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Child undernutrition and women's empowerment in Brazil

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Abstract: Child undernutrition is a worldwide problem with dire consequences that compromises the quality of life and economic growth on different scales (individual, household and community). It affects mainly highly vulnerable populations. Maternal characteristics have proven to be key determinants for child nutritional status. Recently, Brazil has been considered to be a role model in how to fight undernutrition. Nonetheless, the country has a long way to go as it still faces extreme poverty and high levels of gender and income distribution inequality. This paper intended to understand the determining factors leading to child undernutrition of children under the age of 5 years in the Brazilian scenario. This paper used a microeconomic approach by focusing on the correlation between child undernutrition and mothers' socioeconomic status (SES), particularly focusing on mothers' labor status and wealth. The main finding of the investigation was that mothers that are inserted in labor market and earning income have a positive impact on child nutritional status. Their impact is higher than the fathers. Furthermore, the evidence showed that the government must work to provide effective nutrition-sensitive interventions, as well as broader developmental programmes and policies, including socioeconomic opportunities for mother.

Key words: Height-for-age, Weight-for-age, child undernutrition, Brazil, malnutrition, women's empowerment, labor status, income

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1 Introduction

Child undernutrition is a worldwide issue that appears mainly in low and middle-income countries. Moreover, its complications affect the child's life both in short and long term, as it can jeopardize the development of their physical, emotional and cognitive domains (Grantham-McGregor et al., 2007). In 2008, more than one third of children in the developing world were presented with signs of stunting (lower height than expected for the child's age). This is due to the fact that undernourishment is a problem related to poverty, to the lack of resources to guarantee food security (provision of healthy and nutritional food) (Gillespie & Haddad, 2001), among other things. Furthermore, maternal socioeconomic status (SES) have proven to be key determinants to child nutritional status. Thus, an important topic in developing economics is to understand with a holistic view the ways in which maternal characteristics relate to child nutritional status.

In exploiting data on characteristics of Brazilian families (biological and socioeconomic aspects) during the 2000s, this paper used as reference the Mosley and Chen (1984) theoretical framework to understand and point out the possible direct and indirect determinants for undernutrition of children under the age of 5 years. Then, with the use of OLS regression models, it pursued to investigate whether the empowerment of these children's mothers may be viewed as an indirect determinant factor. In this regard, women's empowerment refers to her SES inside and outside the household. Additionally, particular attention was paid to women's empowerment regarding wealth and labor status.

In the last decades, Brazil - a middle-income country - has made important progress in reducing child undernutrition through social protection and health policies, becoming a worldwide reference to fight hunger and extreme poverty (IFPRI, 2016). Even so, the country still has high levels of gender inequality and income inequality that are considered barriers to succeed with the fight against hunger and extreme poverty (OXFAM, 2017). Hence, understanding the importance of preventing child undernutrition by the creation of policies that strength women's empowerment is paramount in winning these fights. Moreover, as the country has been facing an economic recession since mid-2014 (Paula et al., 2017), these measures will also be applicable in helping the country in its reparation from this period.

Although, there are literature over the correlation of maternal characteristics and child undernutrition in a Brazilian context, there remains a lack of knowledge surrounding the empowerment of women (in particular mothers) being inserted in the labor market and their level of income. On the contrary, most of the papers have explored discussions based on human ecology or health areas, surrounding subjects like maternal breastfeeding rights (Kalil et al., 2016) or maternal biological aspects (Miglioli et al., 2015). Besides, the papers that do approach mothers' SES focus on the education of the mother (Montenegro et al., 2014). Probably, because many studies covering different parts of the world have shown that mother's education is a stable predictor of child mortality and nutrition (Smith et al., 2014) and can be used as proxy to mother's wealth - with higher education comes better job opportunities. Nevertheless, it not only education that matters when guaranteeing mothers' employability and wealth, work experience and fair job opportunities (with no gender discrimination and guarantee of maternal protection) are factors to take into consideration as well. Thus, this paper aims to contribute in the discussion by taking a microeconomic perspective and by approaching these other socioeconomic maternal characteristics that are relevant to ensure a healthy child nutritional status that have not previously been explored.

With this background, a cross-sectional study was conducted to assess the nutritional status of children under the age of 5 (up to 60 completed months), using a sample of national level coverage of the Brazilian population acquired from the Consumer Expenditure Survey (POF) data from two periods (2002-2003 and 2008-2009). This household survey was provided by the government agency Brazilian Bureau of Statistics (IBGE) and it is considered to be the most accurate survey on Brazilian household's consumer habits. The dataset contained information on child biological characteristics, including their body measurements (weight and height), which was used to create the dependent variables child's weight-for-age Z score and height-for-age Z score, following the guidelines of the child growth standards of WHO (2006). These variables were able to show whether a child had signs of undernutrition in terms of underweight and stunting. The dataset also contained a mix-set of independent variables related to the mother's socioeconomic status (education level, wealth and insertion in the labor status) and a mix of proximate and distal control variables related to characteristics of the child's parents, household and community.

The findings indicate that mothers' socioeconomic status (SES) are crucial determinants for optimal child development of children under the age of 5. Mothers that are inserted in labor market and earning income from their labor force have a positive impact on child nutritional

status. Their impact appeared to be higher than the impact of fathers also inserted in the labor market and with income. Children from mothers older than 40 years old and with higher educational level are less likely to be undernourished. From the outcomes of the associations with the control variables, children are less likely to be vulnerable to undernutrition if their parents' race/ethnicity is white and if the household they are living in provides basic sanitation service. They are also less vulnerable if the geographical location of their household is in urban area and in one of the three wealthiest Brazilian regions (Central-West, Southeast and South). This is because the household location can be related to easier access to better public services and infrastructure, among other things.

Thus, the implications of these findings are of great significance for policing makers as they give a clear picture of what are the determinants for child undernutrition in the Brazilian scenario. Moreover, they are evidence that gender inequality and income inequality are issues that must be tackling to overcome undernourishment and thus, extreme poverty. The Brazilian government has the duty to assure the elaboration of policies that guarantee child nutritional status. Hence, its efforts must be to encourage and protect women's economic independence and social emancipation inside and outside the household by promoting and enforcing policies to fair jobs opportunities and work conditions. Such actions will have real positive long-term effects on child nutritional status.

2 Aim and Research Questions

Child undernutrition is a widespread problem with dire consequences in low and middle-income countries that compromises the quality of life and the economic growth on different scales (individual, household and community). In 2008, findings showed that one third of children in the developing world presented signs of stunting, which means that the child's growth is lower than expected from her or his stage of human development (Black et al., 2008). Malnourishment can jeopardize the development of physical, emotional and cognitive domains of children, impelling them to have a healthy and productive life in the long-run (Grantham-McGregor et al., 2007).

