated with child health and was not related to the significance of maternal work. However, father's education and household wealth were related, and inputting these into the model reduced the effect of maternal work. This is expected in a very low educated population with high gender gaps in access to education. In such societies, the father is the provider of income for the household, and as such, his education and occupation tend to be determinants of children's access to resources (Desai & Jan, 1994).

Although in general, maternal work in India was associated with higher likelihood of child stunting, this finding is deeply rooted in poverty and ruthless conditions of work for women. When women were provided education and better job opportunities, there was a significant decrease in the chances of having a stunted child. These results highlight how important it is for new policies and investments in women to focus on improving their education and work opportunities in order to facilitate country development, continuous economic growth, and better impact on child's health.

7.5 Conclusion

The first conclusion of this chapter is that although the literature tries to find a consensus on the association between maternal work and child nutrition, this association depends very much on the stage of a country's development, the types of work provided for women, and policies protecting the child and the working mother. As shown for Brazil and India, work is not readily defined, and the nature of female work has different meanings in the different contexts.

For instance, self-employment is described as work with a flexible nature, providing better opportunities to combine market work with childcare (Glick and Sahn, 1998). However, the context of self-employment in Brazil and India has different meanings and implications for the child. In Brazil, self-employment is associated with lower wages and lower education, and considered a disadvantage compared with employed mothers. In India, self-employment is related to a higher status, better education and wealth, because being employed by others does not offer job security or fair wages. The different contexts yield different outcomes, where in Brazil, self-employment was negatively associated with child linear growth in the univariate analysis, while in India, this type of employment was considered less harmful for child stunting compared with other work.

The hypothesis of the trade-off generated by maternal work was easily applied to Brazil, but not to India, due to the various external factors that constrain or induce women to work. In general, work that provided some sort of financial security to women in both countries was positively associated with child's linear growth and lower odds of stunting. This was particularly true for jobs that required better education or higher level of training. Conversely, jobs offering lower income were negatively associated or not associated with child HAZ in Brazil. In India, results showing a lower effect of maternal work on child stunting when the mother worked for the family, suggested the status of the family was more important for child stunting than the income effect, as proposed in the conceptual framework (Figure 6.11).

The fact that some models were no longer significant after entering maternal education or household characteristics as covariates raises the question of whether the results from the univariate models were reflecting reverse causality. The literature reinforces that educated mothers tend to live in more economically developed areas, which have sufficient medical facilities and a safer environment for the child (Desai & Alva, 1998), which could explain the positive association between maternal work and child nutrition when work was related with higher education. In the same way, results in India showing association between maternal work and higher odds of stunting could be reflecting the context of poverty that women in poorer conditions of work and their children are situated within.

The results and conclusions obtained from this chapter were based mainly in assumptions of how the different types of work could affect the trade-off between maternal income and maternal time. This involved broad categorization of certain types of work, such as self-employed working away or at home, services and employment according to educational levels, and different occupations grouped in the same category. The erroneous classification of these types of work, or associations between very heterogeneous groups can lead to biased results. Furthermore, despite studies showing associations between education and income, education does not always guarantee a better income, nor the lack of education always lead to poorer work conditions. The assumptions in this analysis were carefully raised based on the literature, aiming to minimize these errors, and to enable the best possible use of this data for the understanding of the trade-offs between maternal income and time. Still, these limitations should be considered when interpreting the results.

The next chapter intends to go further in this investigation by exploring the influences of the context on the association between maternal work and child nutrition in India. This was not explored in Brazil because the rates of stunting in the country were smaller, as well as the effect of maternal work on child linear growth in the most recent wave. Oppositely, in India, this association was mostly significant in the most recent wave, which still had a high prevalence of child stunting.

Box 7.1 - Main findings for the effect of maternal work on child HAZ and stunting in Brazil and India

- Hypotheses about the trade-off between income and time available for childcare were not applicable in India, due to the important status of the family, and high rates of unpaid work.

- Overall, work that provided better income, particularly those requiring better education, were positively associated with child HAZ and with lower likelihood of having a stunted child in univariate models.
    - In Brazil, this was found for employed or self-employed women working at home, services with higher education and professionals.
    - In India, this was found in urban areas for those employed with better education and professionals.

- In rural areas of India, maternal work was negatively associated with child nutrition, increasing the likelihood of having a stunted child;

- This association was seen for types of work in the context of poverty, such as: work for others, seasonal work, and work in the agricultural sector.

- These results suggest the context has a more important effect on child nutrition than maternal work.

Chapter 8: Excluding selection bias on the association between maternal work and child nutrition in India

8.1 Introduction

The previous chapter investigating the association between different types of maternal work and child nutrition in India suggested that, overall, maternal work increased the odds of child stunting in univariate models. However, some results were inconsistent and no longer significant when controlling for covariates, even after stratification by types of family. The very different results when estimating univariate and multivariate models raises the question of whether results were showing the effects of the context instead of the real effects of maternal work.

This can happen due to selection bias, which means there are factors determining the decision of whether or not to work that interfethe re with the outcome (child nutrition). In fact, descriptive analyses provided in Chapter 5 showed that working mothers were systematically different from non-working mothers in some sociodemographic aspects. For instance, there were significantly higher percentages of working women between poorer socioeconomic status and lower education when compared with non-working women (Figure 5.4 and 5.5, section 5.3.2). The results also showed differences according to religion and region, what has been reported in the literature to be shaped by culture and regional characteristics (Alfano, Arulampalam and Kambhampati, 2011; Munro *et al.*, 2014).

Selection bias is a common issue in the investigation of associations among social behaviours, and methods to deal with this issue are becoming more common in social sciences. The main ones involve the use of instrumental variables, selection models, and propensity score matching. These methods aim to account for systematic differences in baseline characteristics of those exposed and non-exposed to the variable of interest when estimating the effect of this variable on the outcome.

This chapter focus on question 5 of the thesis, aiming to overcome the problem of selection bias and enhance the understanding of the association between maternal work and child nutrition considering the regional differences in the Indian context. For this, after discussing the possibilities for dealing with selection bias, and selecting the regions to be studied, propensity score matching was used to account for the factors that determine maternal work.

8.2 Randomized and observational studies

The literature on health and social behaviours has become more aware of the importance of causal inference in order to contribute to evidence-based management and translation of research into practice. A causal effect can be defined as the average effect due to an intervention or treatment (Li, 2013), which can only be correctly estimated in a randomized context: experimental data, where participants are randomly assigned to treatment or control group, generate unbiased estimators for causal effects, as all individuals should have equivalent observed and unobserved characteristics. For instance, given a randomized sample of individuals exposed to a treatment, two outcomes are possible: the outcome under the control treatment $Yi(0)$ and the outcome under the active treatment $Yi(1)$. For each subject, the effect of the treatment is defined as $Yi(1) - Yi(0)$.

The impracticality of collecting randomized data within social science and population-based research often results in the use of observational data for understanding health associations. Observational studies, lacking randomized treatment assignment, are not ideal for estimating treatment effects because associations between outcome and treatment are not necessarily a causal effect. Furthermore, it is likely that components determining the treatment also determine the outcome (Austin, 2011).

A fundamental problem of causal inference is how to reproduce outcomes that are not observed, such as the possible outcome if an individual had received treatment, when in fact, no treatment was given. These outcomes are called counterfactuals, and a counterfactual model shows the impossibility of calculating individual-level treatment effects where only aggregated treatment effects are possible (Li, 2013). The main measures of aggregated treatment effects include the average treatment effect (ATE) and the average treatment effect on the treated group (ATT).

ATE is defined as:

$$ATE = E(Y(1)|T = 1{,}0) - E(Y(0)|T = 1{,}0)$$

Where E represents the expectation, Y represents the possible outcomes and T denotes the treatment. ATE shows the average effect observed if moving the population from untreated to treated, compared with if no one in both groups (treated and untreated) received treatment (Austin, 2011). ATT, defined in the formula below, shows the average difference if everyone in the treatment group received treatment compared with if no one in the treatment group received treatment.

$$ATT = E(Y(1)|T = 1) - E(Y(0)|T = 1)$$

Some of the methods used to overcome the selection bias problem in observational studies and to allow the calculation of treatment effects are noted below, with brief explanations on the use of such methods for the treatment (maternal work) and outcome (child stunting) in this study.

Instrumental Variables (IV)

This method requires finding appropriate instruments, or variables that meet three conditions: they are associated with the treatment; they do not affect the outcome except through its potential effect on the treatment; and they do not share causes with the outcome (Hernan and Robins, 2010). The dataset used in this study did not have a variable that determined working that was not potentially correlated with child nutrition, particularly because determinants of work related to poverty, which affects child nutrition. Hence, the IV approach was not applicable.

Treatment effect model (Heckman model)

This model was initially designed to deal with self-selection that generates missing values in the variable of interest, for instance, when data on the outcome is only collected for treated individuals, but there are factors determining the probability of being treated [16]. The method was further expanded to deal with situations where selection bias exists and the outcome is observed for all individuals (treated and untreated), called the treatment effect model. The Heckman model suggests a two-step approach to account for the probability of "treatment" when investigating the "outcome". The first step consists of a regression equation considering mechanisms that determine the outcome variable; and the second consists of the selection equation, considering the mechanisms that determine the selection into treatment (Guo and Fraser, 2014).

One of the basic assumptions of this model is that error terms of the regression equation and the selection equation are bivariate normal and correlated (Guo and Fraser, 2014). In this study, this assumption could not be met, which may be partially explained by the fact that maternal work and child nutrition have very different determinants besides the ones related with socioeconomic status.

[16] The original example for the Heckman model (Heckman, 1974) comes from the study of the determinants of wage, where the variable "wage" is only responded by those who are working, and automatically the others have values truncated to zero. However, the determinants of wage might be influenced by the factors that determine the probability of working, generating selection bias.

Chapter 8

Propensity score method

The propensity score is a method that assigns values to subjects that define the probability of receiving a treatment based on observed characteristics. This is often estimated using a logistic regression, where the treatment is regressed on baseline characteristics, and the propensity score is equivalent to the predicted probability of treatment obtained in the regression model. After applying this balancing score to the data, the distribution of baseline covariates should be similar between treated and untreated subjects.

This method has two important assumptions. The first is the conditional independence assumption, meaning that given a set of observable covariates Z not affected by treatment, potential outcomes are independent of treatment assignment. That implies that selection is only based on characteristics that are observed by the researcher. This is a strong assumption, which requires good quality of data, and evidence-based theories to support the decisions of variables to be used (Caliendo and Kopeinig, 2008). Furthermore, sensitivity analyses and cross checks can be used to investigate if there are potential missing variables that influence treatment assignment (Caliendo and Kopeinig, 2008).

The second assumption is of common support, ensuring that persons with the same X values have a non-zero probability of being both participants and non-participants. The common support assumption can be checked by visual analysis of the density distribution of the propensity score in the treatment and non-treatment groups (Heinrich, Maffioli and Vazquez, 2010).

Four different methods can be used with the propensity score: propensity score matching, stratification, inverse probability of treatment weighting (IPTW), and covariate adjustment (Austin, 2011). Propensity score matching (PSM) is a special procedure that uses the propensity score to match treated and untreated individuals sharing a similar propensity score. Stratification involves stratifying subjects into subsets based on their estimated propensity score, for instance, quintiles of the estimated propensity score. The IPTW method uses weights based on the propensity score to create a sample in which the baseline covariates are independent of treatment assignment. Covariate adjustment consists of the outcome variable being regressed on an indicator variable denoting treatment status and the estimated propensity score.

Given the assumptions of the use of propensity score were a better fit with the data used, this was the method chosen to deal with selection bias. The matching procedure was the most adequate method to simulate a randomized situation and review the prevalence of stunting among working and non-working mothers. The next section explains the methods behind the matching procedure.

8.3 Propensity score matching (PSM)

The matching approach consists of simulating an experimental context, where control individuals with similar characteristics as the treated individuals are allocated as a match (Caliendo and Kopeinig, 2008). One-to-one marching is the most common approach for PSM, but other approaches can be used. When a matched sample is formed, the treatment effect can be estimated by comparing outcomes for the treated and untreated, taking the difference between the proportion of individuals in the two groups that experience the outcome.

Theories behind the implementation of the Propensity score

The implementation of this method requires the careful selection of variables that simultaneously influence the treatment (e.g. maternal work) and the outcome (e.g. child stunting) to be included in the model. In the literature, there are various suggestions on how to define the best set of variables in order to fulfil the independent condition. The decision should be guided by theory and previous knowledge based on the literature, without the omission of important variables (Heckman, Ichimura and Todd, 1997). The chosen variables must be unaffected by the treatment (e.g. reverse causality), and should not be an essential predictor of the treatment in terms of defining that persons with such characteristics would always or never receive the treatment.

There is no analysis to indicate whether the variables are consistent, or whether other variables should be added to the estimation of the propensity score, but the literature recommends that an over-parameterised model should be avoided, as adding variables can increase the variance of the estimates (Bryson, Dorsett and Purdon, 2002). Another study suggests that variables known to be related to the outcome and treatment should remain in the model even if not significant, as those are relevant to the propensity score estimation (Rubin and Thomas, 1996).

If the assumptions are met, and the variables are well chosen, the PSM estimator for the average treatment effect on the treated group (ATT) is given by the mean difference in outcomes weighted by the propensity score distribution of participants:

$$\tau_{ATT}^{PSM} = E_{P(X)|T=1}\{E[Y(1)|T = 1, P(X)] - E[Y(0)|D = 0, P(X)]\}$$

where E represents the expectation and T denotes the treatment.

Among the possible ways of matching algorithms, three are presented here: the nearest neighbour (NN), radius, and Kernel.

The nearest neighbour (NN) matching chooses for comparison individuals that have the closest propensity score. In this case, when allowed replacement, an untreated individual can be used more than once as a match, increasing the quality of the matching and reducing bias (Caliendo and Kopeinig, 2008). Having more than one nearest neighbour is another way of reducing variance for using more information for the outcome.

The NN matching can result in problematic matches if the closest neighbour has a very different propensity score. Overcoming this issue requires imposing a tolerance level on the maximum propensity score distance, or a calliper, but if fewer matches are performed, this method can result in reduced sample size, and increased variance of the estimates. Radius matching is a variant calliper suggested by Dehejia and Wahba (2002), implying in not only using the nearest neighbour within each calliper, but all the comparison members within the calliper. A calliper is best defined as a quarter of the standard deviation of the propensity score.

Kernel matching is a non-parametric matching using weighted averages of all individuals in the control group for defining the outcome. This method has lower variance because of the use of more information, however, poorer matching can result from this method if there is large distance between two individuals.

Each method has a different trade-off between variance and bias, where the performance of each estimator is very dependent on the data structure. As a matter of testing the results, the different approaches should be performed, comparing differences in the estimated results.

Assessing the matching quality

The purpose of the matching is to balance the distribution of variables among control and treatment groups. Then, comparing the situation before and after matching is the first approach to check the quality of this method. T-tests can be used to check whether there are significant differences in covariate means for both groups. After matching, the covariates should be balanced with no significant differences. If there are any remaining differences after conditioning on the propensity score, and quality indicators are not satisfactory, there is a need to rethink the model by changing variables, adding interaction-terms or higher-order terms, and testing the quality once again (Caliendo and Kopeinig, 2008).

Additionally, the quality of the matching is assessed by the standardised bias, and pseudo R^2. The standardised bias assesses the distance in marginal distributions of the variables. This is defined as the difference of sample means in the treated and matched control for each covariate as a percentage of the square root of the average of sample variances in both groups, where a bias reduction below 5% is seen as sufficient (Caliendo and Kopeinig, 2008).

The pseudo R^2 before and after matching indicates how well the regressors explain the treatment probability. The matching procedure should eliminate systematic differences in the distribution of covariates, and R^2 should be low.

Sensitivity analysis

The main assumption for the propensity score matching is that all observed variables are included in the estimation. However, if there are unobserved variables that affect assignment into treatment and the outcome simultaneously, a hidden bias can affect the results. An approach proposed by Rosenbaum as sensitivity analysis assesses how strongly an unmeasured variable must influence the selection process to destabilize the propensity score (Becker and Caliendo, 2007).

For binary outcomes, the Mantel and Haenszel (MH) test statistic is recommended. Considering ui an unobserved variable, and ϒ the effect of u on the treatment assignment, if the study is free of hidden bias, ϒ is equal to zero. However, if there is hidden bias, two individuals with the same covariates X have different chances of receiving the treatment. The sensitivity analysis evaluates how inference about the treatment is changed by moving values of ϒ. In the MH test, two scenarios are useful: Q_{MH}^{+} is the test-statistic given that the treatment effect has been overestimated accompanied of the p-value for this test ($P\_mh +$), and Q_{MH}^{-} when underestimated accompanied of the p-value for this test ($P\_mh -$).

Before clarifying the application of the PSM using the data available, the next section explains the importance of the context in different regions of India for a better understanding of the association between maternal work and child nutrition.

8.4 Regional differences between North and South of India

India offers a very complex context for understanding social impact on health behaviours due to state autonomy, responsible for different policies in different regions, and the major differences in culture and values among states (Jejeebhoy and Sathar, 2001; León, 2011). In fact, many comparative studies in India tended to show regional differences with attention often focused on the north-south differences regarding marriage, malnutrition, fertility and female autonomy (Dyson and Moore, 1983; Jejeebhoy and Sathar, 2001; Navaneetham and Dharmalingam, 2002).

Dyson & Moore (1983), when evaluating demographic trends in India defined important principles of sociocultural variation between North and South. North was classified as having exogamic marriage, where women did not inherit property for their own use, and males tended to cooperate with and receive help from blood-related males. This characterized the region as mainly patrilineal, with preferences for male offspring. In the South, women could inherit and transfer property rights and men were more likely to enter social, economic and political relations with their spouses' families. Women had more autonomy in the South when compared with their Northern counterparts, having more contact with their families despite the establishment of nuclear families.

Rahman and Rao (2004) pointed that regional differences in the gender equity gap in India are not so simply categorized, and the status of women in the South has changed over the years by a certain approximation with traditions in the North. Still, demographic trends point to stronger social development in the South compared with the North. Studies comparing both regions have shown greater improvement in education in the South, particularly for women, lower inequality in educational opportunity (Alfano, Arulampalam and Kambhampati, 2011; Asadullah and Yalonetzky, 2012), lower fertility rate, and lower infant mortality (Jejeebhoy and Sathar, 2001) when compared with sates in the North.

These regional differences modify the context within which maternal work and child nutrition are situated, changing the opportunities and conditions of work offered to mothers, as well as opportunities of improvement of the child nutritional status. Figure 8.1 and 8.2 show the predicted log odds of child stunting across states[17] when the mother is working for the two waves under study, where there is clearly large variation across the states in this association.

These graphs confirm the influence of the context on how maternal work affects child nutrition by showing that states from the South were mainly found on the left side, indicating a lower likelihood of stunting according to maternal work. Conversely, states from the North were found at the middle to top right side, indicating a higher likelihood of stunting when the mother works.

[17] These estimates were obtained from a three level logistic model where maternal work was used as a binary variable (working/not working), as indicated in **Table 7.7** in the previous chapter.

Figure 8.1-Predicted log odds of child stunting by states of India, accounting for maternal work, NFHS 1998-99.

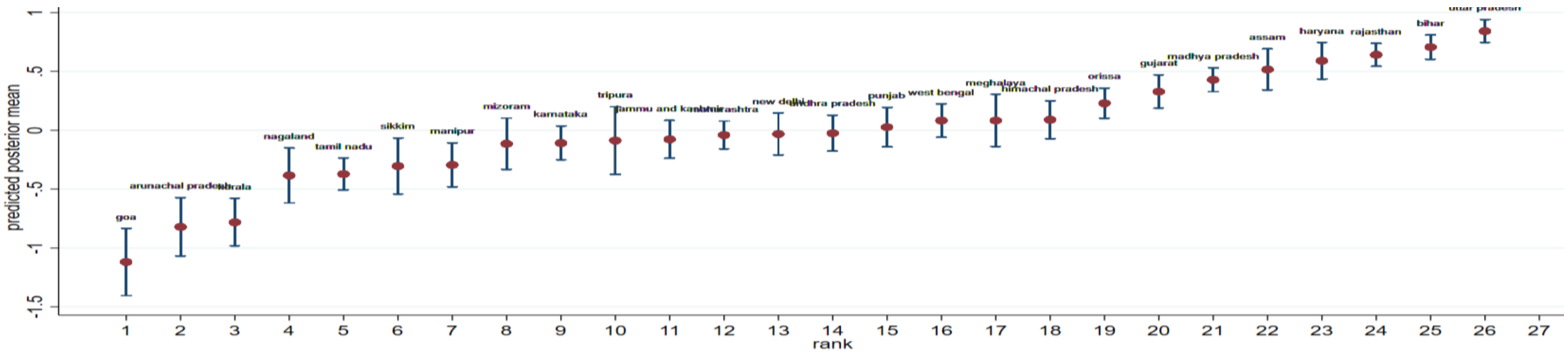
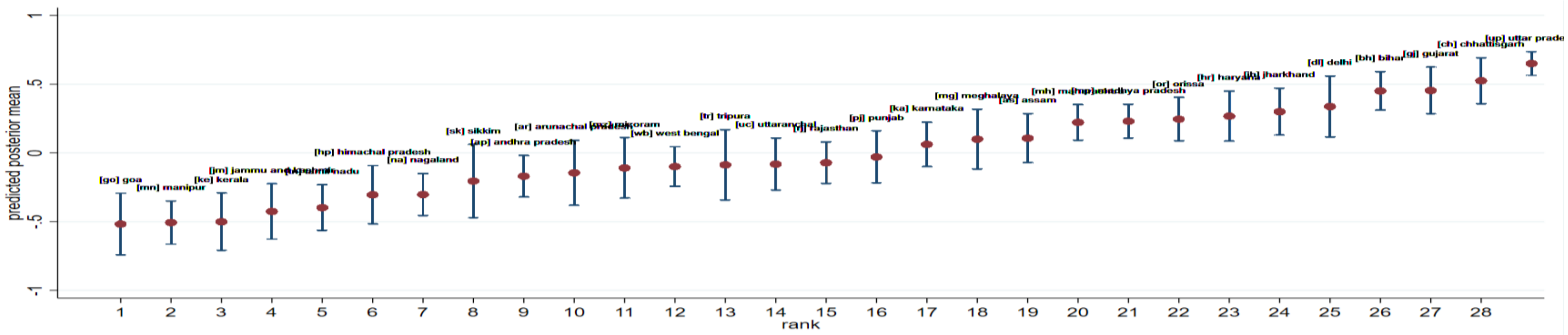


Figure 8.2- Predicted log odds of child stunting by states of India, accounting for maternal work, NFHS 2005-06



Differences in women's autonomy and social development in the North and South region suggest that determinants of female work in both regions are not the same, and PSM should be applied for each region separately. Pooling all states in the North and all states in the South of India was not considered adequate because of the variability within each region. For obtaining similar characteristics in each region, states were selected according to the following features, with the objective of comparing the more extreme contexts:

1- Similar association between maternal work and child nutrition according to Figure 8.1 and 8.2, in which the confidence interval does not pass through zero (significantly different);
2- Proximate geographical region (see map of India in section 2.3);
3- Similar indicators in terms of gender equality and social development.

Figures 8.1 and 8.2 show for 1998-99 and 2005-06 seven states with significantly lower coefficients of child stunting and eight states with significant higher coefficients of child stunting. Among those, considering only states from the North or the South, choices were based on the proximate geographical region, and proximate measures of Human Development Index (HDI) and Gender-related Development Index (GDI).

The HDI, introduced by the United Nations Development Programme in 1990 is an average of three dimension indices that measure achievements in a country with regard to 'a long and healthy life' (measured by life expectancy at birth and infant mortality); 'Knowledge' (measured by the adult literacy rate and mean years of education for those older than 15 years old and the combined primary, secondary and tertiary gross enrolment ratio); and 'a decent standard of living' (measured by estimated earned income in Purchasing Power Parity US$ - female/male estimated earned income share per capita per annum) (Desai, 1991). In 1995, the UNDP introduced the Gender-related Development Index (GDI) as the ratio of the HDI calculated separately for females and males. It is a direct measure of gender gap using the female HDI as a percentage of the male HDI (Bardhan and Klasen, 1999).

The evaluation of those indicators by the Government of India showed some differences between states, but they followed a trend in which the South generally scored better than the North (IIPA, 2009). Kerala had the highest score in the country in 1996 (HID=0.736 and GDI=0.721) and high scores in 2006 (HDI=0.764 and GDI=0.745), followed by high scores for Goa and Tamil Nadu in the

South. The states with consistently low achievement on HDI and GDI were Bihar, Uttar Pradesh, Madhya Pradesh, Rajasthan, and Orissa.

After evaluating the three features, Goa, Kerala and Tamil Nandu were pooled to represent states with higher development within the South region. In the North, the pooling took into consideration that the three states created in 2000 (Jharkhand, Uttaranchal, and Chattisgarth) were still part of Bihar, Uttar Pradesh and Madya Pradesh in the 1996. From these, Uttar Pradesh was not included in the analysis because the latter state created – Uttaranchal – had no similarities with other states. As such, states in the North with opposite context from the South were represented by Bihar, Madya Pradesh and Orissa for 1996, and by Bihar and Jharkhand, Madya Pradesh and Chattisgarth, and Orissa for 2006.

8.5 The application of PSM

The literature in India, as well as the previous analyses conducted in this thesis, showed a higher prevalence of working women in India among those with lower socioeconomic status and education (Desai and Jain, 1994; Srivastava and Srivastava, 2010; Klasen and Pieters, 2015). Such variables are also predictors of child nutrition, and therefore, the estimated effect of maternal work on child nutrition might be biased. The use of PSM intends to eliminate selection bias, and simulate a randomized environment in which working and non-working mothers have similar baseline characteristics.

For this, the choice of the variables was based on the common factors associated with both stunting and the decision of mothers to work. Variables that measure socioeconomic status are maternal education, tertiles of wealth, caste and type of residence (rural/urban). Religion can also influence the choices of maternal work, maternal autonomy, and priorities inside the household that influence child nutrition.