There is comprehensive knowledge about child undernutrition being the result not only of direct determinants (i.e. dietary intake and health status), but primarily of indirect determinants (i.e. factors related to socioeconomic matters). Bhutta et al. (2013) showed that even when programmes of nutrition interventions managed to work with 90% of the target groups in countries with high levels of undernutrition, they were only capable to reduce 15% of total child mortality among children under the age of 5.

In this context, Brazil is considered a role model in the fight against hunger, and has had positive nutrition outcomes since the 1980s, particularly with a sharp increase of social programs and economic prosperity in the first decade of the new millennium (IFPRI, 2016). Nonetheless, undernutrition is an issue affecting mainly highly vulnerable populations. Thus, it cannot be said that it has been eradicated as the country still faces extreme poverty and high levels of gender inequality in socio-economic opportunities and income distribution inequality (OXFAM, 2017).

With the foregoing key points in mind, this paper will look at the Brazilian scenario in the beginning of the 21st century to tackle the main research questions, which are formulated thus:
What are the underlying determinants for child's undernutrition?

- *Does women's socioeconomic status, particularly in terms of income and labor status, have a positive impact in the fight against child undernutrition?*

By building up a solid body of literature on child undernutrition and its correlation with maternal characteristics, this paper intends to provide evidence that reinforces the need to strengthen public policies that contribute to women's empowerment and consider their potential as human capital to the national economy and providers of resources (food security, care and health provisions) for their children and other members of their households. To sum up, the idea is to establish the potential of women's empowerment to achieve positive nutrition outcomes for children. Further, by emphasizing the importance of strengthening programmes and policies related to better job opportunities and better work environments for women, there will be progress towards their empowerment as they will be to ameliorate child undernutrition and promote sustainable economic growth.

3 Background

As the awareness over the multilevel consequences of child malnutrition has risen, its eradication has become a key topic within the global development agenda. For instance, from the 17 Sustainable Development Goals (SDGs) created in the 2030 Agenda for Sustainable Development, there is one SDG that specifically focuses on the betterment of food security and nutrition (SDG 2 - 'Zero Hunger'). Nevertheless, a closer scrutiny of the other SDGs reveals that twelve of them are also relevant to nutrition (IFPRI, 2016) as can be seen in Figure 1 below.

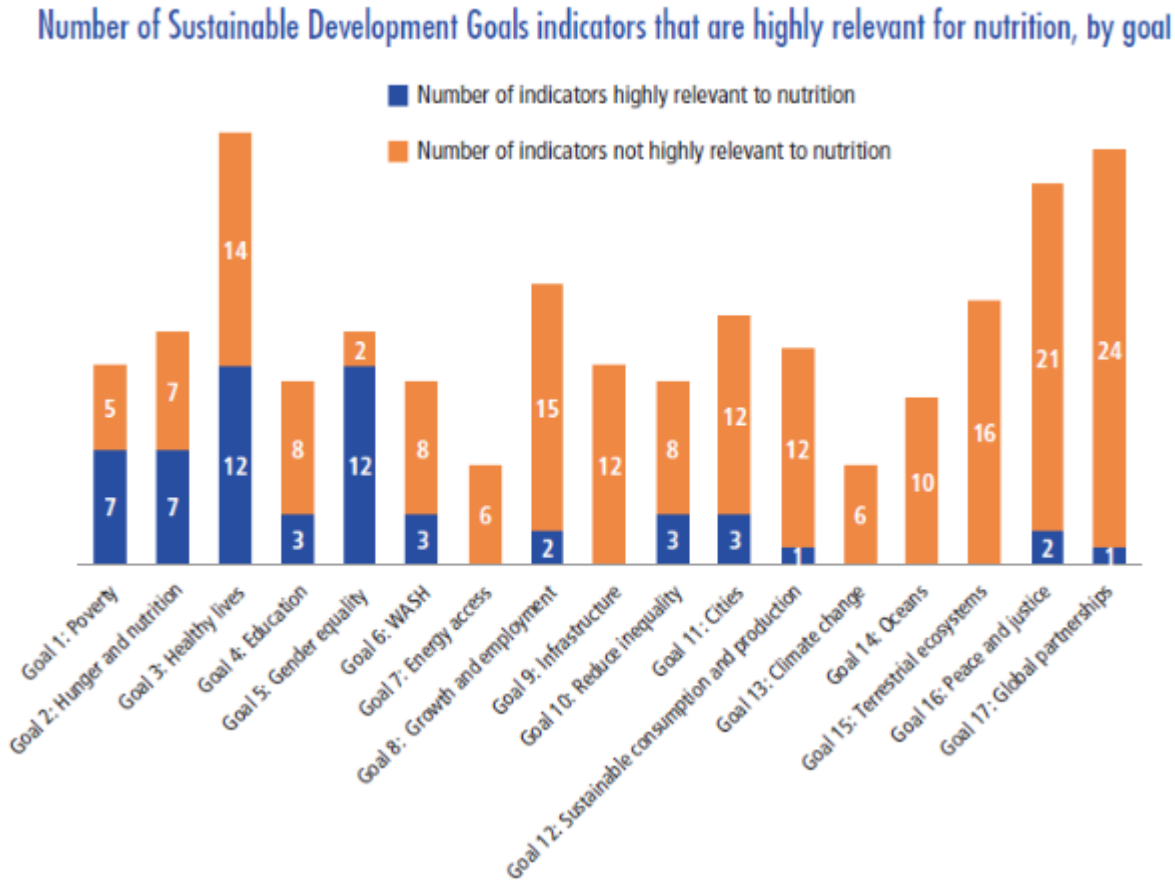

Figure 1 - Number of Sustainable Development Goals indicators that are highly relevant for nutrition, by goal
Data Source: IFPRI, 2016

Brazil, a middle-income country, since the 1980s has managed to lift more than 28 million people out of extreme poverty (OXFAM, 2017). Additionally, during this period, a lot of progress has been made over nutritional outcomes in the whole population, particularly when it comes to the subject of child undernutrition. With the expansion of the concept of health and

social protection inside the Brazilian Constitution of 1988, health became a basic right to all citizens and the government received the obligation to guarantee that this basic right was accessible to all - formulation of public policies and health programmes.

The contraction of unprivileged people with levels of undernutrition decreased faster in the early 2000s. The newly elected party to lead the country have put the fight against hunger as a top priority of their political agenda. It increased the number of key strategies and public policies on food security and nutrition interventions, starting with the most famous strategy, called 'Fome Zero' (Zero Hunger) in 2003. Then, it was created under this strategy, the 'Bolsa Familia', a conditional cash transfer (CCT) program (Paiva et al., 2016). It is a socio-economic program that fights poverty and malnutrition inside Brazilian households by increasing their purchasing power and stimulating the attendance of children in the educational system. The program also has positive implications on women's empowerment, because most of the households that are inside the program have the women as the responsible one to control the funds. Moreover, this gives them more power over the decision-making inside the household. Their autonomy is beneficial not only for them, but to all household members in terms of living conditions, as women tend to use their wealth to matters related to the household, more than men (Smith et al., 2003).