Maternal and child's age are also predictors of both maternal work and child nutrition. Working women in India tend to be older, and the age of the mother can influence the likelihood of having a low birth weight child, specifically when the mother is too young or older than the ideal reproductive age. Furthermore, maternal work tends to increase with child's age (Klasen and Pieters, 2015). Age of the child is a major factor associated with child nutrition, since young children are more vulnerable to diseases and to the environment.

Each of these variables cover the required assumptions, as they are determinants of both, the treatment (work) and outcome (child stunting), while they are not essential determinants of the treatment. Table 8.1 shows how these variables are significantly different among non-working and working women for North and South regions. Most variables were significantly different for working and non-working mothers in both regions, and some differences by region can be noted. Although there is a higher percentage of working mothers with lower education and in lower wealth tertiles in the South, the discrepancy when compared with non-working mothers is much lower than for women in the North. The more recent wave even had the highest percentage of working women in higher tertiles of wealth in the South.

Table 8.1-Characteristics of working and non-working mothers in North and South regions of India, 1998-99 and 2005-06.

	1998-99				**2005-06**			
	South		**North**		**South**		**North**	
	NW	**W**	**NW**	**W**	**NW**	**W**	**NW**	**W**
Child's age								
0	31.4	18.3	29.7	26.1	30.6	17.9	31.3	24.6
1	33.9	43.2	35.7	35.1	35.3	30.4	35.6	37.7
2	34.7	38.5	34.6	38.8	34.1	51.7	33.1	37.7
P value	**<0.001**		**0.005**		**<0.001**		**<0.001**	
Maternal age								
18-22	29.4	27.4	33.3	26.7	25.9	12.6	34.7	23.0
23-28	50.1	45.2	41.7	39.4	49.5	47.5	44.4	39.9
29+	20.5	27.4	25.0	34.0	24.6	39.9	20.9	37.1
P value	**0.042**		**<0.001**		**<0.001**		**<0.001**	
Education								
No schooling	12.6	32.9	59.2	82.2	7.3	22.2	55.0	74.0
primary	19.9	28.5	13.9	9.6	12.0	23.2	14.4	11.5
secondary	49.4	22.7	21.1	6.1	50.8	32.9	23.6	11.1
higher	18.1	16.0	5.8	2.1	29.9	21.7	7.1	3.4
P value	**<0.001**		**<0.001**		**<0.001**		**<0.001**	
Wealth tertiles								
1st (Poorest)	11.6	21.9	50.4	56.0	4.1	10.4	53.2	72.7
2nd	34.9	46.9	28.2	37.0	25.1	35.5	26.9	21.2
3rd (Richest)	53.5	31.2	21.4	7.1	70.8	54.2	19.9	6.2
P value	**<0.001**		**<0.001**		**<0.001**		**<0.001**	
Caste								
Sheduled caste	18.2	29.0	26.9	51.7	22	26.9	28.7	46.9
Other caste	81.8	71.0	73.1	48.3	78	73.1	71.3	53.1
P value	**<0.001**		**<0.001**		0.177		**<0.001**	
Religion								
Hindu	69.1	86.7	85.1	92.5	69.3	87.5	84.7	86.9
Muslim	22.0	5.8	13.4	5.5	20.8	4.9	13.4	8.6
other	9.0	7.5	1.5	2.0	9.8	8.4	2	4.5
P value	**<0.001**		**<0.001**		**<0.001**		**0.002**	
Residence								
Urban	32.1	26.7	17.0	8.6	43.3	36.2	19.6	7.4
Rural	67.9	73.3	83.0	91.4	56.7	63.8	80.4	92.6
P value	0.15		**<0.001**		0.125		**<0.001**	

Note: This analysis was restricted to children from 3 to 36 months for comparability over the years.

To account for differences between North and South, religion in the North was categorized as "hindu" or "other religion". All the other variables were used as shown in the table above.

These variables were used to estimate the propensity score by using logistic regression. The balance of the score was checked by evaluating whether any remaining differences between working and non-working mothers could be found (Appendix G). Then, the three matching algorithms previously cited (nearest neighbour, radius and Kernel) were applied. This verified whether one procedure had very different estimates compared to another in order to maintain consistency among results. The conditional independence assumption is very important for the success of results from the matching procedure. However, besides assessing the matching quality, it is not clear if the variables used were correct, or whether variables that influence maternal work and child nutrition are omitted. Hence, after matching, sensitivity analyses were conducted to test the strength of the results if unmeasured variables could influence the selection process.

For a better understanding of the effect of maternal work on child nutrition, the matching procedure was also applied, stratifying the data in rural and urban areas. Furthermore, the matched data were used to verify differences in the prevalence of stunting by the different types of work in each area of residence.

8.6 Results

The South region comprised 2,027 children in 1998-99 and 1,893 in 2005-06, while the North had 5,470 and 4,981 children in 1998 and 2006, respectively. The propensity score was created for each region, and then, the matching was performed using three different methods: the NN, the radius and the kernel method. Appendix G.1 provides the additional analyses to support the assumptions required for the PSM.

Controlling by the selectivity into female employment, maternal work was not associated with child nutrition in any year and any region. Results were very similar between the different methods used, where in the North, children of working mothers had 1 to 3% higher prevalence of stunting when compared with children of non-working mothers, and this difference was non-significant (Table 8.2). In the South region, this difference varied from 1-4%, also non-significant (Table 8.3). These results suggest that the negative effect of maternal work on child stunting observed in India is in fact the effect of poverty, lower education, and other variables that affect the probability of working and child nutrition simultaneously.

Table 8.2- Proportion of child stunting for working and non-working mothers in the North of India after the matching procedure.

		1998-99			2005-06		
		NN	**Radius**	**Kernel**	**NN**	**Radios**	**Kernel**
% Stunting	Working	61.9	61.9	61.9	55.7	55.7	55.7
	Non-working	60.9	61.1	61.1	53.5	53.1	53.2
Difference		1.0	0.8	0.8	2.2	3.0	2.0
S.E.		0.06	0.02	0.02	0.06	0.02	0.02
P-value		0.868	0.631	0.637	0.710	0.168	0.170

Note: Standard errors were bootstrapped to 1000.

Table 8.3-Proportion of child stunting for working and non-working mothers in the South of India after the matching procedure.

		1998-99			2005-06		
		NN	**Radius**	**Kernel**	**NN**	**Radios**	**Kernel**
% Stunting	Working	37.4	37.4	37.4	36.3	36.3	36.3
	Non-working	37.0	37.3	37.1	32.6	33.8	33.5
Difference		0.4	0.1	0.2	3.7	2.5	2.8
S.E.		0.03	0.01	0.03	0.05	0.03	0.03
p		0.906	0.972	0.932	0.501	0.445	0.493

Note: Standard errors were bootstrapped to 1000.

The balancing of the variables was tested after matching using a t test (results are provided in Appendix G). The aim of matching is to eliminate bias, and it is very important that no significant difference be found in the prevalence of each covariate between working and non-working mothers. No significant differences were found and the mean bias was reduced from 22.7 for non-matched sample to 2.9 for the matched sample.

The Mantel-Haenszel sensitivity test (Table 8.4 and Table 8.5) shows that results were insensitive to bias that increased or decreased the odds of working. The p-value for the test statistic in case the effect of work was overestimated (P_mh+) was non-significant for at least 30% of increased bias. For the case of underestimation of the effect of work, the p-value was non-significant for at least 20% bias ($P\_mh\,-$). This result does not mean that unobserved heterogeneity exists, but evaluates what the results would be if other variables could add bias to the models.

Table 8.4- Mantel-Haenszel sensitivity analysis for the North region of India, 1998-99 and 2005-06.

	1998				2006			
Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-
1	-0.062	-0.062	0.524	0.524	0.328	0.328	0.372	0.372
1.10	0.449	0.499	0.326	0.308	0.127	0.940	0.449	0.174
1.20	0.959	1.012	0.168	0.155	0.684	1.501	0.247	0.067
1.30	1.429	1.485	0.076	0.068	1.197	2.018	0.116	0.022
1.40	1.866	1.924	0.030	0.027	1.673	2.498	0.047	0.006
1.50	2.275	2.33	0.011	0.009	2.118	2.947	0.017	0.002

Note: Gamma is the effect of an unobserved variable on the selection of maternal work. Q_{MH}^{+} is the test-statistic given that maternal work has been overestimated accompanied of the p-value for this test ($P\_mh +$), and Q_{MH}^{-} when underestimated accompanied of the p-value for this test ($P\_mh -$).

Table 8.5- Mantel-Haenszel sensitivity analysis for the South region of India, 1998-99 and 2005-06.

	1998				2006			
Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-
1	0.010	0.010	0.496	0.496	0.624	0.624	0.266	0.266
1.10	0.268	0.489	0.394	0.312	0.164	1.085	0.435	0.139
1.20	0.704	0.927	0.241	0.177	0.047	1.506	0.481	0.066
1.30	1.106	1.330	0.134	0.092	0.432	1.894	0.333	0.029
1.40	1.478	1.704	0.070	0.044	0.789	2.255	0.215	0.012
1.50	1.827	2.054	0.034	0.020	1.121	2.592	0.131	0.005

Note: Gamma is the effect of an unobserved variable on the selection of maternal work. Q_{MH}^{+} is the test-statistic given that maternal work has been overestimated accompanied of the p-value for this test ($P\_mh +$), and Q_{MH}^{-} when underestimated accompanied of the p-value for this test ($P\_mh -$).

Considering the differences in work in rural and urban areas, matching was performed stratifying the sample by rural and urban areas. Results for the North region (Table 8.6) showed higher differences between working and non-working mothers in 2005-06, where the difference in the prevalence of stunting varied from 2.5% to 5.3%. In rural areas, working mothers had children with a slightly higher prevalence of stunting (3.5% higher), while in urban areas, results suggested that children of working mothers had lower rates of stunting (40.2%) when compared with non-working mothers (from 42.7% to 45.5%). These results were not statistically significant, and results were insensitive to at least 20% of bias that could underestimate the effect of work (Table 8.8).

In the South region of India, the same was observed in 1998-99, where although not significant, the prevalence of stunting among working mothers was lower (30.1%) than non-working mothers in urban areas (34.1% to 35.9%), and there was a high difference in stunting between urban and rural areas (30.1% in urban areas, and 40.8% in rural areas). However, the second wave showed different results for urban areas, where working mothers had non-significant higher rates of stunting, varying from 4.0% to 6.0% higher. No important changes were observed in rural areas (between 0.2% to 2.0% difference). Results were also insensitive to at least 40% of bias in the second wave (Table 8.9).

For a further investigation, the scores created by the PSM were used to investigate differences in the prevalence of stunting according to characteristics of maternal work.

Table 8.6- Proportion of child stunting for working and non-working mothers in the North of India after the matching procedure.

		1998-99	Rural		1998-99	Urban		2005-06	Rural		2005-06	Urban	
		NN	**Radius**	**Kernel**	**NN**	**Radios**	**Kernel**	**NN**	**Radius**	**Kernel**	**NN**	**Radius**	**Kernel**
% Stunting	Working	62.8	62.8	62.8	53.5	53.5	53.5	58.8	58.8	58.8	40.2	40.2	40.2
	Non-working	61.5	61.8	61.9	53.4	53.5	52.1	55.3	55.2	55.2	42.7	45.5	44.8
Difference		1.3	1.0	0.8	0.03	0.02	1.4	3.5	3.6	3.6	-2.5	-5.3	-4.6
S.E.		0.02	0.02	0.02	0.05	0.05	0.05	0.02	0.02	0.02	0.04	0.04	0.04
P-value		0.459	0.57	0.604	0.994	0.996	0.769	0.090	0.067	0.063	0.534	0.185	0.224

Note: Standard errors were bootstrapped to 1000.

Table 8.7- Proportion of child stunting for working and non-working mothers in the South of India after the matching procedure.

		1998-99	Rural		1998-99	Urban		2005-06	Rural		2005-06	Urban	
		NN	**Radius**	**Kernel**	**NN**	**Radios**	**Kernel**	**NN**	**Radius**	**Kernel**	**NN**	**Radius**	**Kernel**
% Stunting	Working	40.8	40.8	40.8	30.1	30.1	30.1	36.3	36.3	36.3	35.7	35.7	35.7
	Non-working	36.0	38.3	38.2	35.9	34.1	34.4	38.3	36.6	36.5	30.9	29.8	29.7
Difference		4.9	2.4	2.5	-5.8	-4.0	-4.2	-2.0	-0.3	-0.2	4.0	5.9	6.0
S.E.		0.03	0.04	0.04	0.05	0.04	0.04	0.07	0.05	0.04	0.04	0.05	0.05
P-value		0.210	0.505	0.491	0.259	0.375	0.330	0.709	0.947	0.967	0.321	0.222	0.198

Note: Standard errors were bootstrapped to 1000.

Table 8.8- Mantel-Haenszel sensitivity analysis for the North region of India stratified by rural and urban areas, 1998-99 and 2005-06.

	1998-99 Rural				**1998-99 Urban**				**2005-06 Rural**				**2005-06 Urban**			
Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-
1	1.264	1.264	0.103	0.103	0.981	0.981	0.163	0.163	0.763	0.763	0.223	0.223	0.133	0.133	0.447	0.447
1.10	0.833	1.697	0.202	**0.045**	1.274	0.693	0.101	0.244	0.282	1.246	0.389	0.106	0.023	0.530	0.491	0.298
1.20	0.441	2.095	0.330	0.018	1.542	0.429	0.062	0.334	-0.042	1.689	0.517	**0.046**	0.384	0.892	0.350	0.186
1.30	0.081	2.465	0.468	0.007	1.789	0.186	**0.037**	0.426	0.359	2.098	0.360	0.018	0.717	1.226	0.237	0.110
1.40	0.026	2.809	0.490	0.002	2.020	-0.038	0.022	0.515	0.731	2.479	0.232	0.007	1.025	1.536	0.153	0.062
1.50	0.332	3.132	0.370	0.001	2.236	-0.082	0.013	0.533	1.077	2.835	0.141	0.002	1.313	1.825	0.095	0.034

Note: Gamma is the effect of an unobserved variable on the selection of maternal work. Q^{+}_{MH} is the test-statistic given that maternal work has been overestimated accompanied of the p-value for this test (P_mh+), and Q^{-}_{MH} when underestimated accompanied of the p-value for this test (P_mh-).

Table 8.9-Mantel-Haenszel sensitivity analysis for the South region of India stratified by rural and urban areas, 1998-99 and 2005-06.

	1998-99 Rural				**1998-99 Urban**				**2005-06 Rural**				**2005-06 Urban**			
Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-	Q_mh+	Q_mh-	P_mh+	P_mh-
1	0.187	0.187	0.426	0.426	1.006	1.006	0.157	0.157	0.216	0.216	0.415	0.415	0.464	0.464	0.321	0.321
1.10	0.032	0.625	0.487	0.266	1.324	0.694	0.093	0.244	0.567	-0.135	0.285	0.554	0.173	0.758	0.431	0.224
1.20	0.430	1.025	0.333	0.153	1.613	0.407	**0.053**	0.342	0.888	0.184	0.187	0.427	-0.093	1.026	0.537	0.153
1.30	0.797	1.394	0.213	0.082	1.880	0.144	0.030	0.443	1.184	0.480	0.118	0.316	0.009	1.272	0.496	0.102
1.40	1.138	1.736	0.128	**0.041**	2.128	-0.099	0.017	0.540	1.458	0.754	0.072	0.225	0.234	1.502	0.408	0.067
1.50	1.455	2.055	0.073	0.020	2.361	0.023	0.009	0.491	1.715	1.009	**0.043**	0.156	0.443	1.716	0.329	**0.043**

Note: Gamma is the effect of an unobserved variable on the selection of maternal work. Q^{+}_{MH} is the test-statistic given that maternal work has been overestimated accompanied of the p-value for this test (P_mh+), and Q^{-}_{MH} when underestimated accompanied of the p-value for this test (P_mh-).

Table 8.10- Percentage and odds ratio of child stunting according to characteristics of maternal work in the North of India after matching procedure.

	Rural					
	1998-99			2005-06		
	%	OR	p value (OR)	%	OR	p-value
Employment						
not working	*60.1*	*1*		*55.2*	*1*	
work for family	64.0	1.18	0.094	55.9	1.03	0.796
work for others	61.6	1.06	0.513	64.1	**1.45**	**0.004**
self-employed	63.0	1.13	0.466	58.8	1.16	0.482
Occupation						
agriculture	63.9	**1.18**	**0.048**	58.6	1.15	0.151
non-agriculture	59.1	0.96	0.726	59.2	1.18	0.233
Seasonality						
all year	62.1	1.09	0.341	57.3	1.09	0.45
seasonal	64.1	1.19	0.107	60.1	**1.22**	**0.058**
	Urban					
	1998-99			**2005-06**		
	%	**OR**	**p value (OR)**	**%**	**OR**	**p-value**
Employment						
not working	*52.1*	*1*		*43.01*	*1*	
Self-employed	42.4	0.67	0.313	27.9	**0.51**	**0.07**
Employed	56.4	1.19	0.469	43.4	1.01	0.944
Occupation						
Services	58.3	1.29	0.451	43.5	1.02	0.931
Skilled	56.3	1.18	0.616	48.9	1.27	0.472
Professional	24.0	**0.29**	**0.012**	16.1	**0.25**	**0.007**

After the matching procedure, some characteristics of work were still associated with higher rates of stunting. In the rural North, rates of stunting were slightly higher for those working in agriculture in the first wave (63.9%, OR=1.18), while in 2005-06, rates of child stunting were higher among mothers who worked for others (64%, OR=1.45), and among mothers who worked seasonally (60.1%, OR=1.22, borderline association). In urban areas, both years showed that children of professional mothers had lower stunting values, even after matching by socioeconomic status and maternal education. Self-employed mothers had lower rates of stunted children in 2005-06 (27.9%, OR=0.51), with borderline association.

Table 8.11- Percentage and odds ratio of child stunting according to characteristics of maternal work in the South of India after matching procedure.

	Rural					
	1998-99			2005-06		
	%	**OR**	**p value (OR)**	**%**	**OR**	**p-value**
Employment						
not working	*42.5*	*1*		*35.1*	*1*	
work for family	41.7	0.97	0.982	35.2	1.00	0.989
work for others	43.7	1.05	0.787	37.4	1.10	0.684
self-employed	13.0	**0.20**	**0.011**	42.1	1.35	0.544
Occupation						
agriculture	46.3	0.94	0.751	46.7	**1.62**	**0.06**
non-agriculture	33.1	0.93	0.726	28.1	0.72	0.237
Seasonality						
all year	41.1	1.17	0.409	27.4	0.70	0.155
seasonal	40.7	**0.67**	**0.070**	56.3	**2.38**	**0.003**
	Urban					
	1998-99			**2005-06**		
	%	**OR**	**p value (OR)**	**%**	**OR**	**p-value**
Occupation						
Services	57.1	**2.27**	**0.021**	50.0	**2.19**	**0.019**
Skilled	23.1	0.51	0.107	45.8	1.85	0.170
Professional	9.8	**0.19**	**0.001**	15.2	**0.39**	**0.038**

Note: In urban areas in the South region, it was not possible to evaluate the prevalence of stunting among employed and self-employed because of the small sample size for self-employed in the matched sample.

In the South region, self-employed mothers and those working seasonally in rural areas had children with lower rates of stunting. However, in the second wave, seasonal work was associated with higher rates of stunting (56.3%, OR=2.38). In urban areas, maternal work in the services sector was associated with higher rates of stunting and professionals with lower rates of stunting for both waves.

8.7 Discussion

No other studies in low-income countries investigating the effect of maternal work on child nutrition have used an adequate procedure to eliminate selection bias, but several studies in low-income countries have acknowledged the complexity of this association due to the effect of poverty on both maternal work and child nutrition. Leslie (1988), in an extensive literature review, pointed out that 16 studies recognized that maternal work was likely to be correlated with other factors linked to child nutritional status. Results from this chapter, using propensity score matching to eliminate selection bias, showed that overall maternal work in India was not associated with child stunting, and the negative association between maternal work and child nutrition observed in other analyses was in fact showing the effects of the background characteristics that determine the participation of mothers in the labour force.

Previous studies in India (Abbi *et al.*, 1991; Sivakami, 1997) and studies in other low-income countries (Popkin and Solon, 1976; Lamontagne, Engle and Zeitlin, 1998) have also reported that working mothers were more likely to be found among poorer neighbourhoods. This is often the case described at the early stages of a country's development (Sinha, 1965), and in countries with low levels of education and high female force in rural areas (Goldin, 1994). Despite increased economic growth, this was also the case in India, demonstrated by the concentration of female work in rural areas, lower education among women and low rates of FLFP (Gaddis and Klasen, 2014).

The analyses were stratified by South and North regions and by urban and rural areas, due to the different context between these areas, as well as the contrasting nature of female work. No significant differences in the prevalence of child stunting for working and non-working mothers were found between waves or regions, but the observed small variances in the stunting prevalence suggest the potential effect of work differs. In the North, the prevalence of stunting by maternal work was similar in the first wave, while in the second wave, stunting was slightly higher for working mothers in rural areas, and lower for urban areas. The amplified effect of work in the second wave was already discussed (see section 7.5) in view of economic growth and changes in the labour market. Likewise, the opportunities of work in urban areas and the advantage of working outside agriculture were discussed, which can explain the lower prevalence of child stunting among working mothers in urban areas, although it was not significantly different.

In the South, the first wave followed the same trend observed in the North, but in the following wave, the prevalence of child stunting for working mothers in urban areas was slightly higher, adding 4-6 percent to the prevalence of stunting. Although not significant, this might be indicating a trend developing with increased economic growth that requires further investigation. The literature is not clear about differences in the types of jobs offered in urban areas between North and South, but the context in these two areas differ greatly, where higher autonomy and better rates of education are generally observed in the South (Jejeebhoy and Sathar, 2001). The use of a binary variable (working/not working) does not help the understanding of the trade-off between income and time availability for childcare among working women in the South urban context, but the literature suggests female work is often paid, generating some sort of income to the household (Klasen and Pieters, 2015). Therefore, it might be the case that working mothers in urban areas have higher restriction on time, or that the income generated by work is still not enough to provide better conditions for the child.

Examining the literature, two factors about the South urban context stand out, which are the nuclearization of families (Allendorf, 2013) and the rapid increase in the number of slums (Sarkar *et al.*, 2013). Although a nuclear family can have a strong hold on decision-making about the child's health, the family has lower support for childcare, while the extended family can offer financial and social resources that help provide good-quality childcare (Kumar and Ram, 2013). Additionally, the poor housing, water and sanitation conditions in slums have been associated with child malnutrition and recurrent episodes of illness such as gastrointestinal and respiratory morbidities (Sarkar *et al.*, 2013).

While the analyses using a binary variable show evidence that maternal work alone was not associated with child nutrition, the analyses by characteristics of work confirm that lower status jobs are still associated with higher levels of child stunting, even after the elimination of selection bias. In rural areas of the North, working in agriculture increased the odds of stunting in the first wave, while in the second wave, working for others and seasonal work were significantly associated with higher levels of stunting. In the South, agricultural and seasonal work were also associated with higher odds of stunting. These types of work are interrelated, since agricultural employment is often seasonal employment (Parida, 2015). These types of work offer lower income returns, poorer work conditions, with lower protection of workers due to informal arrangements and tend to demand long hours of maternal work (Srivastava and Srivastava, 2010; Nceus, 2012). Therefore, the earnings from these types of work might not be enough to improve household conditions or child feeding, nor to provide good quality of childcare, which combined with the absence of the mother in the household, can affect child nutrition negatively.

Results suggested that working in the service sector in urban areas affects child nutrition differently in the North and South, where in the South, it was associated with significantly higher rates of stunting. The services sector had rapid expansion during the period of economic growth, involving varied occupations (Bosworth and Collins, 2008), but no major differences between North and South were noted in the literature. More research is needed to observe whether this is a matter of concern in urban areas in the South due to poorer conditions of work in the services sector, or whether this difference could also be attributed to the lack of time and people available for childcare in nuclear families.

These analyses provide a solution for eliminating selection bias, but they rely on the assumption that all variables that jointly influence maternal work and child nutrition were observed. Although measures of socioeconomic status and age were included as covariates, there may be other reasons affecting the decision of working or withdrawing from work. Sensitivity analyses showed results were very robust to the introduction of bias, but the lack of certainty is a limitation of this chapter's analyses.

The next chapter goes back to the evaluation of this association in Brazil, by looking closely at the effects of maternal work on childhood overweight.

Box 8.1 - Main findings for the association between maternal work and child stunting after eliminating selection bias

- After eliminating selection bias, no differences were observed between rates of stunting for working and non-working mothers.

- No significant differences were observed between rural and urban areas, but the prevalence of stunting were slightly lower for children of working mothers in urban areas in the North, and slightly higher in urban areas in the South.

- Some characteristics of work remained associated with child stunting after matching. Working for others was worse for child stunting in the North, and agricultural and seasonal work was worse in the South. Professionals had lower rates of stunting for both regions.

Chapter 9: Maternal work and childhood overweight in Brazil: what is the role of diet?

9.1 Introduction

Brazil has undergone various social changes since 1996, as described in the previous chapters, which culminated in improved access to goods and services for the poor. Such changes, together with the demographic transition, increases in education and women's labour force participation have resulted in modifications in the family life as well as in individuals' lifestyle. In addition to this, the nutrition transition in the country has been fast, with steep decreases in stunting and underweight prevalence, simultaneously with increases in the prevalence of overweight.

Many studies in high-income countries suggest that maternal work is associated with increases in child overweight due to the reduced time mothers spend with their children and the increased household income. Many of these associations were discussed in chapter three. Changes in the Brazilian lifestyle together with increases in overweight prevalence suggest that this association can also be found in this emerging country. However, in contrast to high-income countries, transitions in Brazil have been fast, generating a wide range of policy concerns in Brazil in terms of maternity leave, gender differences at the work place, childcare arrangements and maternal and child's health.

This chapter intends to investigate the role of diet in the associations between maternal work and child's BMI, using structural equation modelling for data from 2006. It extends this further by testing whether these associations change according to educational level and family arrangements.