However, it is important to take into consideration that, Brazil is also a country with high levels of income inequality, where 10% of the richest quintile retain more than 50% of the pre-tax national income against the share of around 14% from 50% of the poorest (WID, 2018). In addition, since 2014, the country has been facing an enormous economic recession. Therefore, the government has been implementing fiscal austerity measures and cutting the funds and investments towards socio economic projects - jeopardizing attainment of SDGs for child nutritional status. Furthermore, in times of crisis, normally, the first people to suffer are those belonging in the lowest social classes. According to the World Bank (2017), this crisis has already taken more than 3.6 million people back to extreme poverty.

In addition, much of the literature emphasizes the importance of mothers' economic independence and social emancipation to child nutritional status as socio-economic distal determinants. Even so, Brazil is still far behind in the race to achieve gender equality and all the benefits that come with it as mentioned before. Recently, a report from OXFAM (2017) has presented figures of Brazilian gender inequality, showing that women with the same labor conditions and the same level of education as men will only earn the same amount as them in

2047. Moreover, nowadays women represent 43,55% of the total labor force of the country, and in 37.3% of Brazilian households they are the only responsible for its maintenance (Kalil et al, 2016).

4 Literature Review

Amartya Sen (1999) introduced the concept of development as freedom, in which the individual action is crucial to overcome factors of a deprived life including extreme poverty, hunger and unemployment. Nonetheless, social, political and economic opportunities need to be taken into consideration as they are responsible for regulating the capability of the individual to make these actions. Additionally, when the individual in subject is a woman, the implications of her being able to reach all these opportunities are transmitted to those surrounding her, particularly her children. Moreover, Duflo (2012) reveals a bidirectional relationship between economic development and women's empowerment, as one depends on the other to reach its full potential.

By reaching social emancipation and economic autonomy, women can play a bigger role in matters related to income distribution. Hence, they tend to acquire more control over decision-making and bargaining power inside their family and the community they belong to (Smith et al., 2003; Doss, 2006). Besides, women are more likely than men to use their wealth for subjects that will be beneficial to all family members like those related to food security, health and education (Thomas, 1997; Hazarika & Guha-Khasnobis, 2008).

Furthermore, the literature surrounding women's empowerment being crucial to improve child nutritional status has been surveyed by many authors, most of them aiming at explaining the aspect of the mother's education. Since, with higher school enrollment, women acquire knowledge over the best way to raise their children (healthier food choice and understanding the importance of breastfeeding). Also, they become more qualified to enter the job market and receive higher wages. Finally, they boost their confidence and self-esteem to play the role as decision-maker inside the household. Through the use of a cross-sectional study, Smith and Haddad (2014) show that the probability of a child to be malnourished is lower when the mother has a secondary school education. Collecting information on inequalities of infant mortality in Colombia in the last decades, Palacio (2013) discovered that maternal education is one of the most stable predictors of infant mortality. Chen and Li (2009) found similar results for adopted children from China. Moreover, these authors show that maternal education becomes a stronger factor for child survival in post-natal nurturing.

Smith and Haddad (2014) separated women's education from women's empowerment, with the second being defined as women's power relative to men's. In their work, they revisited data from 1970-2012 for 116 countries and found that women's education has a significant correlation with child undernutrition in the short and long term while women's empowerment is more significant only in the long run. Nevertheless, it is important to emphasize the relevance of women's empowerment for child undernutrition.

Additionally, the concept of freedom created by Sen (1999) not only can be referred to women's empowerment, but also to adequately nourished children. Children's stable nutritional framework allows for a life with more freedom because undernutrition impairs the early childhood development, which is considered to be the most important period in life for a human being to achieve his/her full-capacity physically and mentally (Grantham-McGregor et al., 2007) Also, child undernutrition jeopardizes children's potential to become highly skilled workers with good job opportunities in the future (Gillespie & Haddad, 2001). So, women's empowerment and their capacity to take the lead on economic matters inside the household have an influence on child nutritional status (Bhagowalia et al., 2010).

There is quite a substantial body of evidence worldwide, using empirical studies with different methodological approaches, looking into the association of women's wealth and child's health (infant mortality and nutritional status) done worldwide. Some are cross-country studies, such as the study of Smith et al. (2003), who detected similarities in that association in low and middle-income countries over time, when evaluating three developing regions: South Asia, Sub-Saharan Africa, and Latin America and the Caribbean. While others decided to focus their analyses in one developing country such as Doss (2006) for Ghana, Bhagowalia et al. (2010) for Bangladesh, Balagamwala et al. (2015) for Pakistan and Thomas (1997) for Brazil.

Some researches highlighted that the outcomes of the association of women's empowerment and child undernutrition can vary according to the amount of earning received by women and the geographical location of the households. For instance, while investigating the association in metropolitan cities in India, Rastogi et al. (2014) show that the location of the household (poorer or wealthier neighborhoods) has a stronger effect on the child nutritional status than maternal employment. In addition, even though Ngenzebuke et al. (2017) presents findings proving a positive association between mother's wage and child nutritional status, they show that this association only starts to become positive from a specific level of income, if it is lower

than that, its effect is harmful for the child nutritional status. Also, their findings show that households located in urban areas have a stronger association than those in rural areas.

In the past decades, most studies have supported the statement that mother's income contributes positively and even stronger than fathers' income to child nutritional status in a household (Leslie, 1988; Thomas, 1997; Hazarika & Guha-Khasnobis, 2008). Even so, it is possible to find studies that have presented divergent outcomes. As for example, Glick et al. (1998), who investigated the association in West Africa, also found that mother's wealth has its benefits, but the effect itself on child nutrition was not found.

Nevertheless, it is important to take into consideration gender inequality, because it can put the children's health in jeopardy. As the limitation enforced on women related to their access to education, health, economic and political agenda, in comparison to men, remains a worldwide issue (Ahmed et al., 2010). Balagamwala et al. (2015) show how women in Pakistan suffer with gendered norms deep-seated in the agricultural work sector.

Brazil was considered by the Global Nutrition Report of IFPRI (2016) as one of the few cases in the developing world that has shown a sustained political commitment to achieve adequate nutritional status at a population level with the combined efforts of the government and civil society. A faster boost was seen in the 2000s with social safety-net programs targeting women. However, most recent studies covering the association between maternal characteristics and child nutritional status aimed discussions based on human ecology or health areas. For instance, Kalil et al. (2016) provide insights over maternal breastfeeding rights and Brazilian public policies. Almeida et al. (2014) investigate the socio biological determinants for neonatal death and undernutrition in the State of Sao Paulo. Other studies assessed the correlation between the nutrition status of children under five years old and the maternal biological aspects (Miglioli et al., 2015).

Meanwhile, there are a few studies with a microeconomic approach using evidence from Brazil. By doing a comparison between the wages of men and women and their economic contribution to household matters in the Brazilian urban areas, Thomas (1997) focused on health and wages. His findings reinforced the theory that maternal wage had greater effect on child nutritional status than paternal wage and that women would spend more than men on household matters and on the family members inside the household.

Although, the correlation between childhood undernutrition and maternal characteristics (biological, nutritional and socioeconomic status - SES) have been thoroughly studied in a Brazilian context, very little research has been done exploring women's empowerment in terms of their insertion in the labor market and their income. Normally, when it comes to the subject of mother's SES, the focus is on mother's education, which as mentioned previously is a strong predictor for nutritional status of children. Mother's education is associated with mother's employment, because they acquire higher education to be able to have better job opportunities (Montenegro et al., 2014). Nevertheless, it is important to remember that it is not only higher education that guarantees that the mother will have higher income. In Brazil and worldwide, gender pay gap is mainly an issue produced by lack of opportunities and lack of work protection towards woman (Blackden et al., 2006). So, for this matter, looking separately will enrich the holistic view over how maternal characteristics effect child undernutrition. While focusing in this perspective, this study will bring more awareness over the importance in safeguarding women's employment and income security, not only to the women herself, but to her children and other family members and to the community. Hence, this paper aims to contribute in the discussion regarding the effect of maternal characteristics on child nutritional status in Brazil during the first decade of the years 2000 by having a microeconomic approach, looking at mother's wealth and labor status.

5 Theoretical Framework

The early childhood is considered to be the most important period of development in a human life. From the prenatal stage to eight years of age, the development of physical, emotional and cognitive domains is crucial to guarantee a healthy and productive life for a child's future (Grantham-McGregor et al., 2007).

For this matter, creating a theoretical framework to understand what elements are relevant for a child's survival is an important topic in developing economics. The interests go beyond the academy, because it is a key point for public policies (particularly, in the public health system) and in the economic contribution to proponed human capital in the progress of a country (Balagamwala et al., 2015). During the 80s, Mosley and Chen (1984) proponed analytical models for infant and child survival in developing countries. Still nowadays, their work is relevant as their theoretical approach and framework can be traced in internationally renowned organizations that use them as reference to evaluate health inequalities worldwide, such as the standards created by the Commission of Social Determinants of Health of the World Health Organization (CSDH, 2008). Recent study has shown that 45% of deaths of children under age 5 were related to child malnutrition in low-income and middle-income countries (Black et al, 2013). So, the guidelines created by Mosley and Chen (1984) are useful to understand what factors affect child mortality and child malnutrition (undernutrition and overnutrition). These authors presented an approach that embodies social and biological variables in a model that has a coherent hierarchical structure for research purposes - to understand and to guarantee a healthy early childhood development. This structure made it possible to consider and to frame distinct factors according to their precedence over time and their relevance to the determination of the outcome (Lima et al, 2008). As the authors show that even though the direct determinants, or proximate determinants, to impel malnutrition and mortality are normally a set of biological components (diseases or bad nourishment, for example), there are social and economic determinants behind these components that shape their impact. These components are known as indirect determinants or independent determinants.

For the proximate determinants, Mosley and Chen gather in five broad categories: maternal factors, environmental contamination, nutrient deficiency, injury, and personal illness control.

These categories are used to point out the components that lead to the problem (child malnutrition) and they must be capable of being measured in population-based studies. As for the independent variables, which reflect the socioeconomic status (SES), they gather in three broad categories of levels: individual, household, and community. The individual-level variables relate to the individual productivity (mainly fathers and mothers) and to society's cultural traditions, norms, rules and habits. The household-level variables relate to income and wealth. As for the community-level variables, they relate to the ecological system (geography), political and economic institutions, and health system.

By mapping and creating scales to present the interaction between different types of distant and proximate variables that effect child survival, Mosley and Chen (1984) managed to show the importance in structuring a multidisciplinary approach illustrated in Figure 2. Moreover, they show how intrinsic the relationship between social inequality and child survival is.

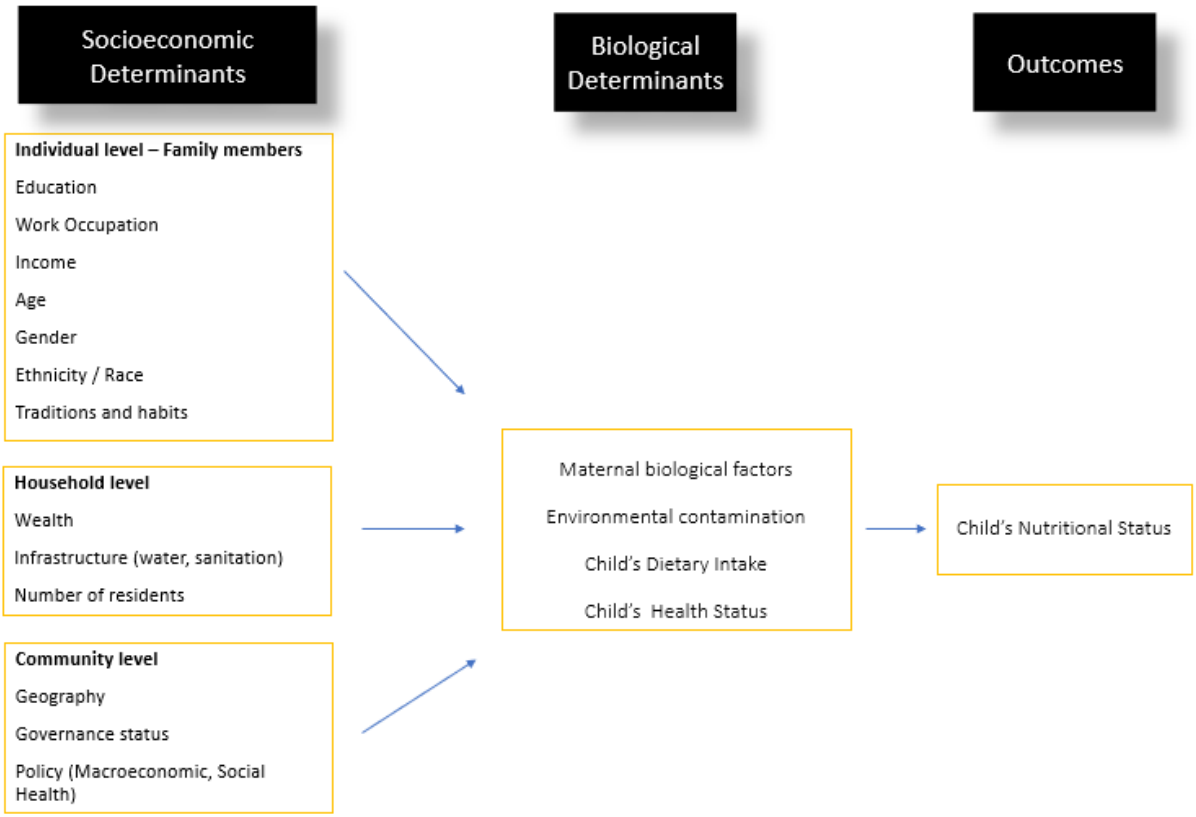

Figure 2: The theoretical framework
Data Source: adapted from the Mosley and Chen (1984) framework by the author

Smith and Haddad (2014) points out how income influences child undernutrition in two main scenarios. The first scenario is that households with higher income are better able to afford nutrition goods like healthy food, healthy living conditions (a household with good

infrastructure; access to water and sanitation) and medical care (doctor appointments, medicine). In addition, their second scenario is that countries with a higher level of national income provide better public services to their population (health, security and educational systems).