9.2 Literature Review

Overweight and obesity have been a great public health concern worldwide, and alarming increases in its prevalence among children requires urgent attention, as it is associated with obesity in adult life and comorbidities throughout life (Black *et al.*, 2013). The ECHO (Ending Childhood Obesity) Commission was established by the WHO in 2014 aiming to review and address gaps in strategies to end childhood obesity. The ECHO report highlighted behavioural and biological responses to the obesogenic environment and recommended six overall actions to tackle childhood obesity. From those, four were adapted particularly for young children: the importance of breastfeeding, guidance and support of caregivers when offering complementary feeding in order to provide appropriate diet and portion size for the age group as well as avoiding specific categories of food, food education and physical activity incorporated into the daily routine, and appropriate sleep and screen time (WHO, 2016). These recommendations show that the caregiver is extremely important for child health, as infants and young children are wholly vulnerable to the actions, choices and care of adults or caregivers.

Many studies in high-income countries have noted that increases in childhood obesity coincided with increases in FLFP and documented a positive association between maternal employment and childhood overweight (Anderson, Butcher and Levine, 2003; Hawkins, Cole and Law, 2008; Brown *et al.*, 2010; Cawley and Liu, 2012). The mechanism behind this association is the aforementioned trade-off between income and time availability for childcare are.

Most of these studies focused on maternal hours of work, suggesting that the more the mother works, the less the time available for the child. Those studies also assumed that the mother is the best possible caregiver, failing to consider other factors such as income, education and type of substitute caregiver that can have different effects on child behaviour and nutritional status despite long maternal working hours. For instance, as previously discussed, additional resources provided due to the income received from work can expand access to ready meals, fast food and restaurant meals, at the same as expanding access to healthier diet (Brown *et al.*, 2010).

Parental decisions on how to spend their earnings can be influenced by their own education. There is empirical evidence of an educational gradient and health-related behaviours (Cutler and Lleras-Muney, 2006; Brunello *et al.*, 2016) that also benefit children, influencing a wide range of decisions since before pregnancy until after the child is born (Boyle *et al.*, 2006; Güneş, 2015). In terms of diet, education is a common factor associated with healthier choices for individuals themselves (Robinson *et al.*, 2007) and with healthier offspring (Durão *et al.*, 2017), where maternal education influences what is offered to the child (Vereecken, Keukelier and Maes, 2004; Robinson *et al.*, 2007; Lioret *et al.*, 2015). Furthermore, maternal education is associated with better childcare overall, and higher maternal interest and awareness of what the child is doing (Kalil, Ryan and Corey, 2012).

Other possible confounders in the relationship between maternal work and childhood overweight are family structure and the type of care provided in the absence of the mother. As previously discussed, additional adults in the family can contribute with income and child caring responsibilities. Furthermore, increased income and education can contribute to the choice of better childcare arrangements (Leach *et al.*, 2008; Liu, 2015), minimizing negative effects of the absence of the mother on child nutrition.

Considering such potential confounders, instead of hours of maternal work, the effect of maternal work on child nutrition in high-income countries is much more grounded in the choices of the family about what to do with the additional household income and the circumstances leading to the type of care the child receives. Socioeconomic status clearly plays a role in parental decisions, but if the basic conditions for childcare are met, healthy and unhealthy choices may be made by households in both lower and higher socioeconomic strata. This may explain why the association between maternal work and child nutrition by socioeconomic status has no consistent conclusions (Scholder, 2008; Cawley and Liu, 2012) despite the trend of higher childhood overweight rates among lower socioeconomic status households (Wang, Patterson and Hills, 2002; Marmot, 2005).

9.2.1 The case of Brazil

Brazil has undergone many transitions in the last 40 years, which occurred much faster than in developed countries. Between 1970 and 2000, the country has been through a rapid process of urbanization, a decline in fertility, the growth of the older population, and increases in FLFP (Connelly, DeGraff and Levison, 1996; Paim *et al.*, 2011). The establishment of a popular government in 2002 had pronounced impact on social aspects of the country. Living conditions have changed substantially and the poverty index has decreased, attributable to a combination of inclusive social policies that improved the access to food for the poor, health care, and education (Paim *et al.*, 2011). Chapter six examined some of the differences in the access to goods and services for the poor, comparing 1996 to 2006. There was an overall reduction in socioeconomic inequalities and marked improvement in purchasing power, increasing the number of people with one or more expensive assets such as television, cars and washing machines in the household.

All these changes have also affected dietary intake in Brazil. The expenditure survey comparing purchases for domestic consumption showed that between 2002-03 and 2008-09, traditional meals including rice and beans decreased by 40%, although they are still amongst the most purchased products. Concurrently, there was an overall increase in meat consumption and marked rise in the consumption of ready meals and baking mixes (37%), soft drinks (39.3%) and beer (23.2%) (IBGE, 2010c). As a result, levels of underweight and stunting reduced greatly in the country, while overweight has become the main nutritional concern (Conde and Monteiro, 2014).

The increase in childhood obesity has also coincided with increases in FLFP in Brazil and changes in work arrangements for women, suggesting that Brazil may be following the same patterns found in high-income countries, and that an association between maternal work and childhood obesity may exist. However, this association has not yet been explored in the country. Considering this is a matter of interest for public health and country development, Brazil, with rapid transitions and a growing economy, provides an interesting context for analysing potential relationships.

While there are many factors determining a population's diet, income provided by maternal work enhances decision-making on what to eat (Lelis, Teixeira and da Silva, 2012), and parental choices on purchasing healthy or unhealthy food for the household affects the type of food offered to the child. The availability of healthy or unhealthy food is not dependent on socioeconomic status. Despite Brazil having high socioeconomic inequality, social programs, including the Zero Hunger (Fome Zero) and the conditional cash transfer (Bolsa Familia), have improved food consumption for those living in less advantaged conditions (Levy-Costa *et al.*, 2005; de Bem Lignani *et al.*, 2011). Recent studies find similarities in what the population eats during the main meals independently of social group (Barbosa, 2007). For instance, analysis of a population study have shown that for lunch and dinner, more than 90% of people reported eating rice and beans, accompanied by meat and vegetables, where the main difference according to socioeconomic status was the type of meat included in meals (Barbosa, 2007; Fisberg *et al.*, 2008). Variations in types of food consumed among Brazilians were found during afternoon snacks, where healthy options such as fruits, or unhealthy options such as pizzas, pastries and soft drinks were included (Barbosa, 2007). Afternoon snack choices varied by socioeconomic status, in which soft drinks, deep-fried/baked snacks, and salads were chosen mostly by people in higher income positions, and corn based dishes were most prevalent in lowest income quartiles (Souza *et al.*, 2013). As previously discussed, education, childcare, and family structure have an impact on these mechanisms, and there are some particularities in Brazil worth noting.

Maternal education in Brazil has particular importance because women are commonly the ones responsible for deciding meal composition in the household, with decisions often based on practicality and the individual preferences of the mother (Barbosa, 2007). Regarding childcare, the Brazilian government has focused on elements of this since the 1970s, subsidizing initiatives and providing childcare services at no cost for those in need. Later on, this kind of service was recognized as an educational service, and pre-schooling has become a priority in the country's educational agenda (UNESCO, 2007). However, free services are limited, and there is a clear inequality between children in higher income and low-income families attending pre-school. Meanwhile, public day care centres are not expanding fast enough to meet the demand from rising maternal work (Kappel, Carvalho and Kramer, 2001). Mainly, for those with fewer resources, the presence of grandparents in the household or another adult can be helpful (Kappel, Carvalho and Kramer, 2001). Furthermore, there was a growth in intergenerational income transfers from the retired old to the young, accounting for an important proportion of investments in the child (Sorj, 2001).

This chapter proposes investigating the mechanisms through which maternal work affects child's BMI-for-age in Brazil. According to the literature and the conceptual framework proposed in this thesis (see **Figure 6.11**), maternal work is indirectly associated with child nutrition by changes in household behaviours, such as choices regarding breastfeeding and the type of food offered to the child. For this study, focus was given to child's diet for two reasons. First, the role of the mother regarding care is very strong with respect to child feeding. In the Brazilian society this is particularly important, as the figure of the mother is connected with all processes of food in the household (i.e. decisions on purchasing food, cooking and feeding the child). Second, the data used for this study does not provide information on how the child spends time.

The analyses in this chapter intend to answer the final question of the thesis (question 6) with three specific questions:

1- Is maternal work associated with both healthy and unhealthy dietary patterns?
    -This question considers the hypothesis that the income arising from maternal work can be used to increase food availability in the household, including both healthy and unhealthy food, according to parental choices.

2- Is diet a mediator of the association between maternal work and childhood overweight?
    - This question suggests that maternal work is associated with child nutrition through the effect of work on the diet. If the first question is positive, and an unhealthy diet is associated with child's BMI, the diet can be considered a mediator of this association.

3- Are these associations moderated by maternal education and family structure?
    - This question considers that both education and family structure can affect family decisions on how to spend money generated from maternal work, or how to manage child's diet, enhancing or attenuating associations.

The structural equation modelling (SEM) is an ideal method for this analysis for two main reasons. First, it allows for testing theoretical models with multiple independent and dependent variables using empirical data. Second, it allows each observed variable to have unique variance representing factors that are not included in the model (Acock, 2013).

9.3 Methods

Data from the 2006 wave were used because this data were collected after substantial economic growth and the implementation of policies that improved life of the poor and enhanced the rapid nutrition transition in Brazil. The dataset included all children aged six to 59 months, with no missing values for maternal work or nutritional status. Children younger than six months were excluded from this analysis because of the recommendation for this age group to receive only breast milk (WHO, 2003). This implied the exclusion of 223 children, given the analyses in chapter six (see **Table 6.1**), totalling 3,982 children in the sample.

9.3.1 Variables

The main independent variable was a binary variable indicating whether the mother was working or not. The dependent variable was child's BMI-per-age (more details on data explained in section 4.3.1). The variables chosen to be mediators of the association between maternal work and child's BMI included the number of meals offered to the child, and the frequency of healthy or unhealthy food consumption by the child in the seven days preceding data collection. These variables are explained in detail below.

Data were available for whether the child usually had breakfast, lunch, afternoon meal, dinner and evening meal. The number of "yes" responses were totalled up, and categorized as "ideal" or "not ideal" according to age and breastfeeding status as recommended by the WHO[18]. About half of the children did not have an ideal number of meals (48.3%), and the inadequacy increased with child's age (Table 9.1). This can be explained by the fact that the WHO recommends that after 24 months children should eat at least five meals, including snacks, implying that children in this sample should have all the meals asked in the questionnaire in order to be considered "ideal". This variable has the limitation of including errors in the child's classification because the question is restricted to certain periods of time. For instance, children who have morning snacks might be classified as having a "not ideal" number of meals because the question does not account for snacks in the morning. Furthermore, it does not account for the quantity eaten, which might

[18] The WHO (WHO and UNICEF., 2003) recommends that children being breastfed from 6-8 months should have at least 2 meals per day, and those 9-23 months should have at least 3 meals per day, with 1-2 additional snacks as desired. For those not being breastfeed, at least 1 cup of milk and 1 extra meal per day should be given. Those older than 24 months should have at least 5 meals (including snacks).

influence the next time the child feels hungry. Still, the variable was correlated with the frequency of listed food items consumed (explained below), and was included in further models.

Table 9.1- Percentage of children having specific meals according to child's age group (months).

% meals per age	6-11 months	12-23 months	24-35 months	36-47 months	48-59 months
Breakfast	53.3	88.5	95.1	96.5	93.3
Lunch	65.7	94.5	94.4	94.9	93.2
Afternoon	51.4	85.5	81.3	85.9	86.6
Dinner	52.5	91.4	90.3	94.2	92.5
Evening snack	29.5	49.5	51.0	49.0	52.7
Ideal meal	67.1	81.2	40.3	37.6	41.1

Note: The number of meals were categorized as "ideal" or "not ideal" according to age and breastfeeding status as recommended by the WHO.

Data were collected on the number of days (none, 1, 2-3, 4-6 or everyday) listed food items were consumed by the child in the past week: rice/pasta, beans, bread, other carbohydrates (potatoes/cassava/yams),vegetables, fruits, meat, fried food, sweets, biscuits, pastries, crisps, yoghurt, milk, soft drinks and natural juice. Each food group was scored according to the number of days it was consumed: 0, 1 for 1 day, 3 for 2-3 days, 5 for 4-6 days, and 7 for every day, generating an interval of 0-7 for each type of food. Table 9.2 shows the frequency of food consumption, where rice, beans, meat and bread were the most consumed food. While separated groups of food are not a sufficient assessment of an overall healthy or unhealthy diet, these groups combined could theoretically indicate such patterns. Therefore, latent variables, defined as unobserved variables inferred by correlated measured variables, were created, indicating constructs of a healthy and less healthy score.

Although this list of food is small and more generic than an usual food frequency questionnaire, it can still have errors that decrease accuracy. The main reasons for recall bias documented in the literature are that individuals tend to forget items that were consumed, underestimating their intake; and they can omit or downward items that are viewed as "bad", describing a healthier diet than the reality (Schoeller, 1995; Shim, Oh and Kim, 2014). In this study, there is a particular concern for children of working mothers, as the parents might not be fully aware of the child's diet, and there might be a desire to show that their children are healthier despite their absence in the household.

Table 9.2-Frequency of food type consumption by children 6-59 months.

Food	Never	1/week	2-3/week	4-6/week	Everyday
Rice	3.1	3.1	9.5	7.1	77.2
Beans	7.7	4.8	13.5	7.7	66.2
Meat	7.0	2.9	15.6	15.8	58.7
Bread	11.1	8.7	19.6	8.3	52.4
Biscuits	8.7	6.3	21.0	17.7	46.2
Fruits	11.4	7.0	23.5	13.4	44.7
Natural juice	25.3	10.0	19.4	12.8	32.5
Yoghurt	24.7	11.9	22.8	15.0	25.6
Vegetables	20.8	11.2	28.8	14.3	25.0
Soft drink	25.7	16.1	24.6	11.5	22.1
Sweets	28.4	14.9	23.2	12.2	21.2
Potatoes/roots	25.1	17.8	33.1	9.7	15.3
Crisps	45.0	20.5	18.8	7.3	8.4
Fried food	49.5	19.9	18.9	6.0	5.7
Pastries	76.0	11.8	8.3	2.0	1.9

Control variables included child's age, birthweight, maternal BMI, maternal education, and exclusive breastfeeding. Based on the WHO recommendation that exclusive breastfeeding should occur for the first six months of life (WHO, 2003), the exclusive breastfeeding variable is an indicator of whether this occurred or not, according to maternal reports.

9.3.2 Structural Equation Modelling (SEM)

SEM is a combination of measurement models and structural models tested in an attempt to explain social or behavioural phenomena (Buhi, Goodson and Neilands, 2007). The measurement model enables the use of multiple variables to generate constructs of a particular concept that cannot be obtained through the data. This concept is also called "latent variable". In this study, the measurement model used the data collected in the scored feeding frequency to create constructs of "healthy" and "less-healthy" diet by using confirmatory factor analysis.

The structural model shows the theoretical linkages, or paths between the latent and observed variables, accounting for the direct, indirect, and total effects among factors. In this study, the structural model consisted of examining the associations between maternal work and child BMI, having the latent variables created in the measurement model as mediators of this association.

The full explanation of SEM is described in section 4.5.6, while the present section explains how the model was applied to this data in three steps.

Step 1: Defining the measurement model

This step involves the use of confirmatory factor analysis (CFA) to create a latent variable based on multiple variables (or indicators). The model should be hypothesized in advance, based on empirical evidence on which variables are best to indicate the construct. Then, the parameters of the model (factor loadings or coefficients), variances and covariances) are estimated by creating a correlation matrix which is as close as possible to the correlations between the observed variables.

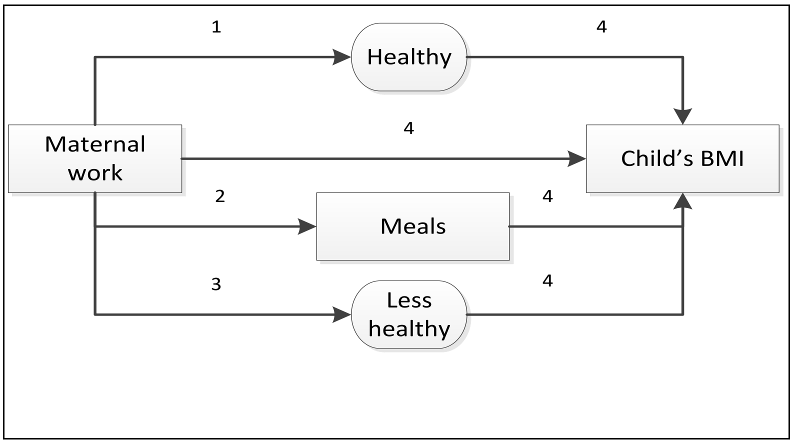
The factor loadings (or coefficients) quantify the relationship between an observed variable and the latent variable, providing a measure of strength of this relationship. Once the model is estimated, the goodness of fit of the model should be assessed (CFI >0.90, RMSEA<0.05 and SRMR<0.08[19]; see section 4.5.6). If the fit of a model is not adequate, a common practice is to modify the model by deleting or adding parameters that can improve it (Hox and Bechger, 2007). Postestimation analyses indicate existing correlation between errors terms or variables that can be modified to improve the model if there is theoretical justification for it.

Step 2: Testing the structural model

The structural model consists of testing the proposed paths between the latent and observed variables. By examining the effect of maternal work on child's BMI, it was suggested that child feeding behaviours were mediators of this association, as shown in Figure 9.1. Mediators were the healthy and less healthy constructs generated by the measurement model and also the number of meals. Both, the type of food consumed and the number of meals are indicators of the quality of the diet (Ruel and Menon, 2002), which has been extensively reported in the literature to be associated with nutritional status (Popkin and Gordon-Larsen, 2004). There are a high number of studies showing an inverse association between meal frequency and overweight, particularly when skipping breakfast (Horikawa *et al.*, 2011; Júnior *et al.*, 2012). An appropriate number of meals among young children not only favour adequate child growth, but it is also associated with reduction of snacking (Dubois *et al.*, 2007); increased daily overall thermogenesis and improved insulin metabolism (Jenkins *et al.*, 1995; Toschke, Thorsteinsdottir and von Kries, 2009).

[19] CFI is Comparative Fit Index, RMSEA is root mean squared error of approximation, and SRMR is Standardized root mean squared residual. See section 4.5.6.

Figure 9.1- Graphical representation of the structural part of the SEM model investigating the mechanisms behind the association between maternal work and child's BMI.



Note: Circular figures represent latent variables, and rectangular figures represent observed variables. Errors are not shown in the graph, but they are present in all endogenous variables (those that act as dependent variables – Healthy, LessHealthy, Meals and Child's BMI).
Equations are represented below, where b1-b11 are intercepts and slope, and e is the error term:

$$\left.\begin{array}{l} 1\ Healthy = b_1 + b_2 Work + e_1 \\ 2\ Meals = b_3 + b_4 Work + e_2 \\ 3\ LessHealthy = b_5 + b_6 Work + e_3 \end{array}\right\} \textbf{PART I}$$

$$4\ BMI = b_7 + b_8 Healthy + b_9 Meals + b_{10} LessHealthy + b_{11} Work + e_4 \text{ – } \textbf{PART II}$$

Several equations were used (Equations 1-4) in which variables were considered as response or independent variables in different steps of the analysis. To simplify the understanding of these paths, they can be divided into two parts. The first tested how maternal work was associated with mediators (Equations 1-3), where mediators were considered response variables. In the second part (equation 4), the mediators and maternal work were considered independent variables, when testing their association with child's BMI-for-age. The combination of coefficients in part I and II of the model shows the indirect effect of maternal work on child's BMI, while $b_{11}Work$, in part II of the model, shows the direct effect of work on child's BMI.

Errors were included in each endogenous variable (those acting as dependent variable in any part of the model) to represent unexplained variances generated by variables not included in the model, although some important covariates were added to the model. Equations in part I included child's age and maternal education as covariates. For part II, covariates representing proximal factors associated with child nutritional status were included: child's age, birthweight, maternal BMI and maternal education.

Children with missing data on feeding frequency were excluded from the analysis. When some data on feeding frequency were present, missing data were handled by using the full information maximum likelihood. This allows all data to be incorporated in the analysis.

Step 3: Comparison by groups

For answering the third research question on whether the associations were moderated by maternal education and family structure, analyses were tested comparing coefficients by groups. SEM allows the simultaneous comparison for two or more groups, not only estimating the path according to a determined group, but also testing if there is statistical difference between paths for each group.

The measurement part of the model (step 1) is again the first to be estimated by group, aiming to test whether any of the parameters (factor loadings (or coefficients), variances and covariances) differ by group. The first step is to compare a model where all parameters are constrained to be the same (invariant model) in all groups, and a model where all parameters vary by group (variant model). If the variant model performs better, it is assumed that one or more parameters vary by group. Then, several models constraining each parameter at each time to be the same across groups are estimated and tested with the variant model.

The choice of the best model is based on the goodness of fit of these models and the likelihood-ratio test. When the likelihood-ratio test is significant, the model is considered poorer, and if it is not significant, the model is considered equivalent to the previous one. Among models with similar chi-square and goodness of fit, the more restrictive model - that restricts the parameters to be invariant - is preferable.

Once the best measurement model is chosen, this is included in step 2, where the paths are tested according to the groups. At this point of the analyses, the main question is: "Which paths are significantly different between groups and which paths can be considered equal?". Again, a variant model, allowing coefficients and variances to vary across groups is estimated, followed by a postestimation that shows which parameters are significantly different. The variant model can then be compared with a refitted model constraining certain paths to be the same, as indicated by the postestimation. The steps of the analysis by group were explained in detail in the results section.

Interpretation of the results

Unstandardized results were shown in figures for interpretation of the findings, while the standardized solution was presented in the tables. The unstandardized values for the measurement part of the model show the correlation between the construct (diet score) and indicator (observed variables) compared with a reference indicator, fixed at 1.0. The standardization of the coefficients based on the standard deviations of the variables is the approach typically used to make coefficients comparable. This converts variables into standard deviation units and, therefore, the expected impact of a standard deviation difference in one variable can be compared with a standard deviation difference in another variable.

9.4 Results

As described in the methodology, the measurement part of the model consisted of the use of observed variables for generating constructs of healthy and less healthy diet. The use of confirmatory factor analysis for defining these constructs has to be based on the definitions of healthy and less healthy diet. The Brazilian food guide defines a healthy diet as food "in natura" – food with no changes after extraction from nature, or minimally processed food subject to minimal alterations (e.g. without added salt, sugar, fat or other substances), such as dried polished grains (Brasil, 2014). The guidelines also recommend ultra-processed food and excess addition of sugar, salt and oils be avoided.

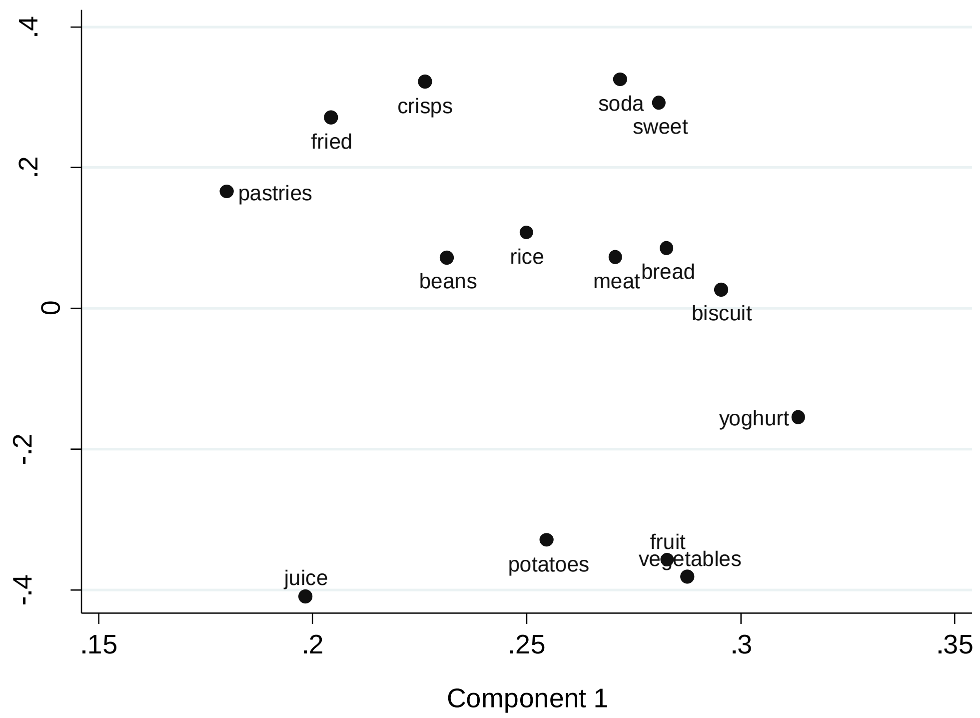
The WHO has more specific recommendations for a healthy diet, such as at least five portions of fruits and vegetables a day, less than 10% of total energy intake from sugars, and less than 30% of total energy intake from fats, highlighting that processed foods are not part of a healthy diet (WHO, 2015).

According to both classifications, rice, beans, and meat are part of a healthy diet, and because these are standard Brazilian meal components (Barbosa, 2007; Souza *et al.*, 2013), they cannot be used to differentiate between healthy or unhealthy patterns of diet. Bread, a processed food, is also among the standard Brazilian diet and cannot help to differentiate patterns of diet. Therefore, the above foods were excluded from the analyses and the remaining foods were assigned to the healthy or less healthy group based on the definitions above.

A principal component analysis (PCA) was performed to verify whether the correlations between variables were in agreement with the theory presented above. A loading plot (Figure 9.2) showed that food classified as healthy - seen at the bottom of the graph - was distinct from other foods.

Less healthy choices were found at the top of the graph, while the standard foods were in the middle. Biscuits were found among the standard foods, frequently consumed every day (Table 9.2). Yoghurt fell between a standard and healthier food.