So, the theoretical framework of this paper will consider child undernutrition as the dependent variable. Child undernutrition can be understood as a poor anthropometric status of a human being (growth faltering), which signalizes insufficient growth and an unhealthy life. For this matter, child undernutrition is the result of a narrow and complex relationship between factors of various dimensions, which demands the elaboration of a complex analytical theoretical model for the study of their socioeconomic determinants and interrelationships.

In addition, analyzing the mother's characteristics with the nutritional status of her child has shown to be more relevant while understanding a child's development compared to the father's characteristics. This is not only because of maternal biological features (e.g., intergenerational transmission of health and the act of breastfeed), but also empowered women (e.g., higher education level, insertion in the labor market and wage) have more control over the economic decisions in the household (Duflo, 2012). Moreover, women tend to allocate a higher amount of resources in areas that benefit all the individuals in the household, such as food, health and education (Thomas, 1997). As shown previously, most studies focus on the mother's education, for this matter, the research will be done with the intention to contribute to the holistic view of the determinants leading to childhood undernutrition by focusing on mother's income and labor status in the recent Brazilian scenario. Thus, in this paper a theoretical framework will be constructed over the hypothesis that mothers inserted in the labor market and receiving their own income are crucial indirect determinants for child nutritional status.

6 Data

The construction of empirical analyses using recent quantitative data for Brazilian households at the national level will be used to address the research questions raised previously. A cross-sectional study will be conducted, selecting children of 5 years of age and under (up to 60 completed months), using data of two recent periods (2002-2003 and 2008-2009).

6.1 Dataset - Consumer Expenditure Survey (POF)

In Brazil state agencies and autonomous research institutions are specialized in collecting reliable data on different features of the country. This paper works with the Consumer Expenditure Survey (POF), which nowadays is considered to be the most accurate investigation about Brazilian household's consumer habits. It is formulated by the Brazilian Bureau of Statistics (IBGE), a federal public institute bound to the Brazilian Ministry of Planning, Development and Management.

POF's main goal is to know what services and consumer goods have been used by families in urban and rural areas from all regions of the country over a period of one year. During this period of one year, once it collects information on the characteristics of all individuals living inside the household (e.g., anthropometric measures, education, labor status, income) and of the household itself (e.g., location, physical structure, access to clean water). Thus, this dataset does not only apprise the changes of the population's consumption habits (i.e. increase in digital consumption), it also provides information that can be used to investigate questions of different fields like expenditures on leisure and education or living conditions.

Since its creation in 1970, five consumer expenditure surveys have been conducted. The two most recent surveys were done in 2002-2003 and 2008-2009 with samples of national level coverage. Families from all social classes were chosen proportionally. The number of individuals being interviewed in each social class followed the same scope of income distribution among the Brazilian population. A total of 182,333 observations in the first period and of 190,159 in the second, representing a sample of 10% of the total population.

A dataset was formulated with the information provided by POF 2002-2003 (first period) and POF 2008-2009 (second period). The intention is to understand undernutrition of children under the age of 5 years and its determinants, especially those variables related to women's empowerment (income and labor status) in the Brazilian scenario during the first decade of the 2000s. The total number of observations of children for the analysis is 23,803 (12,859 from first and 10,944 from second).

This papers' dataset only considers children aged equal to or less than 60 months (equal or under 5 years old). Furthermore, only those living with both parents (21,717 observations) or only with their mother (2,086) were considered for the dataset, leading to 131 observations being omitted. As the percentage of households with parents of the same gender was very low, they were also dropped (24 observations). The observations contain information on the child's characteristics, her or his parents' characteristics and the household conditions. Children below 24 months of age had their length measured instead of their height, because they cannot stand straight yet.

Whilst constructing the dataset, an interesting fact was noticed. An increase was noted in the categories of information collected from the first survey to the second that could be relevant to future analyses, for example, women's pregnancy status and child feeding practices, including breastfeeding and complementary feeding. This is a good sign as it shows that the government has become more concerned with matters of nutritional status. Nevertheless, since the dataset will only use information that appears in both time periods, these new information categories will not be considered.

6.2 Measures for Child Nutritional Status

Undernutrition is a condition that occurs when there is a deficiency of certain vital nutrients in a person's diet. This deficiency can cause damages related to the development of growth, physical health, mood, behavior and other functions of the body. undernutrition tends to affect infants, children and the elderly in general; however, children under 5 years old are those at greatest risk from growth faltering (Grantham-McGregor et al., 2007). To tackle this issue, direct and indirect methods to measure a child nutritional status exist (Beghin et al., 1988).

They are useful to alert a medical professional whether a child or a group is malnourished or is at risk of becoming malnourished.

The direct methods are related to individuals and estimate the objective criteria. They can be clinical (physical signs associated with undernutrition), biochemical (laboratory investigations in body metabolism and nutrition), functional, anthropometry (physical body measurements like height or weight), and biophysical and radiological methods. As for indirect methods, these are measurements that use population health indices to predict the nutritional status. These methods can consider the dietary intake (eating pattern), vital statistics (such as mortality or morbidity data) and ecological studies (such as quality, accessibility and availability of health services). All of these measurements have their advantages and limitations and are not mutually exclusive of one another. On the contrary, they can be complementary and give a better overall idea of the child's growth situation.

6.3 Anthropometric indicators

Since POF's dataset does not already provide the population's nutritional status, the assessment will be on the basis of anthropometric indicators as they are normally used for monitoring growth and to appraise variation in the degree of undernutrition over time. With information over the child's features and body measurements, two types of anthropometric indicators will be calculated: height-for-age (HA) and weight-for-age (WA).

Height-for-age indicates stunting, a term used to describe when a child has a remarkably lower height than expected for its age. Stunting is related to chronic undernutrition, occurring when children's growth is compromised over a long-term period, due to deprivation of essential nutrients or constant infections and/or diseases. Its effects are mostly irreversible, being reflected through slowed motor skills development, debilitated cognitive function and low performance at school. During the first decade of the years 2000s, the prevalence of stunting was found for nearly one third of children below five years old in the developing world (Black et al., 2008).

Weight-for-age is a combined measure of height-for-age and weight-for-height. It indicates that a child is underweight, meaning that children have a much lower weight than expected for their

age. As weight oscillates over time, different from stunting, the weight deficit can be the result of recent and acute as well as chronic undernutrition, although it cannot distinguish between them.

To compare a set of anthropometric indicators with a reference standard, different measurements of scales may be used, the most common ones being the percentile and z-score scales. For this paper, a z-score scale will be used to assess undernutrition, as it is considered to be the best scale to differentiate between extreme (or abnormal) and normal results of children's height or weight according to the average of a healthy standard reference population with comparable individuals of the same age and sex. Z-score is a statistical measurement which indicates how many standard deviations an observation is away from the mean of the distribution. The Z-score formula is shown below.

$$Z-\text{score} = \frac{(\text{Observed value in the dataset}) - (\text{Mean reference value})}{\text{Standard Deviation of reference population}}$$

In this case, the standard reference population is taken from the World Health Organization (WHO, 2006), where for height-for-age as well as for weight-for-age z-scores below two standard deviations (-2SD) from the median of the reference population indicate malnourishment. WHO's child growth standards were formulated on the basis of the growth and development process of healthy children with healthy mothers from six countries across the world with different ethnic backgrounds. Thus, its use in many studies has proven that genetic (or natural) determinants have lower influence than socioeconomic determinants for growth faltering in children from developing countries.

6.4 Key Variables

Dependent Variable - Child characteristics

Child undernutrition as the dependent variable will be measured through the child weight-for-age Z score (WAZ), and length/height-for-age Z score (HAZ), following the guidelines of the child growth standards of WHO (2006). Both variables were created with the Stata user-written programme zscore06 (Leroy, 2011), which already considered the gender of the child for the formula, because the growth standards differ from boys to girls. Charts 1 and 2 in the Appendix represent the WHO's growth standard charts of length/height-for-age for both genders to illustrate. Observations with values outside the z-score ranges were considered outliers, hence children with HAZ below –5SD or above +3SD and WAZ below –4SD or above +5SD were omitted (326 observations deleted). As a result, it is possible to identify whether the child faces any problem of undernutrition (i.e. stunting and/or underweight).

Table 1 presents the child's summary statistics of both years combined; Tables 2 and 3 present the same variables, but for each period to see the evolution over time. With 12,859 observations in 2002-2003 and 10,944 in 2008-2009, the average of the values is quite similar with 49.03% and 48.95% being girls in 2002-2003 and 2008-2009 respectively. The average age (in months) of the children in both periods is 31 months, and children living in a single-mother household makeup 8.42% and 9.16%, respectively.

Table 1: Summary Statistics - Child Characteristics - Periods combined

Variable	Mean	SD	Min	Max	N	Type
Age in months	31.606	17.431	0	60	23803	Continuous
Height-for-age	-0.318	1.919	-10.83	6.63	23803	Continuous
Weight-for-age	0.199	1.806	-6.71	7.29	23803	Continuous
Male child	0.51	0.500	0	1	23803	Dummy
Signs of Stunting	0.03	0.172	0	1	23803	Dummy
Signs of Underweight	0.02	0.143	0	1	23803	Dummy
Signs of any Malnutrition	0.04	0.212	0	1	23803	Dummy

Table 2: Summary Statistics - Child Characteristics - 2002-2003

Variable	Mean	SD	Min	Max	N	Type
Age in months	31.6	17.370	0	60	12859	Continuous
Height-for-age	-0.575	2.016	-10.83	6.63	12859	Continuous
Weight-for-age	0.046	1.447	-6.71	7.29	12859	Continuous
Male child	0.509	0.499	0	1	12859	Dummy
Signs of Stunting	0.031	0.174	0	1	12859	Dummy
Signs of Underweight	0.022	0.146	0	1	12859	Dummy
Signs of any Malnutrition	0.047	0.213	0	1	12859	Dummy

Table 3: Summary Statistics - Child Characteristics - 2008-2009

Variable	Mean	SD	Min	Max	N	Type
Age in months	31.62	17.490	0	60	10944	Continuous
Height-for-age	-0.016	1.750	-9.35	5.62	10944	Continuous
Weight-for-age	0.379	1.270	-5.49	6.34	10944	Continuous
Male child	0.51	0.499	0	1	10944	Dummy
Signs of Stunting	0.03	0.171	0	1	10944	Dummy
Signs of Underweight	0.0195	0.138	0	1	10944	Dummy
Signs of any Malnutrition	0.0462	0.210	0	1	10944	Dummy

Furthermore, undernutrition has slightly improved by 0.2%, the proportion decreased from 4.8% to 4.6%. The proportion of children presenting signs of stunting and underweight also decreased by 0.2%, from 0.55% to 0.35%. In addition, the mean of weight-for-age Z-score is 0.0462703 for 2002-2003 and 0.3794243 for 2008-2009, also corresponding to a sign of better nutritional outcomes. The distribution of child WAZ for both periods is presented in Figures 3 and 4. Moreover, the mean of height-for-age Z-score is -0.5757205 for 2002-2003 and -0.016133 for 2008-2009, also a sign of improvement, but still below the mean of the standard reference population. The distribution for child HAZ for both periods is presented in Figures 5 and 6.