Figure 9.2- Loading plot from principal component analysis of food frequency score.

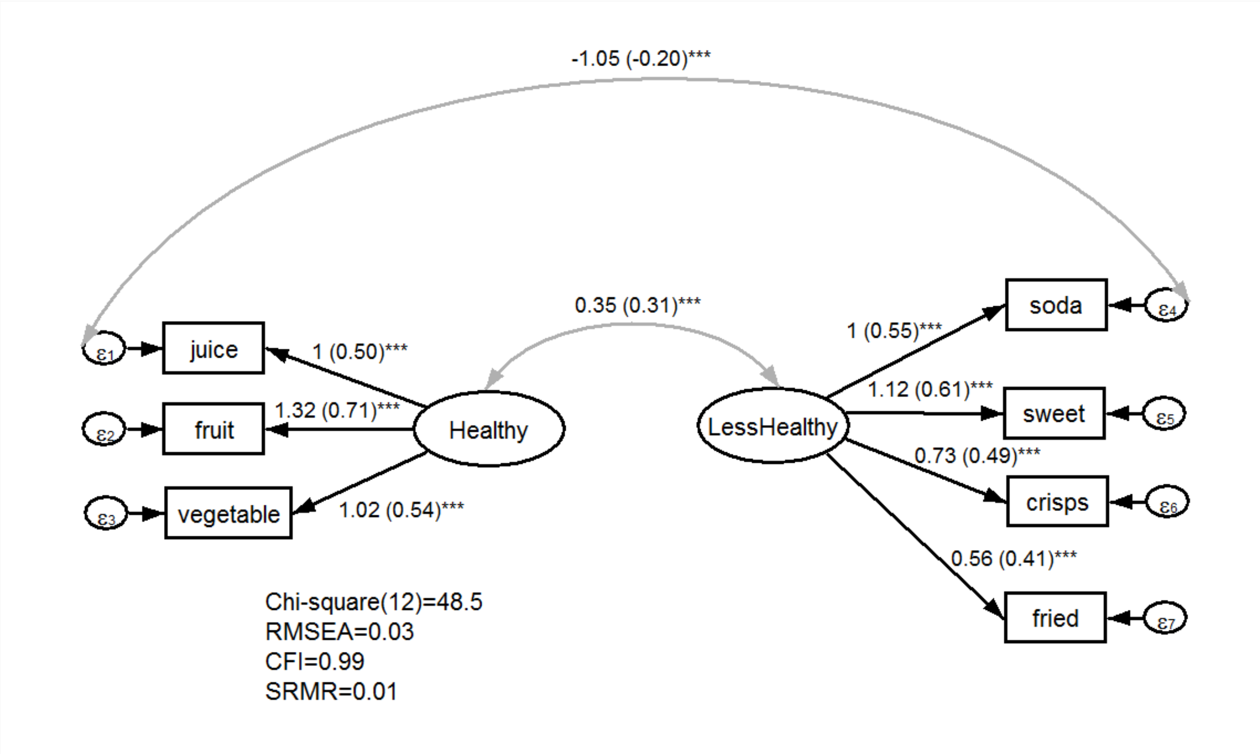


Given that the PCA included biscuits among the standard diet, and Table 9.2 showed a high prevalence of consumption of this food everyday (46.2%), this was also excluded from further analysis. Yoghurt, although processed, was included in the healthy group as it was the only food representing dairy products. The analyses began by using fruit, vegetables, potatoes/roots, natural juice, and yoghurt for the construct of a healthy diet, while crisps, fried food, pastries, soda and sweets were used for the construct of a less healthy diet.

Step 1: Defining the measurement model

The goodness of fit as well as the postestimation analyses suggested modifications in the model. This model was adjusted to include indicators with high correlations, and the justified modifications suggested from the postestimation were accepted. Yoghurt, potatoes/roots and pastries were removed from the analysis as these had a poorer correlation with other food in the groups they were assigned to. Further justification for this include the facts that yoghurt is a processed food, pastries had a very small consumption among children in this sample (Table 9.2), and a high covariance between errors of potatoes/roots and vegetables was found. Potatoes and roots are high in carbohydrates, considered starchy food, and not included in the WHO recommendation of five fruits and vegetables/day (WHO, 2015). Still, they are included in Brazilian meals as an addition to rice, increasing the amount of carbohydrates and energy in the diet, which may worsen the healthy score.

Figure 9.3- Confirmatory factor analysis for defining Healthy and Less Healthy children's diet, PNDS, Brazil 2006



*p-value<0.05; **p-value<0.01; ***p-value<0.001. Standardized values in brackets.
-Yoghurt, pastries and potatoes/roots were removed from this model due to the low correlations with other groups in the constructs, and worsening the fit of the model.
- The Chi-square, RMSEA(<0.05), CFI (>0.90) and SRMR(<0.08) showed a good fit of the model.

The final version of the measurement part of the model is presented in Figure 9.3. The loadings of all indicators were strong, proving a high correlation between the construct and indicators. Unstandardized results showed that considering juice the reference variable for a healthy diet, fruit had 32% higher correlation with a healthy diet, and it was the strongest indicator of this diet. The same is shown in the standardized results, where fruit had the highest factor loading (0.71, p<0.001). For the less healthy construct, sweets and soda were the most important indicators, with 0.61 and 0.55 standardized loading factors, respectively. The correlation between healthy and less healthy latent variables was significant (loading factor=0.31, $p<0.001$), revealing some correlation between both patterns. This was expected, considering that the concepts are not mutually exclusive, and vice versa.

Covariances between the errors of juice and soft drink were added to the model, assuming that some of the unexplained variance in drinking juice was correlated with some of the unexplained variance in drinking soft drinks. This is an expected assumption, as someone who decides to drink juice has chosen not to drink soft drinks and vice versa.

Step 2: Testing the structural part of the model

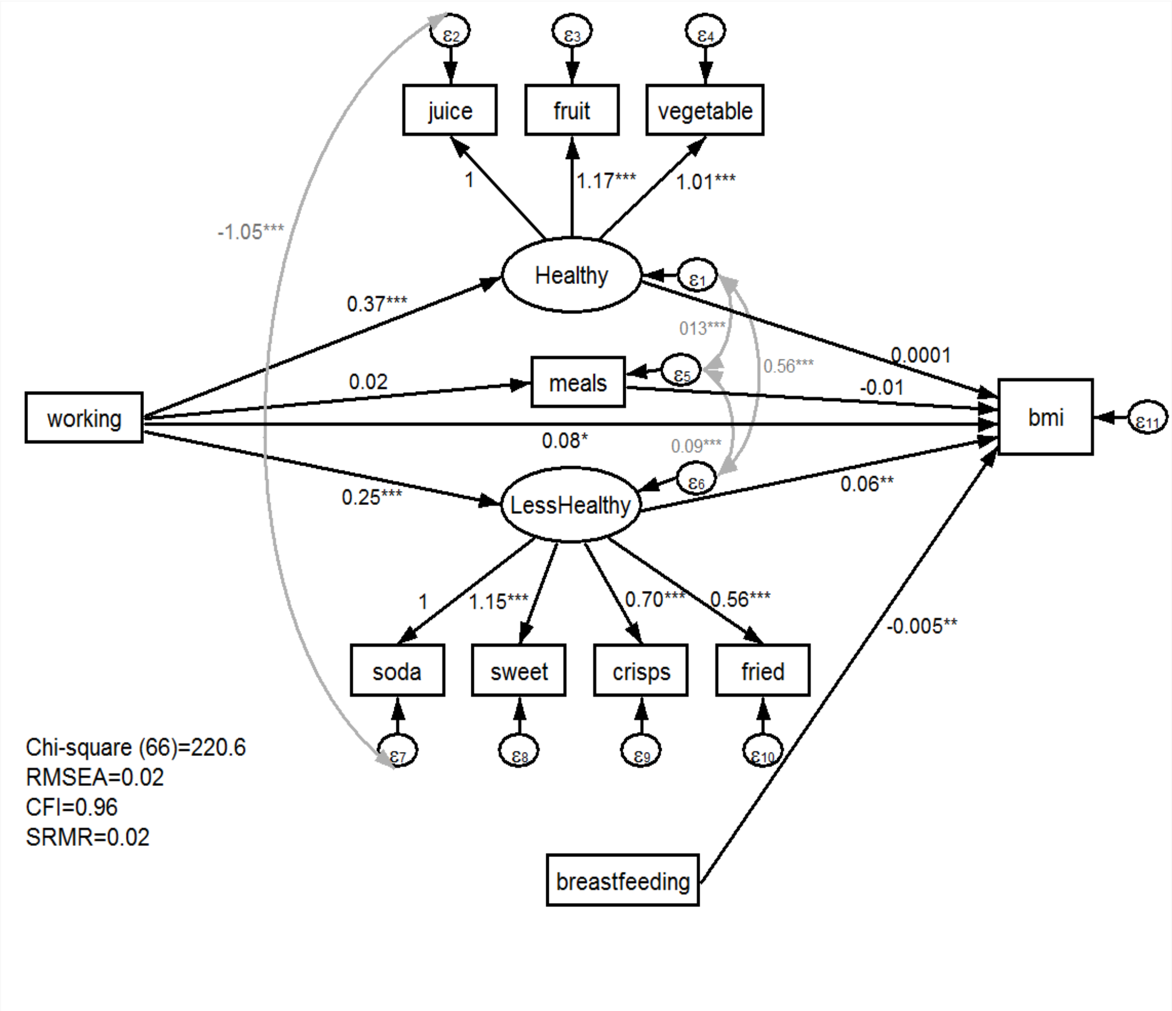
Having the measurement part of the model ready, the next step consisted of exploring if the constructs were mediators of the association between maternal work and child's BMI. For this, a full structural equation model was performed. Unstandardized results are reported in Figure 9.4 because it yields an easier interpretation, and standardized results were presented on Table 9.3.

In Part I of the model, maternal work was positively associated with both healthier and unhealthier diet patterns, increasing the "healthy" score by 0.37 and the "less healthy" score by 0.25 when compared with non-working mothers. Although the effect of working on the healthy diet was stronger than the effect on the unhealthier diet, this difference was not statistically significant (chi2=2.24, $p=0.134$).

Part II of the model showed the less healthy diet to be positively associated with child's BMI ($B=0.06$, $p=0.004$). This result confirms that the "less healthy diet" is a mediator of the association between maternal work and child's BMI, showing the indirect effect of maternal work on child nutrition. The number of meals was not significant in any of the pathways, but its covariance was associated with the other mediators, improving the model. Maternal work was also directly associated with child's BMI ($B=0.09$, $p=0.023$), representing other mechanisms that are not indicated in this theoretical model.

The fit of the model was good, with CFI=0.97, RMSEA and SRMR= 0.02. The model explained around 15.0% of the variance in the latent variables "Healthy" and "Less Healthy", but much less of the variance in child's BMI (5.0%).

Figure 9.4- Full structure equation modelling testing how maternal work affects children's BMI directly and through mediators. Unstandardized values provided.



*p-value<0.05; **p-value<0.01; ***p-value<0.001

-Part I of the measurement model had child's age and maternal education as covariates. Part II of the model included child's age, maternal education, child's birthweight and maternal BMI as covariates.
- The Chi –square, RMSEA(<0.05), CFI (>0.90) and SRMR(<0.08) showed a good fit of the model

Table 9.3-Unstandardized (B) and standardized (β) results for full structural equation examining the association between working, mediators and children's BMI.

Paths	B	β	R^2
Measurement Model			
Healthy			
Juice	1	0.52***	0.28
Fruit	1.17***	0.66***	0.43
Vegetables	1.01***	0.57***	0.32
Less healthy			
Soft drink	1	0.55***	0.30
Sweets	1.15***	0.62***	0.39
Crisps	0.70***	0.46***	0.21
Fried food	0.56***	0.41***	0.17
Structural model			
Meals			0.25
Working	0.02	0.02	-
Healthy			0.16
Working	0.37***	0.13***	-
Less healthy			0.15
Working	0.25***	0.09***	-
Children's BMI			0.06
Meals	-0.01	-0.005	-
Healthy	-0.0001	-0.0002	-
Less Healthy	0.06**	0.08**	-
Working	0.08*	0.04*	-
Breastfeeding	-0.005**	-0.05*	-
Cov(juice, soda)	-1.05***	-0.21***	
Cov (Healthy,Less healthy)	0.56***	0.32***	
Cov (meals, Healthy)	0.13***	0.20***	
Cov (meals, Less healthy)	0.09***	0.15***	
Overall R^2			0.40
x^2(df)	220.6 (66)		
RMSEA	0.025		
CFI	0.964		
TLI	0.945		
SRMR	0.018		

*p-value<0.05; **p-value<0.01; ***p-value<0.001
-Part I of the measurement model had child's age and maternal education as covariates. Part II of the model included child's age, maternal education, child's birthweight and maternal BMI as covariates.
- The Chi –square, RMSEA(<0.05), CFI (>0.90) and SRMR(<0.08) showed a good fit of the model

The results so far answered the first and second research questions showing that maternal work was associated with increases in both healthy and unhealthy diet, but only unhealthy diet was a mediator for the association between maternal work and increased child's BMI.

The next phase consists of analysing results by groups.

9.4.1 Analysis by maternal education

This section evaluates if the associations between maternal work, mediators, and child nutrition change according to maternal education. For this, the first step in the analysis was to verify the measurement part of the model, checking whether the construct of healthy and less healthy diet differed by groups, or whether the correlation between the indicators and constructs were the same according to maternal education. For this, different models were estimated, where some allowed parameters to vary according to maternal education and others constrained parameters to be the same independent of maternal education. The fit of each model was compared with each other to decide on the most appropriate model.

Two models were initially estimated for the measurement part of the model. The first (Model 1, Table 9.4) constrained all parameters to be the same by maternal education. The second (Model 2, Table 9.4) allowed all parameters to vary by maternal education. Comparing these two models, the fit of the model was better for the variant model (Model 2), indicating that some parameters vary by group. The subsequent models constrained each parameter, one at a time, to define the best model.

A new model was estimated constraining only the coefficients to be the same (Model 3). Comparing this model with the previous one, there was no significant difference, and the fit of the model was good. This indicates that the coefficients were the same by maternal education. Models 4 and 5 added constraints to the errors and intercepts, respectively. Both were significantly different from model 3, with increases in their chi-square, indicating a worse performance of the model.

Table 9.4- Model comparison between equal forms and constrained models according to groups of maternal education

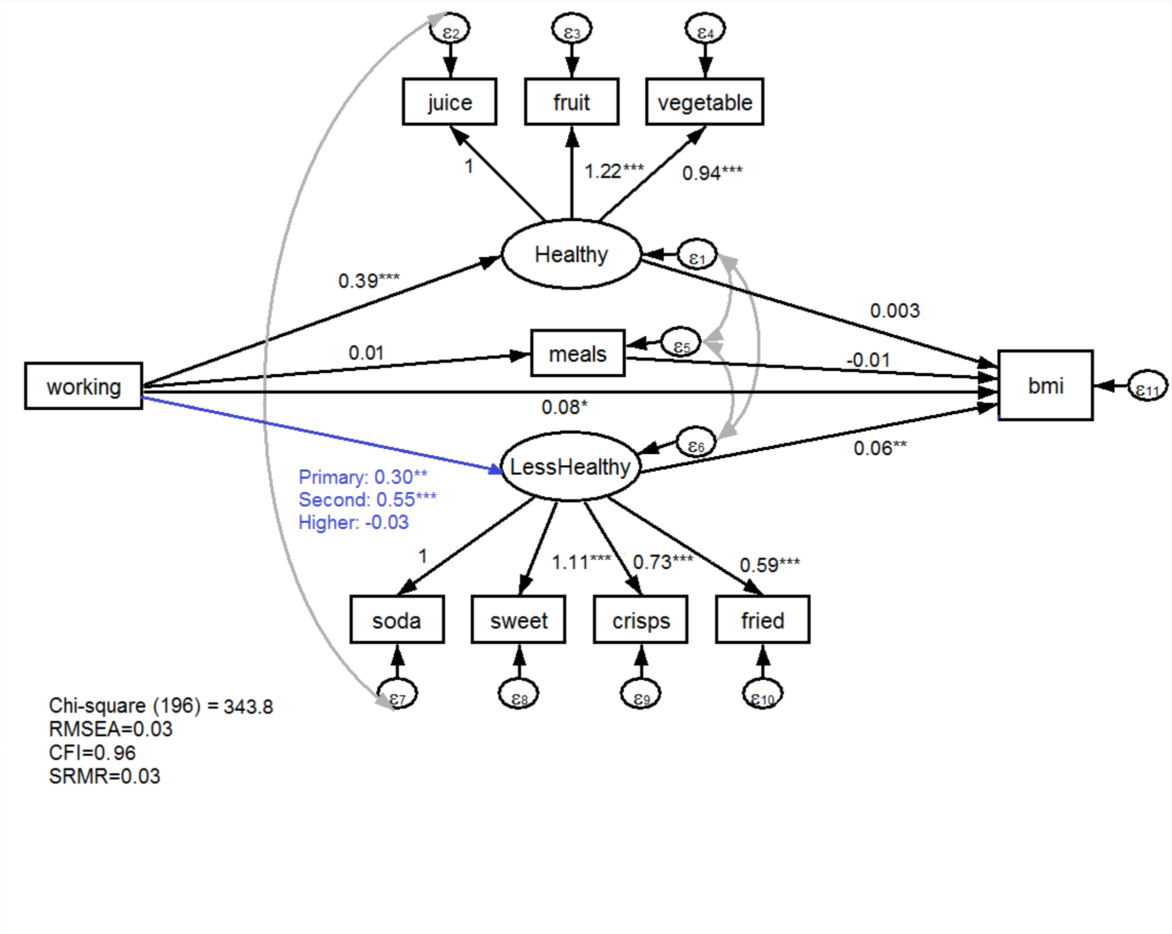
Model	Chi-squared (df)	Model Comparison	Chi-squared (df) difference	RMSEA	CFI
1. Same parameters	793.0 (82)			0.08	0.74
2. All parameters varying by maternal education	136.4 (36)			0.05	0.96
3. Same coefficients, only	**145.3 (46)**	**3 v 2**	**8.91(10) p=0.540**	**0.04**	**0.96**
4. Same coefficients and errors	201.2 (62)	4 v 3	55.85(16) P<0.001	0.04	0.95
5. Same coefficients and intercepts	611.8 (60)	5 v 3	466.5(14) p<0.001	0.08	0.80

Among models 1-5, model 3, with equal coefficients, but different errors and intercepts by maternal education, was the best model, with the best goodness of fit. After defining the measurement part of the model (same coefficients and different errors and intercept), the full structural equation was estimated. Similar to what was done for the measurement part of the model, the full SEM allowing all coefficients to differ by groups of education (variant model) had to be compared with the full SEM constraining the coefficients to be the same between groups (invariant model).

Once the variant model was estimated (Table 9.5), a post estimation used a Wald test to evaluate whether parameters for each education group were significantly different. Most of the coefficients were not significantly different by education, and the only significant path was found when evaluating the association between working and the "less healthy" diet (chi2=16.6, $p<0.001$, Table 9.6). A new model was estimated, constraining all coefficients but "less healthy" to be invariant for groups of education. Since this model had a good fit with CFI=0.95, RMSEA=0.03 and SRMR=0.03, it was considered better than the original unconstrained one (Table 9.5).

The results show that the association between maternal work and a healthy diet for the child was the same, independent of maternal education, increasing the score of a healthier diet by 0.39 ($p<0.001$). But, the association between maternal work and a poorer diet for the child varied according to maternal education, and a significant association was only found for mothers with primary (B=0.30, $p= 0.009$) and secondary education (B=0.55, $p<0.001$). There was no effect of work on the less healthy diet when the mother had higher education (Table 9.5, Figure 9.4)

Figure 9.5- Full structural equation model for maternal work and children's BMI by groups of maternal education. Unstandardized values provided.



*p-value<0.05; **p-value<0.01; ***p-value<0.001
Values for covariances provided in Table 9.5
-Part I of the measurement model had child's age as covariate. Part II of the model included child's age, child's birthweight and maternal BMI.
- The Chi –square, RMSEA(<0.05), CFI (>0.90) and SRMR(<0.08) showed a good fit of the model

Table 9.5- Unstandardized (B) and standardized (β) coefficients for the significant findings in the full structural equation model by maternal education.

Path	**Variant model**						**Invariant model**					
	Primary		**Secondary**		**Higher**		**Primary**		**Secondary**		**Higher**	
	B	β	B	B	B	β	B	β	B	β	B	β
Healthy diet												
Working	0.34**	0.12**	0.32**	0.12**	0.48***	0.17***	0.39***	0.13***	Invariant	0.14***	Invariant	0.14***
Less Healthy diet												
Working	0.16*	0.10*	0.32***	0.18***	-0.02	-0.01	**0.30****	**0.11****	**0.55*****	**0.18*****	**-0.03**	**-0.01**
BMI												
Less Healthy	0.07	0.05	0.09	0.07	0.13**	0.10*	0.06**	0.06**	Invariant	0.08**	Invariant	0.08**
Working	0.14	0.06	0.04	0.02	0.09	0.04	0.08*	0.04*	Invariant	0.04*	Invariant	0.04*
Cov (juice,soda)	-0.66**	-0.14**	-1.36***	-0.26***	-1.20***	-0.24***	-0.66**	-0.11**	-1.36***	-0.25***	-1.20***	-0.21***
Cov (meals,Healthy)	0.12***	0.18***	0.16***	0.24***	0.09***	0.14***	0.12***	0.20***	0.16***	0.26***	0.08***	0.14***
Cov (meals,Less Healthy)	0.06***	0.18***	0.07***	0.18***	0.02*	0.07*	0.10***	0.17***	0.11***	0.20***	0.04*	0.07*
Cov (Healthy,less healthy)	0.57***	0.59***	0.50***	0.46***	0.01	0.01	0.98***	0.58***	0.85***	0.46***	0.02	0.02
x^2overall (df)	chi2 (178)= 329.31						chi2 (198)= 343.81					
CFI	0.956						0.958					
RMSEA	0.027						0.025					
SRMR	0.026						0.027					

*p-value<0.05; **p-value<0.01; ***p-value<0.001; N/A=Not applicable; Bold: Unconstrained value in the constrained model.
Note that in the constrained model, the unstandardized coefficients (B) are the same for all groups of education, apart from coefficients for working→ LessHealthy. However, the standardized coefficients vary. This happens because the standardized solution depends on B and the relative standard deviation of the variables, which in most cases varies by group. Standardized values can only be the same if standard deviations are identical across groups. Therefore, for interpretation, the unstandardized solution is indicated when analysing by groups.

Table 9.6-Wald test for loading values for the structural part of the model among groups of education (2 degrees of freedom).

Outcome	**Chi2**	**P value**
Healthy diet		
Working	1.35	0.505
Less healthy diet		
Working	16.63	<0.001
Children's BMI		
Meals	0.22	0.893
Healthy diet	1.51	0.469
Less healthy diet	0.44	0.802
Working	1.10	0.576

9.4.2 Analysis by family structure

Family structure was categorized as "nuclear" when the household was composed of a couple and children, "extended" when families had other adults or elderly living together, and "single mother" when the mother was the only adult in the household.

Nuclear families, considered the standard type of family in Brazil, represented 70.0% of the families with young children in the sample, while monoparental families represented 4.3% of the families. This difference makes it non-viable to test groups in the same model. Pooling the data for an invariant multiple-group model results in incorrect estimates, because the results tend to override the effect for the group with the smaller number (Acock, 2013). Consequently, SEM was conducted separately for each group, to show estimates by type of family, but it did not allow for testing whether one model was statistically different from another.

Results presented in Table 9.7 showed similar findings for the nuclear family and the overall analysis, while for other types of family, there are some differences worth noting. Although the significance of how maternal work affects diet scores varied among extended families and single mothers, the effect size remained the same, suggesting that the same associations would be found if there was a bigger sample size for these groups. The effect sizes varied greatly in the part II of the model, where maternal work had no association with child's BMI in extended families, and double effect size on single mothers (B=0.10, not significant) compared with nuclear families.

Table 9.7- Unstandardized (B) and standardized (β) coefficients for the significant findings in the full structural equation modelling by maternal education

Path	**Unconstrained model**					
	Nuclear Family		**Extended family**		**Single mothers**	
	B	β	B	β	B	β
Healthy						
Working	0.40***	0.13***	0.36**	0.13**	0.36	0.12
Less Healthy						
Working	0.28***	0.10***	0.21[a]	0.07[a]	0.24	0.08
BMI						
Less Healthy	0.06*	0.08*	0.08*	0.12*	0.01	0.01
Working	0.10*	0.05*	0.02	0.009	0.24	0.10
Cov (juice,soda)	-1.03***	-0.20***	-1.16***	-0.22***	-0.76	-0.16
Cov (meals,Healthy)	0.13***	0.20***	0.11***	0.19***	0.18**	0.30**
Cov (meals,Less Healthy)	0.10***	0.16***	0.05	0.08	0.25***	0.42***
Cov (Healthy,less healthy)	0.63***	0.35***	0.41***	0.25***	0.48*	0.28*
N	2,741		1,051		190	
x^2overall (df)	(58) 152.1***		(58) 110.12****		(58)66.8	
CFI	0.97		0.96		0.96	
RMSEA	0.02		0.03		0.03	
SRMR	0.02		0.03		0.05	

a: borderline association; *p-value<0.05; **p-value<0.01; ***p-value<0.001

9.5 Discussion

This analysis sought to evaluate whether maternal work is associated with child's BMI-for-age through its effect on the child's diet. Results confirmed the hypothesis that the income provided by maternal work improves the access to both healthy and unhealthy food, while the frequent consumption of unhealthy food in the child's diet increases their BMI. Structural equation modelling, a method that allowed the testing of the direct and indirect effects of maternal work on child's BMI, also showed a direct association between these maternal work and child's BMI.

The overall increase in food availability when a mother is working has been commonly observed in low-income countries (Popkin and Solon, 1976; Leslie, 1988; Engle, 1993), and has been previously perceived in Brazil, where maternal work was associated with increased dietary-intake and child's weight gain (Facchini, 1995). This study from Brazil was carried out during the 1990s, when Brazil still had considerable rates of child underweight and poverty, and such results viewed maternal work as favourable for child nutrition. Findings from this chapter are in agreement, where the positive association between maternal work and scores of healthier and unhealthier diet implies increased food availability when the mother works. Although the relationship between maternal work and food availability has remained consistent, changing contexts over time have led to maternal work being favourable for child nutrition in the 1990s and problematic for the rising rates of childhood obesity decades later.

Globalization, together with urbanization and trade liberalization, have improved living standards, quality of life and food security, but it has also brought up an obesogenic environment, with dramatic changes in diet and lifestyle (Malik, Willett and Hu, 2013). Increases in the consumption of food high in calories, fat and sugar have occurred worldwide, although such increases have not been observed at the same time as increases in FLFP. Indeed, greater maternal time spent on activities outside the home results in reduced time for household tasks and childcare, and this has been the focus of studies evaluating childhood overweight and maternal work in high-income countries (Fertig, Glomm and Tchernis, 2009; Brown *et al.*, 2010; Cawley and Liu, 2012). The findings obtained in this study might also be reflecting the decreased maternal time for household tasks in agreement with studies in high-income countries. Although the use of maternal time could not be properly investigated, decreased time for activities such as going grocery shopping, cooking, and eating with children are related to greater consumption of ready-to-eat food (Cawley and Liu, 2012), as the ones used to indicate the “less healthy diet”.

A direct association was also found between maternal work and child’s BMI that was not explained by the child’s diet. This could be reflecting other aspects of maternal income and maternal time that influence parental decisions related with increases in child BMI. For instance, income could be used to buy other modern technologies, which alongside the decreased maternal time to supervise children’s daily activities could be associated with lower energy expenditure. The use of the binary variable working/not working is not ideal for the understanding of these mechanisms. However, the information on characteristics of work provided in this dataset do not add information on maternal time at work. They do provide insights related with maternal income, which are also related with educational levels. Due to the importance of maternal education beyond the income from work, the investigation of the path analyses by groups of education was preferable.

Work was associated with healthy diet scores for all groups of education, while the effect on a less healthy diet was only observed for poorer educated mothers. Previous studies examining maternal work and child nutrition by education did not provide consistent results. Some studies found that children from more educated mothers were at a higher risk of overweight when the mother worked (Anderson, Butcher and Levine, 2003; Fertig, Glomm and Tchernis, 2009); others found no differences by education (Cawley and Liu, 2012) and Scholder (2008) found associations with overweight when the mother had lower education. Those studies included teenagers in their sample that, in comparison to children from this study, have more decision-making power regarding what to eat and are less supervised. Moreover, maternal education is often linked to more demanding jobs and increased hours at work, and hence, analyses using maternal hours at work as the independent variable might be showing an effect of the time constraints generated by work, instead of the effect of maternal work when the mother is better educated. The same studies reported children from better educated mothers to have lower percentages of overweight (Anderson, Butcher and Levine, 2003; Fertig, Glomm and Tchernis, 2009), and healthier habits such as spending less time watching TV and having a higher number of meals (Fertig, Glomm and Tchernis, 2009).

The analysis by groups of maternal education showed that the diet of the child was worse when the working mother had secondary education (B=0.55) compared with working mothers with primary education (B= 0.30). Assuming that an improvement in the educational level also improves income, secondary education could be related to a higher purchasing power, alongside an insufficient health knowledge, that could lead to worse dietary habits. This is particularly observed in individuals belonging to middle-classes in developing countries, who experienced rapid upward dynamic from lower income levels, resulting in better consumption possibilities that go beyond the basic needs, and access to credit (Ferreira *et al.*, 2012; Arnold and Jalles, 2014; Tschirley *et al.*, 2015). This is particular important in Brazil, because of the great expansion in the middle class after social development in the country, associated with rising debt due to their consumption through credit, and greater access to modern technologies (Arnold and Jalles, 2014). Studies in low and middle-income countries have reported that food habits within the middle class tend toward highly processed food (Darmon and Drewnowski, 2008; Gómez and Ricketts, 2013), and their higher access to goods and services has been related with declined levels of physical activity (Popkin, 2014).

Although this analysis could not investigate aspects of maternal time and childcare while the mother works, it intended to provide insights in this discussion by examining family structure. In the presence of other adults in the household, which mainly included grandparents, maternal work increased both healthy and unhealthy diet scores (with borderline significance for unhealthy scores), but it was not directly associated with child's BMI. Similar findings were reported by Hawkins, Cole and Law (2008), who found no differences in the likelihood of childhood overweight when the mother worked more hours and other family members cared for the child. In this sample, it cannot be assumed that the child was cared for by relatives during maternal absence, but the presence of other adults in the household can increase financial resources and food expenditure, and can benefit the child by household task sharing, including grocery shopping and cooking.

The case is different for single mothers. While the effect sizes for the influence of maternal work on healthy and less healthy diet scores were similar to nuclear families, the direct effect of work on child BMI was double the one found in nuclear families. Also, the covariances between meals and less healthy diet scores were much higher than the other family groups. Although not much is known about childcare in these circumstances, the results suggest that the lack of maternal time has a stronger effect on children from this type of family.

Despite the efforts to understand the association between maternal work and child nutrition, there is much more to be debated. This study tried to account for schooling levels and family structure, but limited data on maternal work prevents a more nuanced understanding of how work affects child nutrition. More in-depth data would record other work characteristics such as whether the mother works part-time or full time, occupation and hours at work, as well as more detailed characteristics of childcare. This leaves a scope for future studies in emerging countries, with the use of longitudinal data, best capturing maternal work and child behaviours. Studies investigating types of childcare and its influence on child nutrition are also needed for understanding how important the substitute childcare is for this association, suggesting new policies that benefit children and mother.

In conclusion, maternal work was still associated with increased food availability for child’s diet, but particularly among lower educated mothers and monoparental families, increased consumption of unhealthier food served as a mechanism leading to increases in child BMI. The small significant effect of maternal work on unhealthy lifestyles found in this and previous studies (Brown *et al.*, 2010; Cawley and Liu, 2012) suggests that maternal work has a small effect on the already established obesogenic environment.

Box 9.1 - Main findings for the effect of maternal work on child BMIZ in Brazil having diet as a mediator

- Maternal work was associated with both healthy and less healthy dietary patterns.

- The less healthy diet was a mediator of the association between maternal work and child's BMI.

- The association between maternal work and a healthy diet for the child was the same independently of maternal education. However, the association between maternal work and a worse diet for the child was only significant for mothers with primary and secondary education.

- The direct association between maternal work and child BMI seemed to be null for extended families, and doubled for single mothers.

Chapter 10: Discussion and Conclusion

Adequate child nutrition, as well as the participation of women in the economy are important characteristics for continuous economic growth among emerging countries. An extensive number of studies have demonstrated the effects of child malnutrition on decreased future work capacity and productivity (Martorell *et al.*, 2010; Stein *et al.*, 2010; Smith and Haddad, 2015). Similarly, the status of women, in terms of gender equality, work, and autonomy, has also been shown to be crucial for poverty alleviation and improvement of household conditions (Haddad, 1999; Duflo, 2011; Rendall, 2013). Accordingly, both child nutrition and participation of women in the economy have been prioritized in the international development agenda (Hawkes and Popkin, 2015).

Mothers are particularly important for child nutrition during pregnancy and lactation, and recognized by society as the main caretakers of children, responsible for continuous feeding and health care (Smith, 2003). Therefore, concerns have been raised in the literature about whether improvement in one variable occurs to the detriment of the other, due to a possible association between maternal work and child nutrition (Leslie, 1988). Despite the many studies on this area in the past, this relationship was not completely understood, and there was no further evaluation of this association in emerging countries, where an interesting scenario of economic growth, and rapid demographic, epidemiological, and nutrition transitions are observed. This thesis intended to address this gap by examining two emerging countries through a comparative approach, specifically filling the gaps in the types of analyses previously conducted. The investigation of this association in two periods of time, and the comparison of results between countries provided a broader picture of this association, contributing new conclusions to this debate.

Findings from this study show the importance of the macro context for the association between maternal work and child nutrition. In fact, there cannot be a consensus regarding whether maternal work is positive or negative for child nutrition without understanding the macro and micro contexts. This study showed that the culture, and stages of development of each country determined different rates of female work, and different opportunities of work generated for women in Brazil and India. The macro context also defined the types of work more likely to benefit women and the household. This was discussed in chapters 5 and 7, where the definitions of self-employment and employment in Brazil and India were associated with opposite sociodemographic characteristics, and child outcomes in each country. In the large rural context of India, self-employment was associated with a higher status and better child nutrition, while in the urban context of Brazil, there was a large percentage of self-employed mothers in low paid jobs, which was associated with worse child nutrition.

Once maternal work was contextualized in each country, the conceptual framework developed for this study (Figure 6.11 and 6.12) suggested that the macro context also affected the mechanisms through which maternal work is associated with child nutrition. It was assumed that in both contexts, income generated by work has the chance of improving living conditions, reducing poverty and increasing food availability and health care (Engle, 1993; Smith and Haddad, 2015). Similarly, in both contexts, decreased time for childcare can affect child's health and feeding (Bianchi, 2011). However, the context defines the extent to which these variables are significant for child health.

In an environment of poverty, in the absence of good quality water and sanitation, the effect of income generated by maternal work, as well as the input of time for childcare are crucial for providing a safe environment for the child (Duflo, 2011). In addition, childcare is important for the prevention of diseases, and provision of quality food as a matter of survival and growth (Smith and Haddad, 2015). In such an environment, the income effect can only outweigh the decreased time for childcare if it is enough to improve living conditions, feeding and health care.

When the basic conditions for child growth and development are met – improved living conditions, access to water and sanitation, improved health care – the income provided by maternal work is an additional resource, which can be used in different ways. Then, the parental choices on how to use the money such as what to eat and what to do with the child during free time, have more weight on the outcome for child nutrition. In this context, the stage of the nutrition transition is also a very important contextual factor. Where changes in the economy and food market lead to shifts in dietary habits and physical activity, maternal work can be associated with childhood overweight, stunting, and the coexistence of stunting and overweight in the same individual (Popkin, Adair and Ng, 2012).

These assumptions were well observed in the results presented for Brazil and India. The positive associations between child nutrition and work that required better education, such as a professional occupation, suggested that better income from work was an important determinant of a positive effect of maternal work on child nutrition in both countries (Chapter 7). In contrast, work related to lower wages and poorer conditions (lower job security, irregular hours and other factors) were associated with higher rates of child stunting or poorer child linear growth. In Brazil, this was observed in the first wave when mothers were self-employed, working away from home, or working in agriculture. In India, the same was observed in rural areas when mothers worked for others, in seasonal work, and in agriculture. In the second wave for Brazil, after key changes in social development, the effects of income on child linear growth were no longer significant. Still, the effect of maternal work on child's diet was positively associated with child's BMI (Chapter 9), suggesting that the decisions regarding what to eat were more important than the effect of income from work.

The local environment in which mother and child live is also important for the association between maternal work and child nutriiton. This study calls attention to differences by rural and urban residence, household socioeconomic status, maternal education, caste, and family structure, where all these factors can influence the decision of the mother to work, and determine how maternal work affects childcare and the living conditions for the child. Maternal education was particularly important due to its association with higher wages (Goldin, 1994; Lechman and Kaur, 2015). Furthermore, maternal education is known to be related to healthier choices and behaviours (Engle et al, 2011), shown in this study to be associated with a healthier child diet that prevented increases in child's BMI (section 9.4.1).

In India, there was a clear difference in socioeconomic characteristics of working and non-working mothers, where poorer and less educated women were more likely to be working. Further analyses showed that the overall negative association between maternal work and child nutrition was, in fact, the effects of poverty, the type of work offered to women in the poorer environment and the lack of education and training that restricted women to lower paid jobs (section 8.6). These are situations which require policy intervention to promote better-paid jobs, job security, and better education of women, particularly for those found in lower socioeconomic strata.

Some policy measures have been established since the time of data collection in both countries that indicated a good start in addressing these issues. The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) was developed by the government in India with the objective of providing at least 100 days per year of guaranteed employment in rural areas, in order to reduce rural poverty. The program was recognized as the largest rural employment scheme globally (Breitkreuz *et al.*, 2017), where women should represent at least a third of the employees (MGNREGA, 2013). The program also aimed to ensure women have easy access to work, decent working conditions, equal wages, and representation in decision-making bodies at work (Desai, Vashishtha and Joshi, 2015). Studies evaluating the program report that the scheme has been successful in benefitting the poorest households, particularly those in scheduled castes (Carswell and Neve, 2014), where the participation of women overall has been estimated as 50% of workers (Desai, Vashishtha and Joshi, 2015). The program has also been related to transformative outcomes for rural labourers, pushing up rural wage levels, and enhancing women's bargaining power (Carswell and Neve, 2014; Breitkreuz *et al.*, 2017). While this is indeed some progress, there is the need for more investments in education, information, and skills that enable women to engage in types of work other than agriculture, and increase women's autonomy and control over their earnings.

In Brazil, the recent main investment since data collection was not directly in female work, but in education and capacitation of the population. Besides the cash transfer program that requires children to attend school to receive the benefit (de Bem Lignani *et al.*, 2011), the Prouni (University for all Program) was created by the government to provide scholarships for low-income students to attend higher education (Catani, Hey and Gilioli, 2006; Sguissardi, 2008). The program has also been successful in improving the educational level among those in lower socioeconomic strata, associated with the high rates of women in tertiary education (Beltrão and Alves, 2009).

The contributions of this thesis toward the discussion of childcare while the mother is working was limited due to the lack of data. Still, some results highlight areas for further investigation. In Brazil, self-employment from home was positively associated with child linear growth, which suggests that increased time between mother and child eliminates the negative effect of maternal work on child nutrition. Then, work that gives the mother more flexibility, allowing her to spend more time with the child, such as part-time work and work from home, has more benefits for the child.

Other studies investigate whether part-time work is better for women, suggesting that this kind of policy would solve the concerns related to childcare, and that most women do not desire full time work or leaving their children in non-parental care (Gornick and Meyers, 2004; Leach *et al.*, 2005). However, part-time work is associated with lower wages, poorer career prospects, poorer quality of jobs, and considerable loss of earnings through life. It also can perpetuate the notion that women are disproportionately responsible for household tasks and childcare, exacerbating the gender division in the workforce and workforce discrimination (Craig and Bittman, 2008).

The purpose of this study is not to find working women blameworthy in any way for not being at home. Rather, it presents facts that highlight the importance of women's work for growing the economy, and for the alleviation of poverty in the household (Duflo, 2011). Still, the lack of studies on the effects of substitute childcare when the mother works renders this debate inconclusive.

Two results from this thesis point to the potential benefit of having more adults in the household to share the responsibility of childcare. The first is the result for rural India, where after controlling for selection bias, working for the family was not associated with child stunting. The second is the effect of maternal work on child BMI in Brazil, which was lower in extended families when compared with nuclear families. The fact that another adult in the household can alleviate the effect of maternal work on child nutrition raises the question of whether the low participation in childcare activities by fathers influences the results in nuclear families.

Studies in Australia examining the time mothers and fathers spend on their daily activities reported that fathers do not tend to increase their time allocated toward childcare and household activities when their spouses increase their hours at work (Baxter *et al.*, 2007; Craig and Bittman, 2008). Cawley and Liu (2012) found in the U.S that the magnitude of the increase in time spent with the child by men when their partners worked was very low, totalling around 18 minutes. In contrast, a study in Denmark showed that fathers spent on average 4.7 hours on childcare per day, which is much more than other nationalities, and suggests significant paternal contribution toward child's health (Bonke and Esping-Andersen, 2011). Another study in the same country found no association between maternal or paternal hours of work and child overweight, arguing that the involvement of the father in childcare may contribute explain this finding (Greve, 2011).

This thesis's study of two different countries with different contexts yielded results useful for facilitating a broader discussion of the association between maternal work and child nutrition, which can be extended toward understanding the context of other emerging countries. Additionally, policy recommendations are discussed below.

10.1 **Contributions for policy makers**

As previously discussed, FLFP is important for continuous economic growth and gender equality when improving decision-making of women. Therefore, two important areas of policy concern include empowering women/mothers to enter the labour force if they have the desire to do so, and improving conditions of women's work, especially in areas where there are cultural constraints against FLFP. Also of policy concern is helping families balance work and home responsibilities, alleviating the maternal dual role and contributing to improvements in child nutrition.

Improving education

Findings from this study showed that one key factor for improving working conditions for women is female education. The improvement of FLFP, poverty and health has education as a priority on the government agenda. Additionally, capacity building of the workforce is needed, which includes all schooling phases and technical trainings that can greatly improve work opportunities for women. The previously discussed programs implemented in Brazil to improve education of children and higher education among adults are examples of successful programs for empowering women and enhancing productivity and wages in the labour force.

Decreasing gender inequality

Gender equality depends on how policies address the issue of female non-paid work and the position of women in the labour market. This is a particular issue in India, where there is a high percentage of women working for no wages. Furthermore, cultural constraints prevent women from joining the work force and decrease their power of decision. This study shows that this is not only an issue for women, but it also affects child's health, and therefore, requires strong measures to increase women's power of decision, and improve women's working conditions. Women's autonomy in terms of access to and control of land, mobility, and decision-making in the household is important to empower women to access resources and move into non-agricultural jobs. Therefore, policy initiatives should aim to empower women as economic agents, promote gender sensitive agricultural strategies that increase women's pay and women's role in the agricultural sector, promote measures that formalize female work, particularly in agricultural and service sectors, to guarantee a minimum wage, social security and fair hours of work per day (Srivastava and Srivastava, 2010).

Furthermore, the fiscalization of working conditions in the informal sector can enable workers to be effectively protected by labour law. The International Labour Office (ILO) recognizes labour inspection as the pillar of social reform (ILO, 2011). More investments in training labour inspectors and increasing number of staff are necessary to deal with the challenge of the hidden and diverse nature of wok in the informal economy.

Another important issue for both countries is the rebalance of wages between men and women. Addressing the share of unpaid work between women and men in the household when dealing with domestic tasks and care is also important with increases in time demand from work (Lewis and Giullari, 2006). The whole scope of studies on the effect of maternal work on child's health points to the unbalanced burden of women, despite the similar hours at work.

The societal definition of parental roles, where men are perceived as a breadwinners while women should care for the household and the child, act as a barrier to gender equality. There is a great need for policies that make men responsible to become caregivers. This requires extensive educational campaigns focused on men. Gornick and Meyers (2004) discuss that policies can powerfully shape the choices of couples, by providing ways of dealing with the situation and influencing mindsets about the case. The simple focus on propagandas disclosing male behaviour in the household, such as male help in childcare and household activities when the mother is in the labour force, can prompt changes in families' behaviours and improve men's participation in such tasks. Incentive to paternity leave and more interaction between children and fathers are also important measures, discussed below.

Policies to stimulate female participation

Besides the capacity building of women for the workforce, some focused policies can stimulate FLFP. Tax incentives is one example of policy proposed by Jaumotte (2004), that consists of taxing married women and mothers less than men and single women because their labour supply is more elastic. This is complex because of the principle of equal taxation for equal income, but this was a successful strategy used by Nordic countries as an incentive for FLFP.

The availability of part-time jobs is another way to facilitate the integration of women in labour force, and to allow them to combine work and family responsibilities. Among OECD countries, about one quarter of women work part-time (Jaumotte, 2004) but this type of job tends to be less preferable for highly educated women, because it can restrain the possibility of career growth and earnings.

Policies that benefit childcare

Policies should also offer the best conditions for childcare when mothers are working. Although there are existing laws supporting mother and child, compliance with the law is often not monitored resulting in workplaces ignoring the needs of women as mothers.

Cash-transfers to home-based carers offers the possibility of caring for the child, earning some money to be invested in the child through benefits. These are associated with lower FLFP because it has an income effect without offering any other type of childcare other than maternal care. Childcare subsidies, on the other hand, can help reduce the tax burden on mothers, and tend to be associated with increases in FLFP (Blau and Hagy, 1998). Such policies offer mothers the chance to choose between the dual roles of workforce and childcare or exclusive childcare.

Most governments establish maternity leave, parental leave and childcare leave as a right of the worker. Those are of extreme importance for breastfeeding practices and for the first months of the child. Brazil has paid maternity leave that varies from 120 to 180 days. In India, the duration of maternity leave changed in March 2017 from 12 weeks paid leave to 26 weeks (ILO). However, while these emerging countries increased their maternity leave just recently, some European countries offer very extended leave, sometimes more than a year (Pronzato, 2009), showing that emerging countries are far from providing the best environment for children of working mothers.

Leira (2002) raises the argument that policy analyses, instead of focusing on mothers and children, should consider both fathers and mothers as providers and carers. This strategy has been initiated in Sweeden, where the father was also given leave, and a year leave could be shared by parents or transferred from one another (Klinth, 2008). This has been followed by other European countries, and while still used with modestly by fathers, qualitative studies point to how this kind of policy increases the sense of shared responsibility for the child (Rehel, 2014).

For women in the workforce, the return of women to the workplace, as well as workplace barriers contribute to lower duration of breastfeeding. However, breastfeeding is important for the best development of children and prevention of both overweight and underweight. There are some examples of policies at the workplace that supported lactation as a way to retain female employees (Murtagh and Moulton, 2011). Examples include the prohibition of breastfeeding-related employment discrimination, and the provision of mother-friendly workplace, breaks for breastfeeding, and location and facilities for breastfeeding or lactation, all associated with higher rates of breastfeeding and incentive to FLFP.

10.2 **Limitations of the study**

There are a number of limitations of the thesis that need to be highlighted. Although these do not undermine the conclusions from the thesis, they should be considered when interpreting results and conclusions.

The samples used in each wave and each country were selected to be nationally representative after using sampling weights. Still, natural sampling variation can affect the results obtained. Larger samples can reduce this variation, and hence, the representativeness of data from Brazil is of more concern due to the small sample size when compared with data from India. The methodology used to select the samples in each wave and country is presented in Chapter 4. Those consisted in the use of a sampling frame and stratification of the sample by regions/provinces, and urban and rural areas. Not much information was provided about the sample selection in cities with remote areas, of difficult access, or areas with high number of temporary houses. Considering that these areas may be in the poorest strata of the population, with precarious access to health care, the exclusion of children from these areas in the data may result in biased estimates of child malnutrition, maternal work and the association between the two variables.

Missing values on child anthropometric data for various reasons may also lead to unbiased estimates of child malnutrition and erroneous conclusions in this study. The earlier waves excluded information on children whose mothers were not interviewed. Given the likelihood that absent mothers were at work at time of data collection, the lack of information on these mothers and their children can decrease the representativeness of working mothers in the sample. Furthermore, for all samples, there were further missing data for children who were absent from the household due to the impossibility to measure weight and height. If these children were in childcare when the mother was working, the number of children from working mothers would also be underestimated in the sample.

The DHS had higher proportions of missing data for weight and height with no apparent reason given (data provided in Table 4.4). The comparison of sociodemographic characteristics between children with and without anthropometric data showed some significant differences, particularly for India, where a higher proportion of missing values were found among poorer and lower educated mothers in the first wave, and among better educated mothers and higher wealth quintiles in the second wave (Appendix C). Due to the inconsistence of the results, the data was considered MCAR, and the analyses proceeded by using listwise deletion. However, although the reasons for missing data cannot be identified, the exclusion of these children may skew the results.

The quality of data on maternal work is important for the accuracy of results in these analyses. This has been discussed in the methodology chapter (see section 4.4.4), raising the concern of errors in the measurements of women's economic activity in developing countries (Anker, 1983; Bardasi *et al.*, 2011). Unpaid domestic work is often excluded from national data collection, while this type of activity is a contributor to the challenge of managing work and family (Baxter, 1998, Craig, 2005), and can also prevent or decrease time spent with the child. Underestimated percentages of female work are of particular concern when the woman is not the respondent about her work status (Bardasi, 2011). While this is of less importance in Brazil, it is of great concern in rural areas in India, where a higher percentage of women are performing unpaid jobs, working for the family, or on their own land (Desai and Jain, 1994).

The time period during which the data are collected can also affect the response in rural areas, where employment is highly seasonal, or there is a high number of casual workers (Bardasi, 2011). The restriction of the DHS question to the seven days before data collection increases the chances of excluding workers in the agricultural sector, producing incorrect statistics of employment participation (Bardasi, 2011).

The information on maternity leave was also crucial for this investigation. Mothers who responded that they were not working, but on maternity leave at the time of data collection were counted as not working, while in fact, these women would have possibly been earning income while caring for the child. This introduces bias in the analyses, affecting the assumptions and results obtained.

In order to compare results between countries, variables that characterize maternal work were categorized in a similar way. This study intended to follow the ILO recommendations, but the low number of observations in certain types of jobs resulted in categories containing very diverse groups. Therefore, the generalization of results for certain types of work could lead to erroneous conclusions about the effect of work on child nutrition.

Another issue is that the data used in this study did not allow investigation of specific work characteristics that can affect child nutrition. Considering maternal earnings and time available for childcare were discussed as the main mechanisms for the association between maternal work and

CNS throughout the thesis, variables such as hours at work, definitions of part-time and full-time jobs, and earnings from work are important for the understanding of this association. However, none of these variables were available for Brazil or India, and the analyses were limited to other characteristics of work based on assumptions of how those types of jobs would reflect the proposed mechanisms. Although the assumptions were based on the literature and descriptive analyses, conclusions would be better supported with appropriate data to test the hypotheses raised in the study.

Some topics of study in this thesis such as maternal work and family structure are dynamic, and change over time according to needs and circumstances. The cross-sectional nature of the DHS does not capture these changes, implying an incomplete understanding of the studied associations. Maternal employment is likely to be influenced by circumstances in the past, and so is the decision to have children. Working status in the last seven days preceding the data collection is unlikely to be a good proxy for work status over a long period of time, or to capture the preparedness of life and work for having a child.