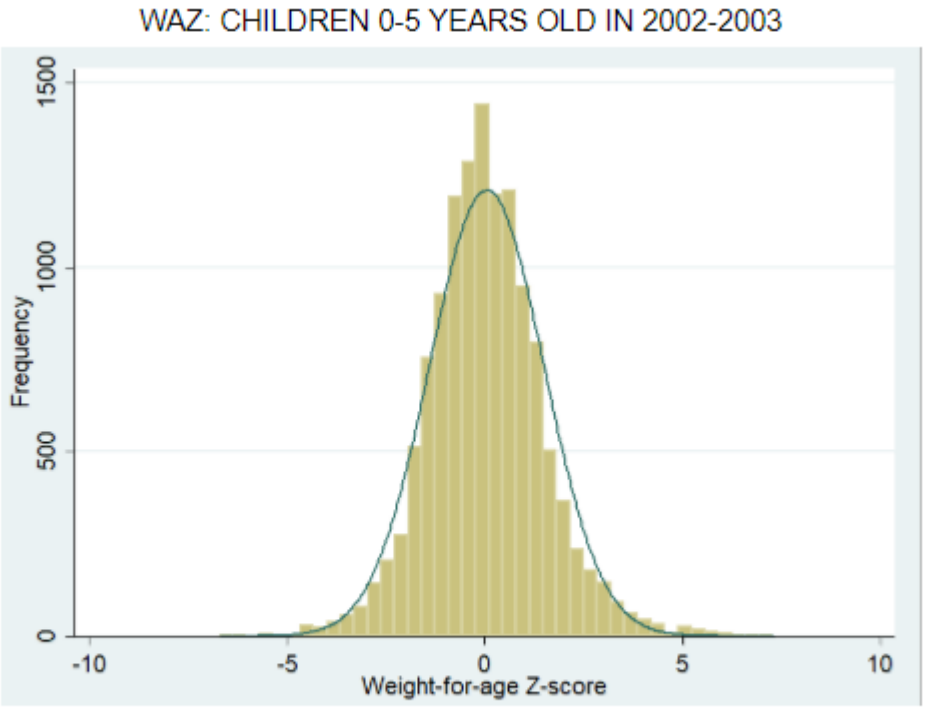

Figure 3. Distribution of child WAZ in 2002-2003
Data source: POF, 2002-2003

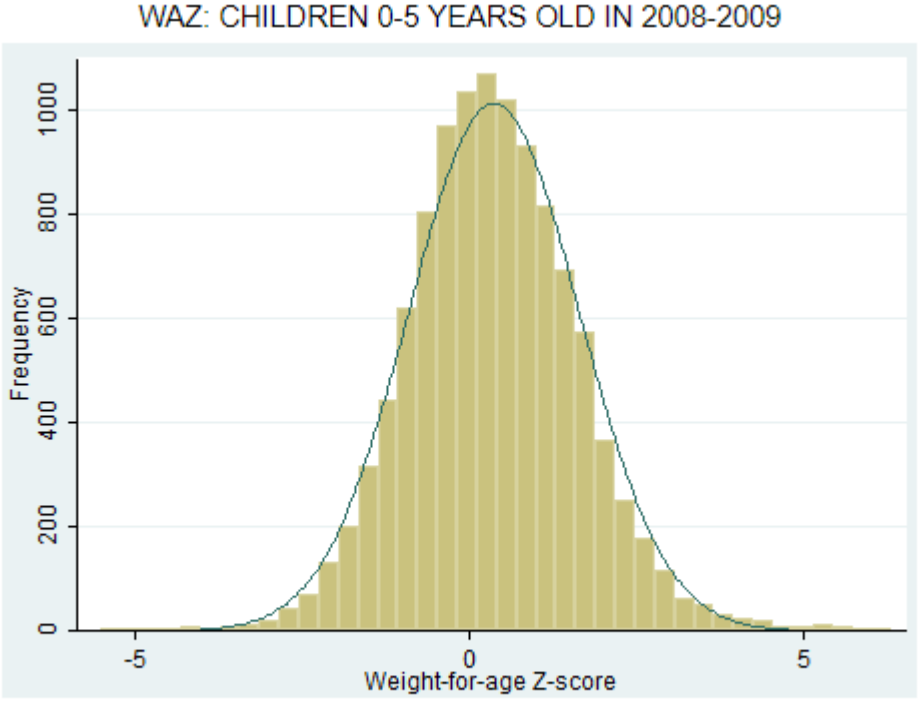

Figure 4. Distribution of child WAZ in 2008-2009
Data source: POF, 2008-2009

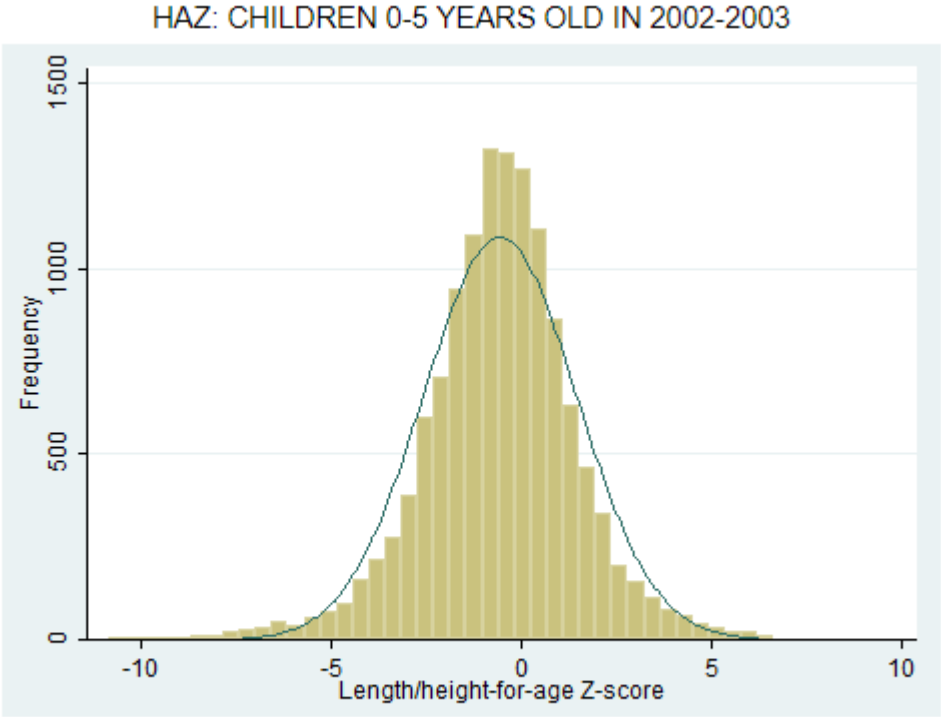

Figure 5. Distribution of child HAZ in 2002-2003
Data source: POF, 2002-2003

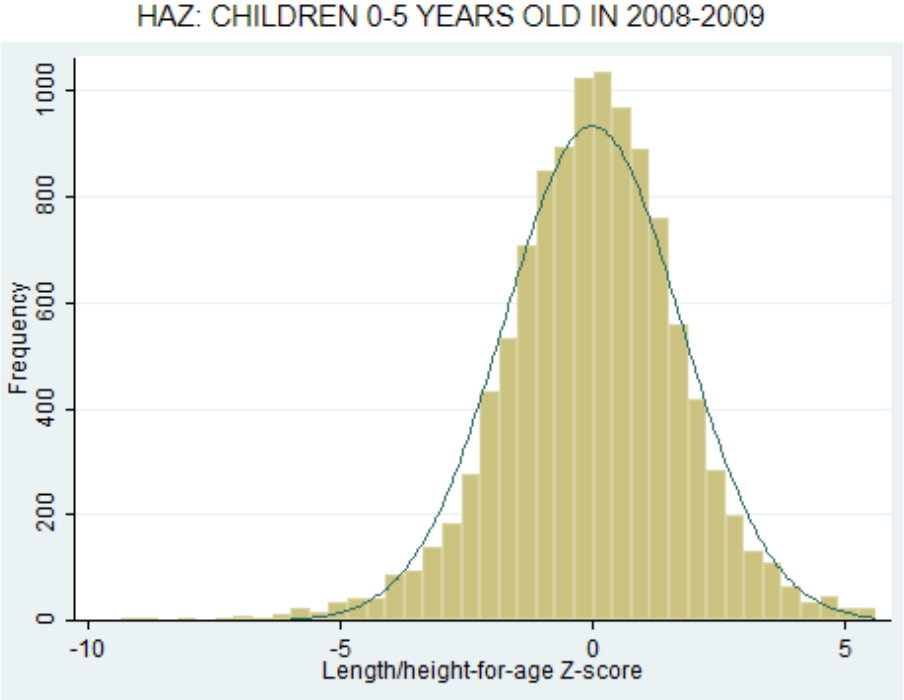

Figure 6. Distribution of child HAZ in 2008-2009
Data source: POF, 2008-2009

Independent Variables - Maternal socioeconomic characteristics

The household surveys collect information on every individual of age 10 or above that has assets and income as a budget unit. Considering variables that relate to the mother, it will be taken into consideration her socioeconomic status: labor status (if she is working or not), type of labor, number of jobs, income status (if she receives monetary income or not), absolute monetary income and education level. The education level variable has four categories: no education, primary education, secondary education and college or above. As for the type of work occupation, there are ten categories: unemployed; private sector; public sector; domestic work; temporary work in rural area; employer; self-employed; internship; household duties and self-consumption work.