Furthermore, changes in women's time available for childcare due to employment, such as maternity leave, return to work, or leaving work, could affect childcare arrangements and have a rapid effect on child nutrition. Considering that child's weight can vary considerably during the early stages of life, depending on care and basic conditions, it is difficult to measure the effect of maternal work on child nutrition using cross-sectional data.

This research aimed to reduce the limitations of cross-sectional data by examining two waves of data and capturing changes in the associations across years. However, this did not improve the understanding of the timing of changes in work status or child nutrition status, nor the acknowledgment of multiple changes occurring within that time interval. Timing of women's return to work after the child is born is a particular point of interest, which could have important consequences for child health but which could not be investigated.

10.3 **Future work**

The limitations described in this study illuminate a variety of research areas that can be addressed by future work in this area. A different dataset could provide additional insights to the association between maternal work and child nutrition. Longitudinal data, capturing transitions in maternal work and family arrangements at the same time as capturing changes in nutrition status, could eliminate cofounders and shed insight into mechanisms not yet explored. In addition, more complete data on maternal and paternal work, activities in the family context, and childcare would improve the understanding of the relationship between these variables.

More specifically, in India, the complexity of understanding work arrangements, such as the implications of working on the family land, types of payment, and whether work has been sought due to family pressure or the woman's preference, highlights the need for qualitative data on how these women perceive their roles as worker and mothers. There is a wide range of studies describing the low FLFP in India, as well as the poor working conditions for women, but there is a lack of understanding on whether these women have the desire to work or not, and how culture exerts constraints on work. Additionally, there is a lack of understanding on childcare arrangements for working women, and whether leaving the child in the care of the joint family is associated with changes in child's health or nutrition.

Among all the studies investigating the associations between maternal work and child's health, none have evaluated how this association plays out when the child receives different types of care. Some studies, such as this study, used family arrangements as proxies of childcare, leaving a huge gap for the analysis of types of care used by nuclear families or single mothers while the mother is absent. This is of great importance for the full understanding of this association, as what happens to the child in the absence of the mother can determine child's health. No data covering these areas were found in the literature, and there is a whole scope of demographic topics that would benefit from a more structured dataset.

Appendix A Explanation on anthropometric indicators

Chapter 3 explains briefly the anthropometric indicators used in the thesis (height-for-age and bmi-for-age). This appendix provides further explanation on these and other anthropometric indicators available for children.

Length/height-for-age (HAZ) - The indicator length/height-for-age (HAZ), based on length (0-24 months) or height (2 to 5 years), measures linear growth. If the measure is below two standard deviations (-2 Z scores), the child is considered 'stunted' (de Onis *et al.*, 2007). Stunting reflects a process of failure to reach linear growth potential because of suboptimal health and/or nutritional conditions. A decrease in the national stunting rate is usually indicative of improvements in overall socioeconomic conditions of a country (de Onis and Blössner, 1997).

Weight-for-length/height (WHZ) and BMI-for-age (BMIZ) – These indicators reflect body weight relative to growth. Low values (<-2 z- scores) are classified as thinness or wasting, indicating a recent and severe process of weight loss, which is often associated with acute starvation and/or severe disease, or a chronic unfavourable condition (de Onis and Blössner, 1997). Recovery from wasting is rather quick once optimal feeding and health are restored. In contrast, high WHZ or BMIZ (+2 Z scores) are classified as overweight. On a population basis, these indicators can be considered as adequate to measure obesity, because the majority of individuals with high WHZ and BMIZ are obese, but for individuals, this measure is not always accurate, since it cannot differentiate between lean and fat body mass (de Onis and Blössner, 1997).

Weight-for-age (WAZ) – This indicator reflects body mass relative to chronological age, and can classify both acute and chronic undernutrition, since wasted and stunted children can also be underweight. In many emergency-affected populations, it fails to distinguish between short children of adequate body weight and tall, thin children, making interpretation complex. In the absence of significant wasting in a community, this index can be used together with height-for-age to reflect long-term health and nutritional experience of the individual or population (de Onis et al., 1997). High WAZ is classified as overweight, even though the indicator weight-for-height is more useful in the evaluation of overweight as a proxy for obesity.

Other anthropometric measurements - Mid Upper Arm Circumference (MUAC), waist, waist/height, and skin fold thickness are measurements less common to be used in population, and better used in individuals. MUAC is not sensible in identifying chronic undernutrition such as growth faltering, but it is a good measure of severe acute malnutrition and a strong predictor of mortality. It is mainly used in emergence humanitarian situations where height and weight can be difficult to be evaluated, and in combination with clinical signs has also been used specifically for targeting adults and adolescents in emergency selective feeding programmes, as the measure of BMI can be affected by oedema or difficult environment (Young *et al.*, 2004).

Skinfolds, waist and waist/height are measures better correlated with the amount of fat in the body. The measure of waist and the index waist/height are very correlated to central fat, which is more related to metabolic diseases, and in children it is better used after 2 years old (Ketel *et al.*, 2007; Maffeis, Banzato and Talamini, 2008). Skinfolds measurements assess the thickness of subcutaneous tissue and can be measured at various places on the body. It is reliable for evaluating adiposity in children aged ≥3 months, but require careful training of observers (WHO, 1995a; Ketel *et al.*, 2007).

Appendix B – Variables included in the thesis

This appendix provides a summary of all variables used in the thesis, and further explanation on the definition of the variable measuring female decision-making.

Appendix B- Variables included in the thesis

Variable	Type	Categories	Data
Response variables			
HAZ (height-for-age z-score)	-Linear for Brazil	N/A	PNDS 1996 and 2006
	- Binary for India -Binary for descriptive analyses in Brazil	-Stunted (individuals with HAZ≤-2) -Non-stunted (if otherwise)	NFHS 1998-99 and 2005-06
BMIZ (Body mass index per age z-score)	-Linear for Brazil -Binary for descriptive analyses	-Overweight (individuals with BMIZ>2) -Non-overweight (if otherwise)	PNDS 1996 and 2006
Variables for maternal work			
Working	Binary	Working/not-working	All
Working status	Categorical	-"currently working" - "worked last 12 months" -"not working"	NFHS 1998-99 and 2005-06, PNDS
Type of work – Brazil and urban areas of India	Binary	-"Employed" -"Self-employed"	All (urban areas India)
Type of work- rural areas of India	Categorical	-"Working for others" -"Working for family" -"Self-employed"	NFHS 1998-99 and 2005-06
Where	Binary	"at home"/ "away from home"	All
Seasonal	Binary	"all year"/ "seasonal or occasional"	NFHS 1998-99 and 2005-06, PNDS 1996
Occupation	Categorical	- "Professionals" (include technicians, clerical and managers) -"Services" -"Agriculture" -"Skilled"	NFHS 1998-99 and 2005-06, PNDS 1996
Cash earnings	Binary	"Cash"/ "not cash"	NFHS 1998-99 and 2005-06, PNDS 1996
Earnings	Continuous	-	PNDS 2006
Decision-making about earnings	Categorical	-"respondent" -"jointly with partner or other" - "someone else"	All
Child characteristics			
Age	-Age in years (continuous, excluding children 0-3 months)	- 0 to 5 for NFHS 2005-06, PNDS 1996 and PNDS 2006 -0 to 3 for NFHS 1998-99	NFHS 2005-06, PNDS 1996 and PNDS 2006 NFHS 1998-99
	-Age in months (continuous)	-6 to 59 for PNDS 2006 (Chapter 9)	PNDS 2006

Appendix B

Sex	Binary	Male/Female	All
Birth order	Continuous	Continuous	All
Birthweight	Categorical	-"Smaller"/ "Average"/ "Larger	NFHS 1998-99 and 2005-06, PNDS 1996
Health care	Binary	" yes"/"no"	NFHS 1998-99 and 2005-06, PNDS 1996
Vaccination	Binary	-"0" if missing only 1 vaccination -"1" if missing 2 or more vaccinations (according to age)	NFHS 1998-99 and 2005-06, PNDS 1996
Maternal characteristics			
Age	Categorical –	- "18-24"/ "25-34"/ "35-49"	All
Ethnicity	Categorical	-"white"/ "mixed"/ "black"	PNDS 1996 and 2006
Maternal BMI	Categorical	-"thin" for BMI<18.5 Kg/m^2 -"Normal" for BMI between 18.5 and 24.9 Kg/m^2 -"Overweight" for BMI ≥25 Kg/m^2	All
Maternal education	Categorical	"No schooling"/ "primary"/ "secondary"/ "higher secondary"/ "college or more"	All, but grouped for analyses with lower number of individuals
Maternal empowerment	Categorical	Empowered to take decisions alone: -"less empowerment" -"medium empowerment" -"higher empowerment"	NFHS 1998-99 and 2005-06
	Categorical	Empowered to take joint decisions: -"less empowerment" -"medium empowerment" -"higher empowerment"	NFHS 1998-99 and 2005-06
Religion	Categorical	"Christian"/ "other"	PNDS 1996 and 2006
	Categorical	"hindu"/ "muslim"/ "other"	NFHS 1998-99 and 2005-06
Household characteristics			
Number of residents	Continuous	-	All
Number of children	Continuous	-	All
Wealth	Categorical	Wealth tertiles	PNDS 1996 and 2006
	Categorical	Wealth quintiles	All
Father's education	Categorical	"primary or less"/ "secondary"/ "higher secondary or more"	All
Type of region	Binary	"rural"/ "urban"	All
Further variables			
International Wealth Index	continuous	-	All
Exclusive breastfeeding for the first 6 months	Binary	"yes"/ "no"	PNDS 2006
Number of meals	Binary	"ideal"/ "non-ideal"	PNDS 2006
Frequency of food consumption (separated questions for each food	Categorical	Number of days per week: "0"/ "1"/ "2-3"/ "4-6"/ "everyday"	PNDS 2006

group, including: rice, bread, beans, fruit, meat, fried food, sweets, biscuits, pastries, crisps, yoghurt, soft drinks, natural juice)			
Score of healthy diet	Latent variable	-	PNDS 2006
Score of Less healthy diet	Latent variable	-	PNDS 2006

B.1 Questions used in the DHS for creating variables to measure female decision-making

The Table below shows the questions used in each wave to create the variable decision-making according to the methodology proposed by Kishor and Subaiya (2005).

Two dummy variables were created for each question. The first had value "1" if the mother could take the decision alone, and "0" if otherwise. The second had value "1" if the mother could take the decision jointly and "0" if otherwise.

The variable "decision making alone" was created with the sum of the dummy variables for decisions alone, varying from 0 to 4. Those were categorized as "lower empowerment" for the sum equal to "0", "medium empowerment" for values "1-2" and "higher empowerment" for values "3-4". The same was done for "decision making jointly".

Questions from the DHS referring to women's decision-making in India (NFHS 1998-99 and 2005-06) -The main question is: *Who usually makes the following decisions: mainly you, mainly your husband, you and your husband jointly, or someone else?*	**NFHS 1998-99**	**NFHS 2005-06**
Decisions about health care for yourself	✓	✓
Decisions about making major household purchases	✓	✓
Decisions about making purchases for daily household needs		✓
Decisions about visits to your family or relatives	✓	✓
Decisions about type of food to be prepared	✓	

Appendix C Sociodemographic characteristics for missing and non-missing anthropometric data

This appendix investigate whether there are sociodemographic differences between children with and without anthropometric data, to understanding reasons behind missing data. Results from the table below show children with no anthropometric data were significantly older in Brazil 1996 and India 1998-99. In India 2005-06, younger and older children had higher percentages with no anthropometric data. This may coincide with the high percentages of children not present at the time of data collection presented in Table 4.4 (section 4.3.2).

Significant differences were observed in Brazil 2006, where a higher percentage of children from white mothers did not have anthropometric data. In India, a higher percentage of children from older, lower educated, and Muslim mothers in poorer wealth quintiles had missing anthropometric data in 1998-99. This wave excluded measures on children whose mothers were absent at the time of data collection, what might explain the high number of missing data among this group of women. In India 2005-06, missing data were higher among children from better educated mothers, higher wealth quintiles and urban areas.

Despite these differences, the analyses in the thesis followed with the assumption that data were missing completely at random, what could be a limitation of the findings in this study.

Variables	Brazil 1996		Brazil 2006		India 1998-99		India 2005-06	
	Anthro	**No anthro**	**Anthro**	**No-anthro**	**Anthro**	**No-anthro**	**Anthro**	**No-anthro**
Age								
0	21.4	11.8	21.3	19.2	34.4	34.2	19.4	23.9
1	20.2	21.5	19.5	14.8	33.6	30.8	20.2	15.7
2	19.3	25.3	19.6	20.5	31.9	34.9	19.8	17.8
3	19.7	24.0	20.2	21.6	N/A		20.4	20.3
4	19.3	17.3	19.3	23.8			20.2	22.4
P value	**<0.001**		0.390		**<0.001**		**<0.001**	
Female	49.7	45.0	47.7	47.7	48.1	47.8	47.6	48.5
	0.070		0.991		0.7694		0.348	
Maternal age								
15-24	33.5	32.9	42.3	46.4	51.8	48.9	41.6	42.6
25-34	50.0	49.0	43,1	34.7	42.4	42.4	49.8	48.8
35-49	16.5	18.1	14.5	18.8	5.8	8.7	8.6	8.6
P value	0.718		0.123		**<0.001**		0.626	
Ethnicity								
white	37.8	41.1	32.4	45.9				
mixed	57.2	53.4	10.9	7.9	N/A		N/A	

Black	5.0	5.4	56.6	46.2				
P value	0.402		**0.006**					
Education								
None	6.5	7.4	2.6	2.1	52.5	63.8	49.5	47.8
Primary	39.2	37.6	17.8	16.3	15.7	11.4	14.1	11.6
Secondary	32.0	30.7	34.8	36.1	23.5	16.7	26.4	28.1
Higher sec	17.7	19.0	37.2	36.1	4.3	4.2	5.0	5.3
Tertiary	4.6	5.1	7.6	9.3	4.0	3.9	5.0	7.2
P value	0.861		0.890		**<0.001**		**<0.001**	
Paternal education								
None	12.1	9.9	20.4	22.9	28.1	33.3	29.6	33.3
Primary	37.4	38.7	19.3	13.0	17.3	14.3	15.0	11.6
Secondary	30.7	28.2	27.4	30.4	23.7	20.9	36.9	33.6
Higher sec	15.0	16.6	26.8	24.0	12.7	12.8	8.6	9.4
Tertiary	4.7	6.6	6.1	9.7	18.3	18.6	9.9	12.2
P value	0.363		0.141		<0.001		<0.001	
Rural	24.1	24.3	19.2	20.4	77.0	80.2	75.2	64.1
P value	0.939		0.672		**<0.001**		**<0.001**	
Wealth								
1	30.9	27.4	22.8	19.2	19.7	24.5	28.1	23.1
2	22.1	20.6	21.9	20.6	22.9	28.7	23.7	21.9
3	18.3	19.0	20.5	20.3	20.7	16.1	19.6	16.9
4	15.1	16.0	21.6	20.3	19.9	16.7	15.7	18.7
5	13.6	17.1	13.2	19.5	16.8	14.0	12.8	19.4
P value	0.347		0.233		<0.001		<0.001	
Scheduled caste		N/A	N/A		30.1	25.7	31.1	28.3
P value					**<0.001**		**0.023**	
Religion								
Hindu	N/A		N/A		79.5	75.9	78.5	74.8
Muslim					15.2	20.7	16.8	21.4
Christian					2.5	1.8	2.0	1.9
Other					2.8	1.6	2.7	1.9
P value					**<0.001**		**<0.001**	

Appendix D Further descriptive analyses on female work

D.1 Percentage of working women according to wealth quintiles by age, education and type of residence

This table describes the percentage of working women according to wealth quintiles by age, education and type of residence in Brazil (1996and 2005)

	Categories	Year	Q1	Q2	Q3	Q4	Q5	Q5-Q1
All	working	1996	43.8	50.9	55.2	58.5	54.5	10.7
		2006	43.9	50.8	60.2	63.5	67.2	23.3
Age	18-24	1996	23.7	33.7	38.4	42.7	43.9	20.2
		2006	31.6	33.3	48.8	46.3	53.4	21.8
	25-34	1996	44.1	49.8	55.1	57.0	50.4	6.3
		2006	48.0	51.1	62.2	66.6	61.8	13.8
	35-49	1996	54.2	59.1	61.2	63.1	58.8	4.6
		2006	49.5	60.2	62.6	66.2	72.2	22.7
Education	Primary or lower	1996	43.1	47.2	49.5	53.9	45.4	2.3
		2006	42.2	49.9	49.9	54.7	66.6	24.4
	Secondary	1996	43.0	48.7	52.2	51.8	44.8	1.8
		2006	39.6	46.2	59.8	60.0	62.4	22.8
	Higher secondary/	1996	58.8	67.3	69.4	70.0	64.1	5.3
	Tertiary	2006	53.8	56.6	65.6	67.1	68.7	14.9
Type of	Urban	1996	42.4	50.9	54.7	58.4	54.5	12.1
Residence		2006	48.8	51.0	60.9	63.2	67.4	18.6
	Rural	1996	44.8	50.9	60.3	60.1	57.6	12.8
		2006	38.7	50.3	51.8	69.3	55.8	17.1

-The percentage of working women increased in almost all wealth quintiles for younger women, but the largest difference between richer and poorer stratum happened for those 35 years age or older (4.6% in 1996, 22.7% in 2006).

-Increases in labour force participation were highest among richer wealth quintiles irrespective of education level, and disparities between richer and poorer were highest for those with lower education

- Female work increased in all wealth quintiles in urban areas, while in rural areas, it decreased for most quintiles of wealth.

Appendix D

This table describes the percentage of working women according to wealth quintiles by age, education and type of residence in India (1998-99 and 2005-06)

	Categories	Year	Q1	Q2	Q3	Q4	Q5	Q5-Q1
All	working	1998-99	47.1	43.5	44.7	29.0	20.6	-26.6
		2005-06	46.8	47.2	43.6	31.7	22.1	-24.7
Age	18-24	1998-99	36.2	33.2	34.8	19.5	11.2	-25.0
		2005-06	31.6	31.2	28.3	18.3	9.6	-22.0
	25-34	1998-99	48.8	46.9	44.5	30.0	18.9	-29.9
		2005-06	48.9	49.0	44.5	31.6	22.3	-26.6
	35-49	1998-99	53.5	48.4	51.9	34.5	26.0	-27.5
		2005-06	55.0	57.0	52.2	39.0	26.1	-28.9
Education	No schooling	1998-99	50.8	48.3	51.5	36.1	23.4	-27.4
		2005-06	48.8	51.5	50.8	40.4	26.5	-22.3
	Up to primary	1998-99	37.7	36.3	40.9	28.9	20.8	-16.9
		2005-06	39.1	42.9	41.4	34.7	20.6	-18.5
	Secondary or higher	1998-99	24.9	26.3	28.9	22.1	19.9	-5.0
		2005-06	35.6	32.3	31.9	25.3	21.6	-14.0
Type of Residence	Urban	1998-99	41.9	42.3	35.4	24.5	19.6	-22.3
		2005-06	42.8	41.7	36.5	30.7	23.5	-19.3
	Rural	1998-99	47.4	43.6	46.3	31.6	23.4	-24.0
		2005-06	48.0	48.5	45.9	35.7	26.3	-21.7

-Overall, higher rates of female work in India were found in poorer quintiles of wealth, and the largest increases in these rates was observed for those over 25 years old and with at least primary schooling.

- Disparities between richer and poorer working women were smaller with increases in education.

-Urban areas had higher increases in women's work in the 4th and 5th quintiles of wealth than rural areas.

D.2 Sociodemographic characteristics of working and non-working groups of women

This table presents sociodemographic characteristics of working and non-working women according to groups of women in Brazil 1996 and 2006.

	Brazil 1996- Working			Brazil 1996- Not Working			Brazil 2006 Working			Brazil 2006 Not Working		
	M<5	M>5	NC	M<5	M>5	NC	M<5	M>5	NC	M<5	M>5	NC
Age group												
18-24	22.7	1.4	28.2	36.4	1.8	47.4	28.8	2.2	33.2	46.1	3.2	57.3
25-34	53.9	27.6	43.2	49.1	28.7	31.6	50.1	27.3	37.0	41.2	27.3	28.6
35+	23.3	71.0	28.5	14.5	69.5	21.0	21.1	70.5	29.8	12.7	69.5	14.1
p value		<0.001			<0.001			<0.001			<0.001	
Education												
No education	5.3	6.8	3.3	6.2	9.9	5.7	1.7	3.2	0.7	2.9	9.1	3.2
Primary	32.7	37.3	21.3	39.5	46.9	37.9	12.7	23.2	9.2	18.2	30.9	13.3
Secondary	27.4	28.2	21.8	35.7	27.8	31.9	31.4	28.6	15.3	37.0	30.7	25.7
Higher secondary	25.6	19.5	30.7	16.0	12.8	22.4	40.5	30.6	48.1	37.3	24.0	50.6
Tertiary	9.0	8.3	23.0	2.5	2.6	2.1	13.8	14.3	26.7	4.6	5.3	7.2
p value		<0.001			<0.001			<0.001			<0.001	
Wealth												
Poorest	22.5	12.1	8.2	28.7	15.4	20.9	17.6	18.1	14.4	24.9	23.1	19.1
2nd	20.1	17.7	13.7	22.2	20.6	26.3	16.5	17.9	13.3	23.3	20.6	17.8
3rd	18.9	21.4	24.6	20.2	19.1	20.8	20.6	20.0	23.1	21.0	17.6	25.1
4th	18.5	22.9	24.2	16.0	23.3	18.6	25.5	20.1	24.3	19.8	21.3	19.6
Richest	20.0	25.8	29.3	12.9	21.6	13.4	19.8	23.9	25.0	11.0	17.4	18.4
p value		<0.001			<0.001			0.043			0.017	
Religion												
Christian	91.3	92.8	88.7	91.1	92.1	93.9	87.7	88.0	82.1	87.9	89.3	83.0
other	8.7	7.2	11.3	8.8	7.9	6.1	12.3	12.0	17.9	12.1	10.7	17.0
p value		0.037			0.325			0.022			0.069	
Region												
Urban	79.8	83.5	82.4	76.4	82.9	80.1	88.3	85.4	88.6	76.4	79.0	79.2
Rural	20.2	16.5	17.6	23.6	17.1	19.9	11.7	14.6	11.4	23.6	21.0	20.8
p value		0.041			<0.001			0.059			0.396	

M<5 mothers of young children; M>5 mothers older children; NC women with no children

- The youngest group of women (mothers of young children and women with no children) had a higher percentage of working women in the age 25-34 years for both waves

- An important increase in the percentage of working among women with no children in the age group 18-24 was observed between 1996 and 2006.

- Working women were in an advantaged position in terms of schooling and wealth compared with non-working women.

Appendix D

This table presents sociodemographic characteristics of working and non-working women according to groups of women in India1998-99 and 2005-06.

	India 1998-99 Working			India 1998-99 Not Working			India 2005-06 Working			India 2005-06 Not working		
	M<5	M>5	NC	M<5	M>5	NC	M<5	M>5	NC	M<5	M>5	NC
Age group												
18-24	38.0	2.1	50.7	43.1	1.9	71.0	31.8	1.6	51.8	43.3	1.5	70.3
25-34	50.9	33.5	26.6	48.6	30.8	19.7	54.9	31.9	28.7	48.7	29.8	20.6
35+	11.1	64.4	22.7	8.3	67.4	9.4	13.3	66.5	19.5	8.0	68.7	9.1
p value		<0.001			<0.001			<0.001			<0.001	
Education												
No education	69.2	67.5	62.5	47.6	45.2	38.2	60.7	62.1	45.2	41.5	41.6	31.3
Primary	12.7	15.5	13.3	15.5	19.9	14.8	13.4	15.1	17.5	13.7	17.5	14.2
Secondary	12.5	11.5	15.8	26.6	27.2	32.6	17.9	15.8	22.4	31.5	30.6	35.4
Higher secondary	2.3	2.1	3.0	5.5	4.0	7.3	2.7	2.5	4.4	6.8	5.2	9.2
Tertiary	3.3	3.3	5.4	4.8	3.8	7.1	5.4	4.5	10.5	6.5	5.2	9.9
p value		<0.001			<0.001			<0.001			<0.001	
Wealth												
Poorest	28.7	20.4	24.8	17.2	10.3	13.7	33.1	20.7	25.9	23.7	14.3	18.2
2nd	23.8	20.3	20.4	22.5	16.7	21.1	28.3	25	22.3	20.2	14.6	18.6
3rd	25.2	26.8	25.5	16.7	15.6	16.7	20.1	24.7	21.7	18.4	17.3	19.1
4th	13.9	19.5	17.2	21.9	23.7	22.2	10.3	17.9	16.2	19.4	24.1	22.1
Richest	8.4	12.9	12.1	21.8	33.7	26.2	8.2	11.6	14.0	18.3	29.7	21.9
p value		<0.001			<0.001			<0.001			<0.001	
Religion												
Hindu	87.2	88.6	87.9	76.2	79.2	79.9	84.0	87.8	86.2	76.7	79.4	80.7
Muslim	8.1	5.6	6.4	18.5	13.9	14.4	11.0	6.7	8.3	18.7	13.9	15.0
Christian	3	3.4	3.7	2.1	2.3	2.2	2.8	2.8	2.9	1.8	2.2	1.7
other	1.7	2.2	2.0	3.2	4.7	3.5	2.2	2.7	2.5	2.9	4.5	2.6
p value		<0.001			<0.001			<0.001			<0.001	
Region												
Urban	13.3	19.8	17.9	28.3	37.1	31.3	16.7	25	24.9	31.7	42.1	34.2
Rural	87.7	80.2	82.1	71.7	62.9	68.7	83.3	75	75.1	68.3	57.9	65.8
p value		<0.001			<0.001			<0.001			<0.001	

M<5 mothers of young children; M>5 mothers older children; NC women with no children

- For working women in India, higher percentages of women with no children were found among the younger groups of age (18-24), while for mothers of young children, higher percentages were found in the group of 25 to 34 years old.

- Working women were mainly found in lower education levels, with the majority with no education and poorest quintiles of wealth.

- Higher percentages of working women were also found in rural areas, with a small increase of this percentage in rural areas in the second wave

D.3 Marital status

Given the focus of the DHS on maternal and child health, focus was previously given to married women aged 15 to 49 years old. However, some countries have important rates of women who are cohabiting, and not legally married, who should be considered in the data collection. Also, the DHS intended to expand its population of study, generating important differences between countries and waves that should be discussed.

In Brazil, where all women were included, 13.6% (N= 528) of women who had children under five in 1996 were single and 0.8% were widowed or divorced. Among those living with a partner, 27.2% (N=899) were not considered married. The table below shows significant differences between women who were cohabiting, single and married. Women who were cohabiting tended to be less educated, poorer and not working. On the contrary, married women were better educated, older and in richer quintiles of wealth.

Sociodemographic characteristics of single, cohabiting and married women in Brazil, 1996.

	Not married	**Cohabiting**	**Married**
Education			
Primary or less	44.0	56.4	43.0
Secondary	35.6	31.9	29.9
More than secondary	20.5	11.7	27.1
P value	*<0.001*		
Age			
18-24	46.0	39.0	24.5
25-34	39.2	47.1	56.2
35-49	14.9	13.9	19.3
P value	*<0.001*		
Wealth Tertiles			
Poorest	45.8	64.1	39.7
Middle	35.1	25.1	30.5
Richest	19.1	10.7	29.8
P value	*<0.001*		
% Working	51.3	32.8	39.9
P value	*<0.001*		

In 2006, among mothers of young children, 13.8% (N=571) were considered single, while for those with a partner, 54.8% (1,951) were cohabiting. The same differences were observed between women who were single, cohabiting and married. Married women were better educated, older and in richest wealth tertiles.

Appendix E

Sociodemographic characteristics of single, cohabiting and married women in Brazil, 2006.

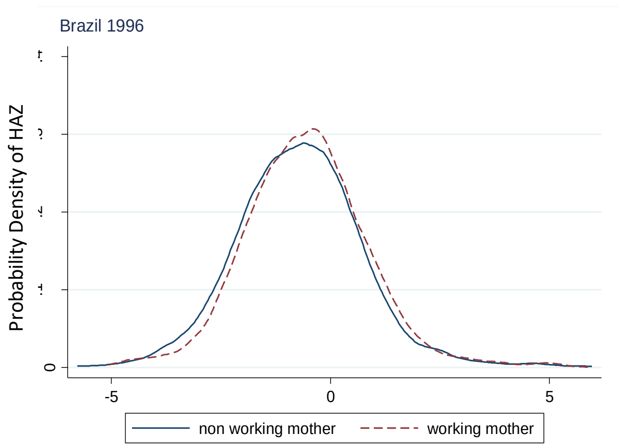
	Not married	**Cohabiting**	**Married**
Education			
Primary or less	18.7	24.0	15.3
Secondary	38.3	39.8	26.7
More than secondary	43.0	36.2	58.0
P value	*<0.001*		
Age			
18-24	51.9	46.2	27.0
25-34	33.1	39.6	54.8
35-49	15.0	14.1	18.1
P value	*<0.001*		
Wealth Tertiles			
Poorest	39.3	40.7	31.6
Middle	37/9	34.6	35.0
Richest	22.8	24.7	33.4
P value	*0.014*		
% Working	46.2	39.2	46.1
P value	*0.051*		

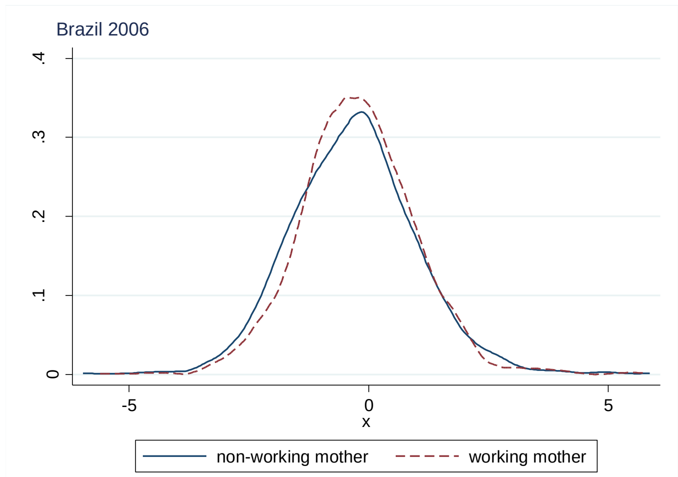
Due to these significant differences, marital status was included in the analyses in Brazil as an independent variable. In India, women who had young children were mainly married women. The percentage of widowed/divorced women with children was very small (0.1% in 1998-99 and 1.06% in 2005-06), and therefore, this was not included in the analyses.

Appendix E Distribution of anthropometric indicators according to maternal work

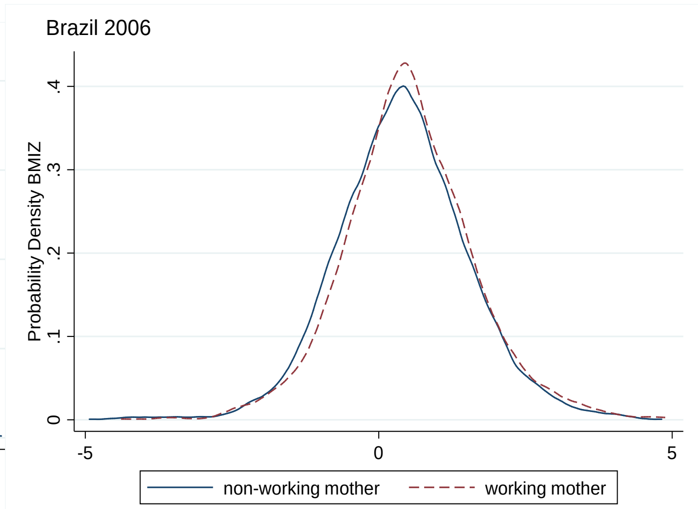
This appendix provides the distribution of HAZ and BMIZ according to maternal work in Brazil, and the distribution of HAZ according to maternal work in India.

Histograms of HAZ according to maternal work for Brazil 1996 and 2006



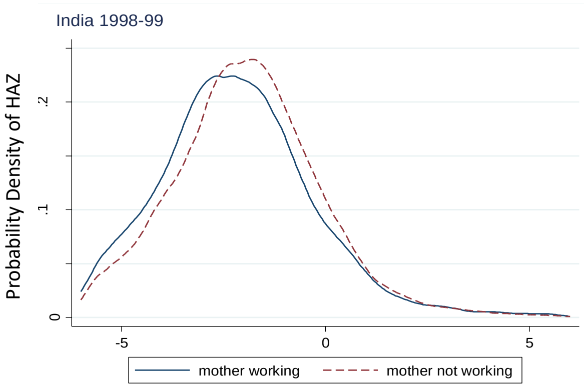


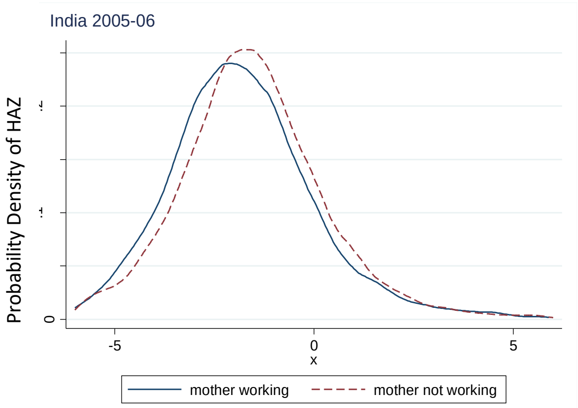
Histograms of BMIZ according to maternal work for Brazil 1996 and 2006



Appendix E

Histograms of HAZ according to maternal work for India 1998-99 and 2005-06





Appendix F The effects of type of maternal work on child nutrition-

This appendix presents the full models for the analyses of the effects of characteristics of maternal work on child nutritional status in chapter 7.

F.1 Results for Brazil

Coefficients from multilevel linear regression on **type of work** and child HAZ in **Brazil (1996/2006)**. Ref. category: not working

	Brazil 1996				Brazil 2006			
	Model 1	Model 2	Model 3	Full Model	Model 1	Model 2	Model 3	Full model
Intercept	-0.49	-1.02	-1.09	-0.87	-0.29	-0.15	-0.22	-0.11
Type of work								
self/away	-0.05	0.10	0.09	0.12	-0.12*	-0.10	-0.11	-0.11
self/home	0.18*	0.25**	0.16’	0.12	0.14*	0.11	0.08	0.08
employed	0.23***	0.21**	0.12	0.12	0.23***	0.22**	0.13’	0.11
Child's age								
1		-0.68***	-0.68***	-0.68***		-0.54***	-0.53***	-0.53***
2		-0.69***	-0.69***	-0.70***		-0.86***	-0.86***	-0.84***
3		-0.68***	-0.69***	-0.67***		-0.84***	-0.85***	-0.82***
4		-0.78***	-0.81***	-0.79***		-0.77***	-0.79***	-0.76***
Female		0.19***	0.18**	0.18**		0.09’	0.09	0.09
Order of birth		-0.09***	-0.08***	-0.05*		-0.05***	-0.04**	-0.03
Birth size								
Average		0.42***	0.38***	0.40***				
Larger		0.64***	0.61***	0.62***				
Not vaccinated		-0.17*	-0.19*	-0.20***				
Health insurance		0.12	0.06	0.05		0.15*	0.03	0.007
Birth interval		0.13***	0.11***	0.09***		0.11***	0.09***	0.08***
Age mother								
25-34			0.02	-0.02			0.10	0.07
35-49			0.23*	0.17			0.18’	0.13
Ethnicity								
Mixed			-0.03	-0.01			-0.17**	-0.15**
Black			-0.08	-0.09			-0.07	-0.06
BMI								
Normal			0.06	-0.03			-0.09	-0.18
Overweight			0.05	-0.02			0.10	-0.01
Non-Christian			-0.02	-0.04			0.02	-0.02
Education								
Secondary			0.22**	0.14			0.28***	0.25***
More than secondary			0.44***	0.24*			0.36***	0.30***
Marital status								
Cohabiting			-0.002	-0.05			-0.04	-0.05
Married			0.05	-0.02			-0.002	-0.03

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HH members				-0.05**				-0.01
Wealth								
Middle				0.25**				0.17**
Richest				0.44***				0.27***
Father's education								
Secondary				0.03				-0.06
higher				0.10				-0.01
State variance	0.09	0.04	0.04	0.01	0.05	0.03	0.02	0.02
Mother's variance	0.63	0.48	0.46	0.47	0.36	0.29	0.26	0.25
Child variance	1.32	1.29	1.29	1.25	1.17	1.08	1.07	1.07
Likelihood	-6640	-4381	-4254	-3924	-6677	-4026	-3975	-3784

Coefficients from multilevel linear regression on **occupation** and child height-for-age in **Brazil (1996).** Ref. category: not working

	Brazil 1996			
	Model 1	Model 2	Model 3	Full model
Intercept	-0.51	-1.07	-0.99	-0.85
Occupation				
Agriculture	-0.48***	-0.11	-0.13	-0.04
Services/LE	-0.14’	0.06	-0.08	0.10
Serivces/HE	0.34***	0.25**	0.25**	0.16’
Professionals	0.49***	0.44***	0.41***	0.29**
Child's age				
1		-0.68***	-0.70***	-0.69***
2		-0.67***	-0.70***	-0.70***
3		-0.66***	-0.57***	-0.67***
4		-0.78***	-0.70***	-0.80***
Female		0.20***	0.81***	0.19***
Order of birth		-0.07***	-0.09***	-0.04*
Birth size				
Average		0.41***	0.41***	0.41***
Larger		0.63***	0.62***	0.63***
Not vaccinated		-0.17*	-0.17*	-0.19*
Health Insurance		0.12	0.1	0.08
Birth interval		0.12***	0.1***	0.09***
Age mother				
25-34			0.05	-0.01
35-49			0.26*	0.18
Ethnicity				
Mixed			-0.05	0.005
Black			-0.09	-0.08
BMI				
Normal			0.03	-0.05
Overweight			0.01	-0.05
Non-Christian			-0.02	-0.05
Marital status				
Cohabiting			0.003	-0.04
Married			0.08	-0.03
HH members				-0.05**
Wealth				
Middle				0.27***
Richest				0.46***
Education father				
Secondary				0.06
higher				0.18’
State variance	0.09	0.04	0.04	0.01
Mother's variance	0.59	0.48	0.47	0.48
Child variance	1.32	1.29	1.29	1.25
Likelihood	-6652	-4402	-4290	-3953

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
‘ <0.10; *<0.05; **<0.01; ***<0.001

Appendix F

Coefficients from multilevel linear regression for **the combination of education and work** and child height-for-age in **Brazil (1996/2006)**. Ref. category: not working/low education

	Brazil 1996				Brazil 2006			
	Model 1	Model 2	Model 3	Full Model	Model 1	Model 2	Model 3	Full model
Intercept	-0.78	-1.18	-1.10	-0.88	-0.60	-0.44	-0.23	-0.12
Interaction W/E								
W/LE	-0.02	0.04	0.04	0.06	0.01	0.002	0.003	-0.02
NW/HE	0.51***	0.21**	0.20**	0.10	0.45***	0.32***	0.32***	0.26***
W/HE	0.71***	0.49***	0.47***	0.31**	0.46***	0.35***	0.32***	0.27***
Child's age								
1		-0.67***	-0.68	-0.68***		-0.55***	-0.55***	-0.54***
2		-0.66***	-0.69	-0.69***		-0.85***	-0.87***	-0.84***
3		-0.66***	-0.70	-0.67***		-0.84***	-0.86***	-0.84***
4		-0.77***	-0.82	-0.79***		-0.76***	-0.80***	-0.77***
Female		0.20***	0.19***	0.19**		0.09*	0.09*	0.10*
Order of birth		-0.06***	-0.08***	-0.05*		-0.03*	-0.05**	-0.3’
Birthweight						-	-	-
Average		0.40***	0.40***	0.41***				
Larger		0.63***	0.61***	0.63***				
Not vaccinated		-0.17*	-0.18*	-0.20*		-		
Health insurance		0.11	0.09	0.08		0.12’	0.07	0.03
Birth interval		0.12***	0.11***	0.09***		0.11***	0.09***	0.08***
Age mother								
25-34			0.05	-0.01			0.11’	0.07
35-49			0.27*	0.18			0.21*	0.15
Ethnicity								
Mixed			-0.05	-0.01			-0.17**	-0.14*
Black			-0.11	-0.09			-0.07	-0.0
BMI								
Normal			0.05	-0.04			-0.07	-0.17
Overweight			0.05	-0.04			0.11	0.001
Marital status								
Cohabiting			0.001	-0.04			-0.04	-0.05
Married			0.06	-0.04			-0.01	-0.03
Non-Christian			-0.004	-0.04			0.02	-0.001
HH members				-0.05**				-0.01
Wealth								
Middle				0.25**				0.18**
Richest				0.44***				0.28***
Education father								
Secondary				0.04				-0.06
higher				0.15				0.01
State variance	0.07	0.04	0.04	0.01	0.04	0.03	0.02	0.02
Mother's variance	0.57	0.48	0.47	0.48	0.32	0.28	0.27	0.26
Child variance	1.31	1.28	1.29	1.25	1.18	1.08	1.07	1.06
Likelihood	-6619	-4397	-4286	-3952	-6652	-4019	-3985	-3792

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
‘ <0.10; *<0.05; **<0.01; ***<0.001

F.2 Results for India

Odds ratio of stunting according to **self-employment/employment** from multilevel logistic regression in **rural India 1998-99/2005-06**. Ref. category: not working

	India 1998-99				India 2005-06			
	Model 1	Model 2	Model 3	Full Model	Model 1	Model 2	Model 3	Full Model
Work for who								
work for family	1.25***	1.03	0.97	0.92	1.38***	1.21**	1.13’	1.07
work for others	1.52***	1.26**	1.16’	1.00	1.58***	1.34***	1.26**	1.17’
self employed	1.09	1.06	1.06	1.01	1.28*	1.14	1.12	1.05
Child's age								
1		5.20***	5.26***	5.09***		4.79***	4.74***	4.51***
2		8.19***	8.38***	8.19***		5.31***	5.43***	5.32***
Female		1.14**	1.15**	1.17**		0.88**	0.88**	0.90’
Birth order		1.07***	1.05***	1.03		1.12***	1.12***	1.07**
Birth size								
average		0.75***	0.79***	0.78***		0.66***	0.69***	0.70***
large		0.53***	0.57***	0.57***		0.55***	0.59***	0.57***
Had disease		1.08	1.06	1.06		0.94	0.93	0.94
Health card		0.88*	0.93	0.99		0.95	1.04	1.11’
Not vaccinated		1.32***	1.22**	1.15*		1.34***	1.19**	1.11
Birth interval		0.93***	0.93***	0.93***				0.89**
Age mother								
25-34			0.96	0.98			0.81***	0.98
35-49			0.88	0.93			0.75**	1.01
BMI								
normal			0.91’	0.95			0.72***	0.74***
overweight			0.57**	0.67*			0.60***	0.75*
Decision alone								
medium			0.99	0.99			0.99	0.99
higher			0.92	0.92			0.77*	0.76*
Decision joint								
medium			0.99	1.00			0.95	0.94
higher			0.92	0.95			0.99	0.97
Education								
Secondary			0.55***	0.72***			0.59***	0.84*
More than secondary			0.33***	0.54***			0.35***	0.66**
Religion								
Muslim			1.03	1.17’			0.96	0.99
other			0.68**	0.65***			1.10	0.98
HH members				1.01				0.99
Scheduled caste				1.27***				1.21**
Father's education								
Secondary				0.88’				0.79***
More than secondary				0.83*				0.69***
Wealth quintiles								
Q2				0.86*				0.89
Q3				0.87’				0.70***
Q4				0.64***				0.57***
Q5 (richest)				0.45***				0.45***
State variance	0.24	0.38	0.25	0.26	0.12	0.15	0.10	0.09
Mother's variance	0.49	1.57	1.56	1.48	0.72	1.44	1.39	1.23
Likelihood	-11302	-7711	-7591	-7436	-9907	-9286	-9122	-6473

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
’ <0.10; *<0.05; **<0.01; ***<0.001

Appendix F

Odds ratio of stunting according to **regular/seasonal employment** from multilevel logistic regression in **rural India 1998-99/2005-06**. Ref. category: not working

	India 1998-99				India 2005-06			
	Model 1	Model 2	Model 3	Full Model	Model 1	Model 2	Model 3	Full Model
Seasonal/regular								
Regular	1.36***	1.15*	1.10	1.01	1.34***	1.13'	1.08	1.04
Occasional	1.28***	1.06	0.97	0.88	1.54***	1.35***	1.26**	1.17*
Child's age								
1		5.19***	5.24***	5.08***		4.61***	4.55***	4.76***
2		8.15***	8.34***	8.17***		5.40***	5.44***	5.35***
Sex								
Female		1.14**	1.15**	1.17**		0.91'	0.91'	0.87**
Birth order		1.07***	1.05**	1.03		1.12***	1.10***	1.09***
Birth size								
average		0.75***	0.78***	0.78***		0.66***	0.69***	0.71***
large		0.54***	0.58***	0.57***		0.53***	0.54***	0.60***
Had disease		1.09	1.07	1.06		0.94	0.93	0.94
Healthcard		0.88*	0.93	0.99		0.99	1.10	1.09
Not vaccinated		1.32***	1.21**	1.15*		1.26***	1.16*	1.13*
Birth interval		0.93***	0.93***	0.93***		0.89***	0.89***	0.88***
Age mother								
25-34			0.96	0.98			0.95	0.95
35-49			0.87	0.67*			0.95	0.95
BMI								
normal			0.91	0.95			0.72***	0.75***
overweight			0.57***	0.67*			0.63***	0.74*
Decision alone								
medium			1.00	0.99			1.00	1.00
higher			0.92	0.92			0.77*	0.76*
Decision joint								
medium			0.99	1.02			0.95	0.94
higher			0.94	0.95			1.00	0.98
Education								
Secondary			0.55***	0.71***			0.64***	0.81**
More than secondary			0.33***	0.54***			0.41***	0.65**
Religion								
Muslim			1.02	1.17'			0.93	1.03
other			0.68**	0.65***			1.03	1.04
HH members				1.01				1.00
Scheduled caste				1.28***				1.22**
Father's education								
Secondary				0.88'				0.83**
More than secondary				0.83*				0.70***
Wealth								
Q2				0.86*				0.92
Q3				0.86'				0.71***
Q4				0.63***				0.59***
Q5				0.45***				0.37***
State variance	0.24	0.38	0.24	0.26	0.12	0.13	0.09	0.08
Mother's variance	0.49	1.54	1.54	1.47	0.72	1.32	1.34	1.24
Likelihood	-11308	-7712	-7591	-7433	-9907	-6686	-6599	-6471

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
' <0.10; *<0.05; **<0.01; ***<0.001

Odds ratio of stunting according to **agriculture/non-agriculture work** from multilevel logistic regression in **rural India 1998-99/2005-06**. Ref. category: not working

	India 1998-99				India 2005-06			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Agriculture/not								
Agriculture	1.42***	1.16*	1.05	0.96	1.54***	1.29***	1.19**	1.12’
Other	1.11	1.00	1.04	0.98	1.17*	1.04	1.06	1.04
Child's age								
1		5.19***	5.25***	5.09***		4.60***	4.54***	4.53***
2		8.16***	8.35***	8.17***		5.37***	5.41***	5.31***
Female		1.14**	1.15**	1.17**		0.91’	0.91’	0.91’
Birth order		1.07***	1.05***	1.03		1.12***	1.10***	1.07**
Birth size								
average		0.76***	0.79***	0.79***		0.66***	0.68***	0.69***
large		0.54***	0.58***	0.57***		0.53***	0.55***	0.57***
Had disease		1.08	1.07	1.07		0.94	0.93	0.94
Healthcard		0.88*	0.95	0.99		0.99	1.05	1.11
Not vaccinated		1.32***	1.21**	1.15*		1.26***	1.16*	1.13’
Birth interval		0.93***	0.93***	0.93***		0.89***	0.89***	0.89***
Age mother								
25-34			0.96	0.98			0.95	0.98
35-49			0.87	0.93			0.95	1.01
BMI								
normal			0.91	0.95			0.71***	0.74***
overweight			0.57**	0.68*			0.64**	0.7’
Decision alone								
medium			1.01	0.99			0.99	0.99
higher			0.92	0.92			0.78*	0.77*
Decision joint								
medium			1.00	1.00			0.96	0.95
higher			0.94	0.92			1.00	0.98
Education								
Secondary			0.55***	0.72***			0.64***	0.84*
More than secondary			0.34***	0.54***			0.42***	0.67**
Religion								
Muslim			1.03	1.17’			0.93	0.99
other			0.34***	0.64***			1.02	0.98
HH members				1.01				0.99
Scheduled caste				1.28***				1.20**
Father's education								
Secondary				0.88’				0.78***
More than secondary				0.83*				0.68***
Wealth								
Q2				0.86*				0.88
Q3				0.86’				0.70***
Q4				0.63***				0.59***
Q5 (richest)				0.45***				0.45***
State variance	0.24	0.38	0.25	0.26	0.12	0.12	0.09	0.08
Mother's variance	0.50	1.56	1.55	1.48	0.71	1.31	1.33	1.24
Likelihood	-11289	-7703	-7583	-7426	-9883	-6679	-6593	-6465

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
‘ <0.10; *<0.05; **<0.01; ***<0.001

Appendix F

Odds ratio of stunting according to **self-employment/employment** from multilevel logistic regression in **urban India 1998-99/2005-06**. Ref. category: not working

	India 1998-99				India 2005-06			
	Model 1	Model 2	Model 3	Full Model	Model 1	Model 2	Model 3	Full Model
Employed/not								
Self employed	0.91	0.76	0.75	0.76	1.12	0.99	1.12	1.14
Employed (LE)	2.08***	1.47*	1.29	0.95	2.07***	1.40*	1.32*	0.93
Employed (HE)	0.77’	0.54**	0.63*	0.71	0.77*	0.79’	0.92	1.04
Child's age								
1		4.55***	4.65***	4.69***		4.99***	4.94***	5.31***
2		5.73***	6.12***	6.04***		4.94***	5.16***	5.18***
Female		1.09	1.08	1.10		0.78***	0.78***	0.75***
Birth order		1.13***	1.17***	1.08’		1.16***	1.27***	1.15***
Birth size								
average		0.44***	0.47***	0.51***		0.49***	0.53***	0.57***
large		0.34***	0.38***	0.39***		0.44***	0.49***	0.50***
Had disease		0.94	0.85	0.85		0.96	0.93	0.93
Healthcard		0.68**	0.72**	0.84		0.73**	0.79**	0.89
Not vaccinated		1.24***	1.15	1.01		1.59***	1.37***	1.20*
Birth interval		0.85***	0.89**	0.88***				
Age mother								
25-34			0.76*	0.90**			0.63***	0.80**
35-49			0.64*	0.83*			0.39***	0.52***
BMI								
normal			0.59***	0.66***			0.78**	0.87’
overweight			0.35***	0.50***			0.49***	0.66***
Decision alone								
medium			0.92	0.94			0.99	0.98
higher			0.86	0.89			1.00	1.03
Decision joint								
medium			1.14	1.17			0.98	0.99
higher			0.98	1.02			0.97	0.95
Religion								
Muslim			1.03	1.11			1.04	0.99
other			0.62**	0.58**			0.85	0.77*
HH members				1.02				0.99
Scheduled caste				1.31*				1.28**
Father's education								
Secondary				0.91				0.83*
More than secondary				0.72*				0.49***
Wealth								
Q2				0.71**				0.77*
Q3				0.41***				0.50***
State variance	0.14	0.10	0.07	0.09	0.10	0.12	0.10	0.12
Mother's variance	0.63	1.69	1.67	1.60	1.22	1.84	1.78	1.65
Likelihood	-4275	2611	-2560	-2483	-5530	-5192	-5093	-4659

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
’ <0.10; *<0.05; **<0.01; ***<0.001

Odds ratio of stunting according to **occupation** from multilevel logistic regression in **urban India 1998-99/2005-06**. Ref. category: not working

	India 1998-99				India 2005-06			
	Model 1	Model 2	Model 3	Full Model	Model 1	Model 2	Model 3	Full Model
Occupation								
Services	1.92***	1.35	1.10	1.02	1.77***	1.35*	1.34*	1.17
Skilled	1.31’	1.02	0.84	0.74	1.64**	1.29	1.28	1.17
Professional	0.42***	0.31***	0.55*	0.54	0.38***	0.52**	0.66’	0.87
Child's age								
1		4.80***	4.89***	4.85***		4.90***	4.85***	5.23***
2		6.03***	6.25***	6.19***		4.77***	4.98***	5.03***
Female		1.09	1.11	1.11		0.78***	0.78***	0.76***
Birth order		1.13***	1.09*	1.08*		1.17***	1.28***	1.15***
Birth size								
average		0.45***	0.48***	0.52***		0.49***	0.53***	0.56***
large		0.33***	0.37***	0.37***		0.45***	0.49***	0.51***
Had disease		0.92	0.86	0.85		0.92	0.89	0.90
Health card		0.67**	0.74*	0.81’		0.74**	0.78**	0.89
Not vaccinated		1.28*	1.09	1.02		1.50***	1.35***	1.19*
Birth interval		0.85***	0.88***	0.89**		0.85***	0.89***	0.89*
Age mother								
25-34			0.83	0.87			0.64***	0.80**
35-49			0.74	0.77			0.42***	0.54**
BMI								
normal			0.63***	0.64***			0.81**	0.90
overweight			0.42***	0.49***			0.52***	0.68**
Decision alone								
medium			0.92	0.94			0.99	1.02
higher			0.83	0.87			0.99	1.15
Decision joint								
medium			1.18	1.16			0.99	1.02
higher			0.99	1.00			0.99	1.00
Religion								
Muslim			1.06	1.17			1.03	0.97
other			0.73*	0.62**			0.89	0.81’
HH members				1.01				0.99
Scheduled caste				1.36***				125*
Father's education								
Secondary				0.89				0.86’
More than secondary				0.68**				0.51***
Wealth								
Q2				0.72**				0.80*
Q3				0.42***				0.53***
State variance	0.13	0.09	0.08	0.09	0.10	0.08	0.07	0.07
Mother's variance	0.63	1.85	1.86	1.76	1.20	1.14	1.19	1.03
Likelihood	-4153	-2529	2464	2409	-5391	-3194	-3148	-2949

Model 1: Univariate
Model 2: Model 1 + child characteristics
Model 3: Model 2 + Maternal characteristics
Full model: Model 2 + Household characteristics
’ <0.10; *<0.05; **<0.01; ***<0.001

F.3 Results for India according to family structure

This appendix shows the effects of the characteristics of maternal work on child stunting in India by family structure

Results from multilevel modelling on the effect of types of work on stunting in rural areas of India by family structure

	1998-99				2005-06			
	Nuclear		Joint		Nuclear		Joint	
	Univariate	Full model	Univariate	Full model	Univariate	Full model	Univariate	Full model
Emp family	**1.18***	0.90	**1.27****	0.93	**1.27****	1.02	**1.54*****	1.14
Emp others	**1.34*****	1.00	**1.74*****	**1.31***	**1.47*****	1.13	**1.62*****	1.28
Self-employed	1.11	0.98	1.03	0.74	**1.34***	1.18	0.95	0.82
Var state	0.32	0.29	0.21	0.09	0.16	0.10	0.12	0.14
Var mother	0.59	1.05	0.31	1.1	0.72	1.31	0.85	1.36
Agriculture	**1.30*****	0.95	**1.46*****	1.02	**1.49*****	**1.13’**	**1.60*****	1.14
Non agriculture	1.09	1.00	1.16	0.99	1.08	0.99	1.13	1.15
Var state	0.32	0.30	0.21	0.09	0.15	0.09	0.12	0.15
Var mother	0.59	1.07	0.31	1.1	0.74	1.32	0.84	1.48
Regular	**1.25*****	0.98	**1.43*****	1.04	**1.23****	0.98	**1.49*****	1.16
Seasonal	**1.21***	0.91	**1.32****	0.99	**1.54*****	**1.24***	**1.46*****	1.09
Var state	0.32	0.29	0.21	0.09	0.15	0.09	0.13	0.14
Var mother	0.57	1.03	0.31	1.08	0.74	1.32	0.86	1.36

‘ <0.10; * <0.05; **<0.01; ***<0.001
Model 1 - univariate model
Full model – Univariate model + child, maternal and household characteristics

Results from multilevel modelling on the effect of types of work on stunting in rural areas of India by family structure

	1998-99				2005-06			
	Nuclear		Joint		Nuclear		Joint	
	Univariate	Full model	Univariate	Full model	Univariate	Full model	Univariate	Full model
Self-employed	1.00	0.92	0.70	0.79	1.24	0.94	0.92	0.97
Employed (LE)	**1.67*****	0.81	**2.38****	1.06	**1.66****	0.88	**2.97*****	1.46
Employed (HE)	**0.74’**	1.05	0.93	1.51	0.79	1.02	0.76	0.97
Var state	0.15	0.11	0.11	0.11	0.14	0.11	0.11	0.11
Var mother	0.15	0.33	1.38	2.09	1.02	1.37	1.51	1.79
Services	**1.67****	1.01	**1.82’**	1.34	**1.71*****	1.25	1.45	1.29
Skilled	1.26	0.92	1.33	1.06	**1.44***	1.08	**1.89***	1.27
Professionals	**0.43*****	0.78	**0.55***	1.24	**0.32*****	**0.56***	**0.48****	0.83
Var state	0.13	0.09	0.10	0.10	0.12	0.11	0.10	0.15
Var mother	0.14	0.32	1.49	2.31	0.99	1.48	1.57	2.09

‘ <0.10; * <0.05; **<0.01; ***<0.001
Model 1 - univariate model
Full model – Univariate + child, maternal and household characteristics

The analyses by family structure intended to extend the understanding of the trade-off caused by maternal work in the presence of potential caregivers in joint families. No conclusive differences could be observed among nuclear or joint families, but the odds ratios were slightly higher for joint families when the type of employment was related to a lower socioeconomic status. For instance, in disagreement with the hypothesis suggesting that the effect of being employed by others would be more detrimental for nuclear families, the results showed a higher effect size for joint families, which remained significant after controlling for covariates in 1998-99. This might be indicating that joint families in poorer conditions are in disadvantage when comparing with nuclear families, having more difficulties for providing for all members of the family. Another explanation found in the literature is about the status of women as daughter-in-law in a patriarchal family, claiming that those receive less investment in health during pregnancy, they are engaged in more hours of work including onerous task, and receive less quality-food (Barua *et al.*, 2004; Chorghade *et al.*, 2006). This could affect the child indirectly through maternal health, and directly by applying the same neglect to the child. Further analyses are needed to explore these associations controlling for confounding factors.

Appendix G – Propensity Score Matching

This appendix provides further results obtained from the Propensity Score Matching conducted in Chapter 8.

The tables below show the mean of sociodemographic characteristics among working and non-working mothers before and after matching. After matching, there was important reduction in the percentage of bias, and the t-test, together with the P-value show that sociodemographic characteristics were the same between groups.

Mean of sociodemographic characteristics for working and non-working mothers before and after matching for **South of India 1998-99**.

Variable	Status	Mean working	Mean not-working	% reduction bias	t-test	P value
Maternal age						
18-24	Unmatched	.22	.27		-1.98	0.048
	Matched	.22	.22	95.3	0.08	0.936
25-34	Unmatched	.44	.49		-2.14	0.033
	Matched	.44	.45	77.1	-0.40	0.691
35-49	Unmatched	.34	.24		4.39	0.000
	Matched	.34	.33	89.4	0.35	0.728
Wealth tertile						
1st (poorest)	Unmatched	.17	.09		4.64	0.000
	Matched	.17	.15	66.7	1.08	0.282
2nd	Unmatched	.44	.31		5.04	0.000
	Matched	.44	.46	77.7	-0.86	0.390
3rd (richest)	Unmatched	.39	.59		-7.83	0.000
	Matched	.39	.39	98.9	0.07	0.946
Child's age						
1	Unmatched	.20	.30		-4.25	0.000
	Matched	.20	.20	97.8	-0.08	0.934
2	Unmatched	.38	.34		1.36	0.173
	Matched	.38	.37	68.7	0.34	0.734
Religion						
Hindu	Unmatched	.83	.67		6.55	0.000
	Matched	.83	.85	88.9	-0.72	0.473
Muslim	Unmatched	.05	.21		-7.98	0.000
	Matched	.05	.04	90.5	1.09	0.275
Others	Unmatched	.11	.11		0.16	0.871
	Matched	.11	.11	21	0.10	0.918

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Mean of sociodemographic characteristics for working and non-working mothers before and after matching for **North of India 1998-99**.

Variable	Status	Mean working	Mean not-working	% reduction bias	t-test	P value
Maternal age						
18-24	Unmatched	.27	.32		-4.02	0.000
	Matched	.27	.27	91.1	-0.32	0.750
25-34	Unmatched	.39	.43		-2.42	0.016
	Matched	.39	.39	93.1	0.14	0.885
35-49	Unmatched	.34	.25		6.84	0.000
	Matched	.34	.34	97.3	0.15	0.881
Wealth tertile						
1st (poorest)	Unmatched	.53	.47		4.04	0.000
	Matched	.53	.53	93.9	-0.21	0.832
2nd	Unmatched	.39	.29		6.81	0.000
	Matched	.39	.38	94.8	0.29	0.772
3rd (richest)	Unmatched	.08	.24		-13.47	0.000
	Matched	.08	.08	99.2	-0.13	0.898
Child's age						
1	Unmatched	.27	.30		-2.55	0.011
	Matched	.27	.27	82.3	-0.40	0.691
2	Unmatched	.39	.34		3.10	0.002
	Matched	.39	.39	95.8	0.11	0.913
Religion						
Hindu	Unmatched	.93	.86		7.26	0.000
	Matched	.93	.94	91.9	-0.66	0.512
Muslim	Unmatched	.06	.13		-7.26	0.000
	Matched	.06	.06	91.9	0.66	0.512

Mean of sociodemographic characteristics for working and non-working mothers before and after matching for **South of India 2005-06**.

Variable	Status	Mean working	Mean not-working	% reduction bias	t-test	P value
Maternal age						
18-24	Unmatched	.12	.22		-4.18	0.000
	Matched	.12	.13	91	-0.36	0.722
25-34	Unmatched	.42	.46		-1.32	0.188
	Matched	.42	.43	100	0.00	1.000
35-49	Unmatched	.45	.32		4.92	0.000
	Matched	.45	.44	93.5	0.24	0.813
Wealth tertile						
1st (poorest)	Unmatched	.09	.03		5.30	0.000
	Matched	.08	.07	90.1	0.30	0.765
2nd	Unmatched	.27	.20		2.88	0.004
	Matched	.27	.29	83.1	-0.35	0.728
3rd (richest)	Unmatched	.63	.77		-5.07	0.000
	Matched	.65	.64	95.4	0.16	0.870
Child's age						
1	Unmatched	.17	.28		-4.01	0.000
	Matched	.17	.17	94.3	0.21	0.835
2	Unmatched	.50	.35		5.36	0.000
	Matched	.50	.52	88.4	-0.47	0.638
Religion						
Hindu	Unmatched	.79	.68		4.23	0.000
	Matched	.79	.82	79.2	-0.79	0.428
Muslim	Unmatched	.04	.19		-6.42	0.000
	Matched	.04	.04	95.7	0.39	0.700
Others	Unmatched	.16	.13		1.17	0.241
	Matched	.16	.14	25.8	0.66	0.511

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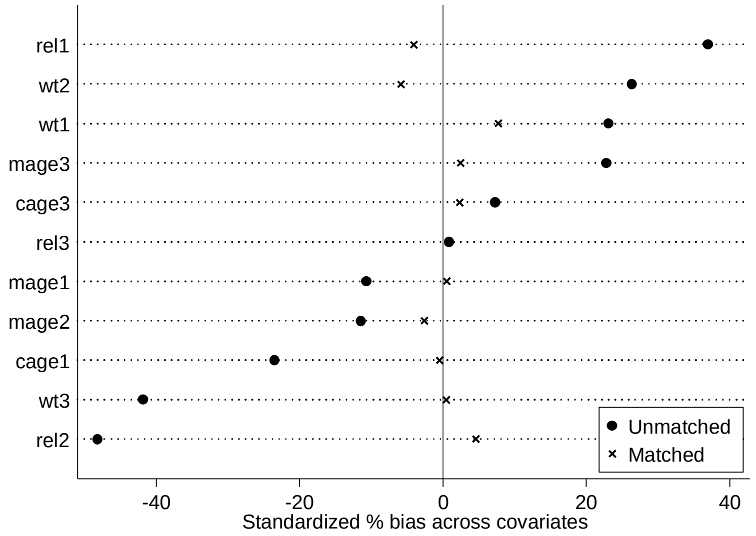
Mean of sociodemographic characteristics for working and non-working mothers before and after matching for the **North of India 2005-06**

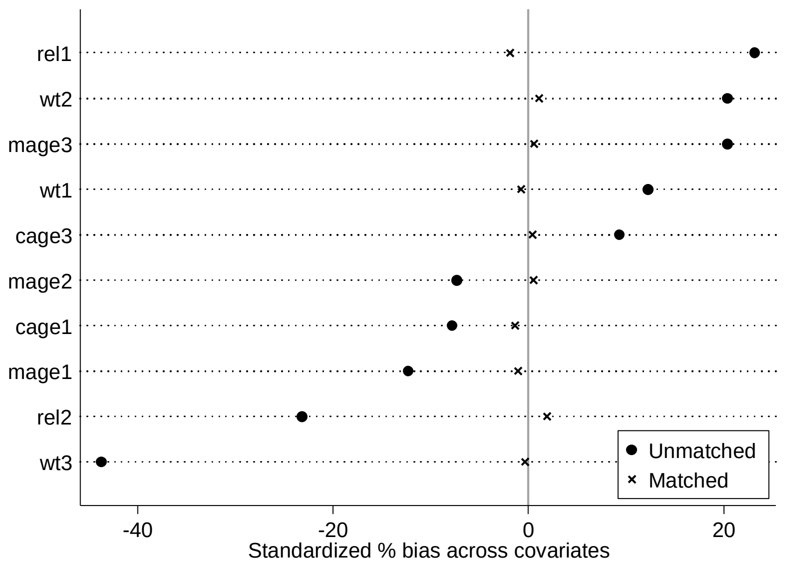
Variable	Status	Mean working	Mean not-working	% reduction bias	t-test	P value
Maternal age						
25-34	Unmatched	.39	.45		-3.54	0.000
	Matched	.39	.40	89	-0.33	0.743
35-49	Unmatched	.36	.22		9.80	0.000
	Matched	.36	.36	94.9	0.38	0.707
Child's age						
1	Unmatched	.37	.35		1.21	0.225
	Matched	.37	.37	87.6	-0.12	0.901
2	Unmatched	.39	.34		3.07	0.002
	Matched	.39	.39	96.7	0.08	0.934
Education						
Primary	Unmatched	.12	.15		-2.73	0.006
	Matched	.12	.12	92.4	-0.18	0.854
Secondary	Unmatched	.14	.27		-9.26	0.000
	Matched	.14	.14	96.9	0.29	0.771
Higher secondary	Unmatched	.05	.11		-5.47	0.000
	Matched	.05	.05	80.5	1.18	0.240
Wealth tertile						
2nd	Unmatched	.22	.25		-2.04	0.042
	Matched	.22	.22	100	-0.00	1.00
3rd (richest)	Unmatched	.13	.31		-12.96	0.000
	Matched	.13	.13	99.1	-0.12	0.905
Religion						
Muslim	Unmatched	.13	.15		-2.30	0.021
	Matched	.13	.12	61.4	0.80	0.423
Area						
rural	Unmatched	.83	.61		13.88	0.000
	Matched	.83	.83	97.3	0.37	0.709
caste	Unmatched	.48	.31		10.77	0.000
	Matched	.48	.49	95.8	-0.36	0.718

The graphs below show the balance of variables before and after matching, where after matching, the percentage of bias should be close to zero.

South of India- 1998-99

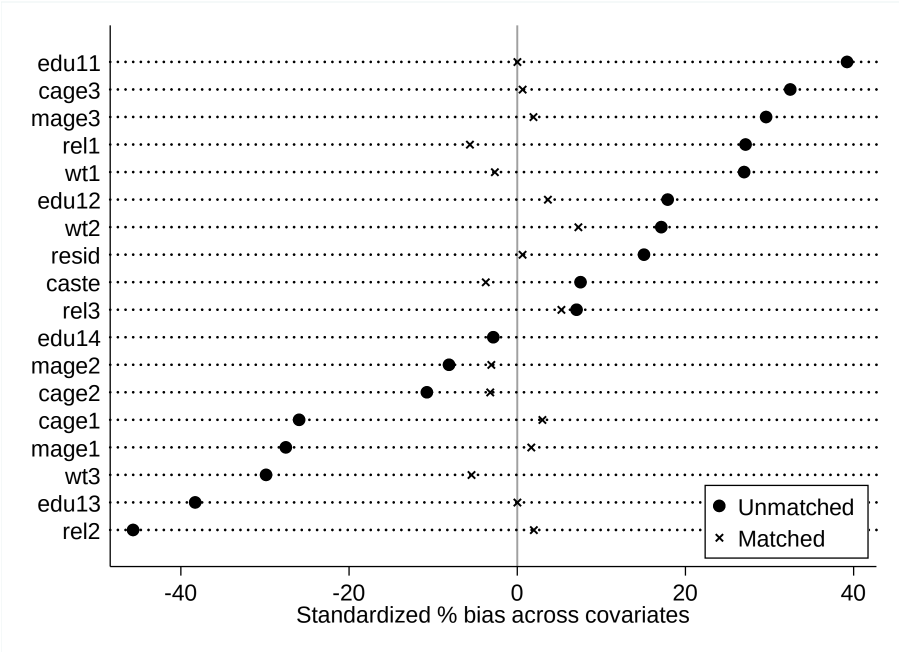


North of India 1998-99

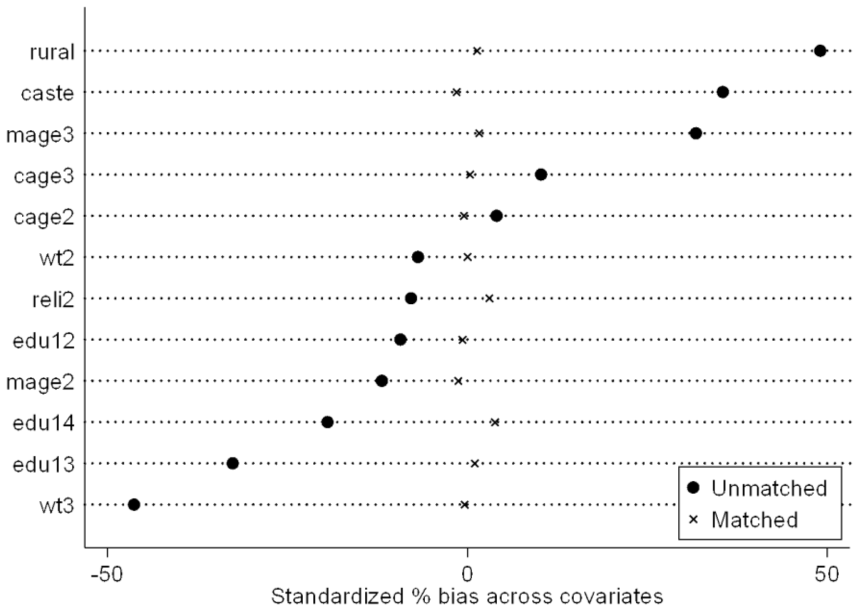


Appendix G

South of India 2005-06



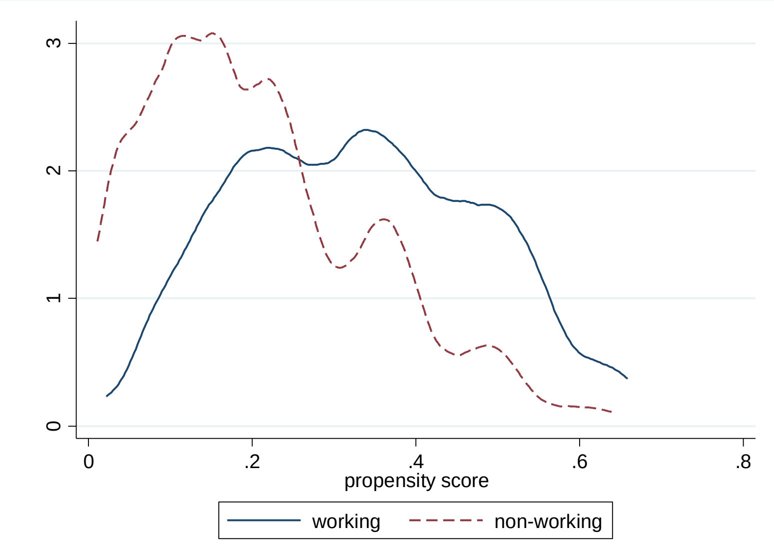
North of India 2005-06



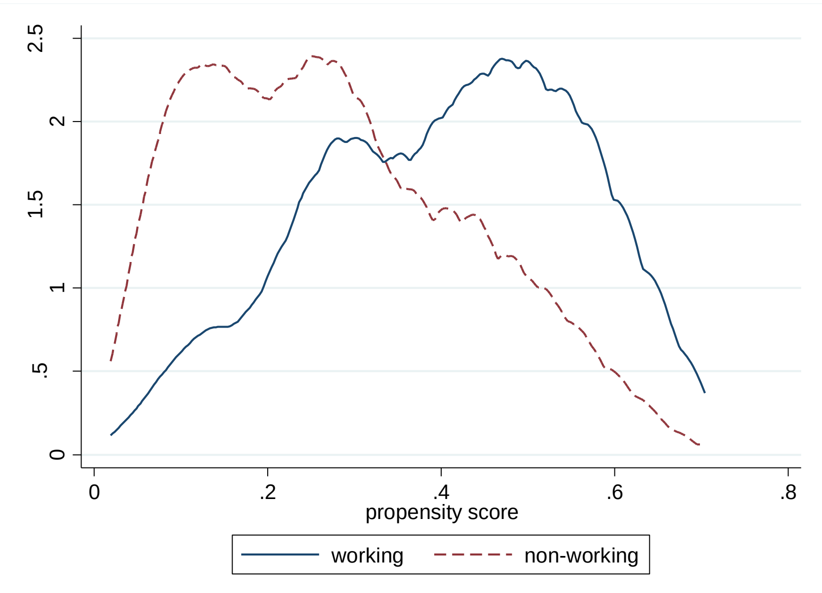
G.1 Common support assumption

The next graphs provide visual analysis of the density distribution of the propensity score for working and non-working mothers, in order to prove that the common support assumption was met in each region and wave of India.

South of India 1998-99

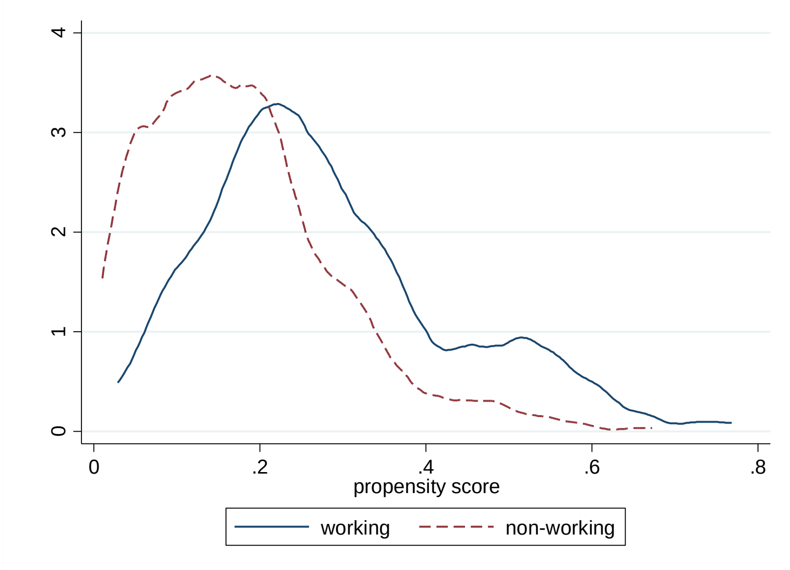


North of India 1998-99

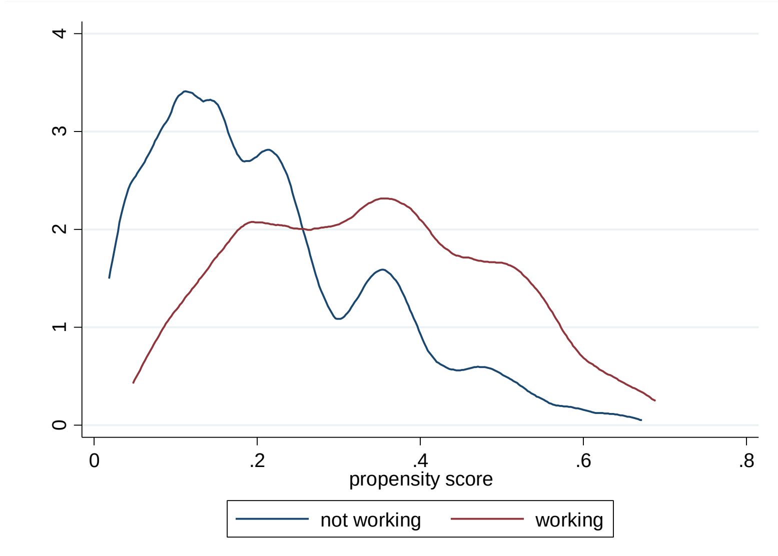


Appendix G

South of India 2005-06



North of India 2005-06



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