This dataset only considers the income of the primary work of the mother. In 2002-2003, 45% of the children's mothers employed, and from this pool, 18% of the mothers do not receive monetary income. As for 2008-2009, 49% of children have a mother employed and 6% of those mothers did not receive income. The main reason for that employed mothers do not receive an income is due to the fact that the household survey considers an unpaid internship, household duties and work for self-consumption as labor.

Table 4 presents the independent variables' summary statistics of both years combined, Tables 5 and 6 present the same variables, but for each period to see the evolution over time.

Table 4: Summary Statistics – Maternal Socioeconomic Characteristics – Both Periods

Variable		Mean	SD	Min	Max	N	Type
Mother is employed		0.471	0.499	0	1	23803	Dummy
Mother has income		0.397	0.489	0	1	23803	Dummy
Number of jobs		0.57	0.700	0	7	23803	Continuous
Mother's income		21.794	810.231	0	70000	23803	Continuous
Mother's education						23803	Categorical
	No Education	RC	RC	RC	RC		
	Primary School	0.55	0.496	0	1		
	Secondary School	0.26	0.442	0	1		
	College or above	0.06	0.238	0	1		
Work Occupation						23803	Categorical
	Unemployed	RC	RC	RC	RC		
	Private Sector	0.125		0	1		
	Public Sector	0.073		0	1		
	Domestic Work	0.078		0	1		
	Temporary in Rural Area	0.008		0	1		
	Employer	0.007		0	1		
	Self-employed	0.107		0	1		
	Internship	0.001		0	1		
	Household Duties	0.044		0	1		
	Self-consumption work	0.024		0	1		

RC = Reference Category

Table 5: Summary Statistics - Maternal Socioeconomic Characteristics - 2002-2003

Variable		Mean	SD	Min	Max	N	Type
Mother is employed		0.454	0.497	0	1	12859	Dummy
Mother has income		0.371	0.483	0	1	12859	Dummy
Number of jobs		0.57	0.744	0	7	12859	Continuous
Mother's income		145.188	793.091	0	70000	12859	Continuous
Mother's education						12859	Categorical
	No Education	RC	RC	RC	RC		
	Primary School	0.625	0.484	0	1		
	Secondary School	0.215	0.411	0	1		
	College or above	0.053	0.224	0	1		
Work Occupation						12859	Categorical
	Unemployment	RC	RC	RC	RC		
	Private Sector	0.109	0.312	0	1		
	Public Sector	0.0692	0.253	0	1		
	Domestic Work	0.0727	0.259	0	1		
	Temporary in Rural Area	0.009	0.094	0	1		
	Employer	0.006	0.079	0	1		
	Self-employed	0.001	0.309	0	1		
	Internship	0.001	0.042	0	1		
	Household Duties	0.05	0.217	0	1		
	Self-consumption work	0.027	0.164	0	1		

RC = Reference Category

Table 6: Summary Statistics - Maternal Socioeconomic Characteristics - 2008-2009

Variable		Mean	SD	Min	Max	N	Type
Mother is employed		0.491	0.499	0	1	10944	Dummy
Mother has income		0.426	0.494	0	1	10944	Dummy
Number of jobs		0.578	0.663	0	5	10944	Continuous
Mother's income		292.23	822.880	0	17201	10944	Continuous
Mother's education						10944	Categorical
	No Education	RC	RC	RC	RC		
	Primary School	0.48	0.499	0	1		
	Secondary School	0.32	0.469	0	1		
	College or above	0.6	0.254	0	1		
Work Occupation						10944	Categorical
	Unemployment	RC	RC	RC	RC		
	Private Sector	0.145	0.352	0	1		
	Public Sector	0.078	0.269	0	1		
	Domestic Work	0.086	0.280	0	1		
	Temporary in Rural Area	0.006	0.082	0	1		
	Employer	0.007	0.087	0	1		
	Self-employed	0.106	0.308	0	1		
	Internship	0.002	0.016	0	1		
	Household Duties	0.038	0.193	0	1		
	Self-consumption work	0.021	0.143	0	1		

RC = Reference Category

Control variables

The regression models will contain control variables, including a mix of distant and proximate determinants, according to the model of Mosley and Chen (1984). First, individual-level variables are included, considering the age and race/ethnicity from both mother and father. The variable 'age' is categorical. Age is divided into three categories: under 25, between 25 and 40, and above 40. Additionally, variables that report the father's income exist, so that it is possible to detect which parent contributes most with respect to the child nutritional status in households with two parents.

Second, the model incorporates household-level variables, which are the household features: access to clean water, access to sanitation, number of residents and household gross income. The household gross income incorporates all kinds of income (monetary and non-monetary). With this variable, a household socioeconomic quintile variable was also created.

Lastly, community-level variables will be examined through geographical aspects of the habitation, depending on whether the habitation is located in an urban or rural area and in which of the five country's regions - North, Northeast, South, Southeast and Central-West. Both variables are very relevant to help to understand not only child undernutrition, but also women's empowerment, as different studies have shown that Brazil is a country with regional inequalities, such as the living conditions of Brazilian families (Oliveira et al., 2013), with variation in the access to public services and job conditions.

Some interesting statistics are worth mentioning. In both periods, the majority of mothers is between 25 to 40 years old, with a small increase of 3.94% in 2008-2009. The increase of maternal aging can be a sign of women deciding to focus in other life priorities before becoming a mother (e.g., higher education, work career, family planning) The proportion of households with access to clean water has improved by 13%. This is a positive sign, as together with hygiene practices and access to sanitation services, this has a direct impact on waterborne infectious diseases such as diarrhea (Ngure et al., 2014). The mean of household gross income increased by 61% (from BRL 1110 to BRL 1791). In both periods, around 71% of the children are living in urban areas. The distribution of children around Brazilian regions from one period to another does not differ that much, with a higher variation of numbers in the Northeast and Southeast, a decrease of 4% and an increase of 5%, respectively.

Table 7 presents the control variables' summary statistics of both years combined, Tables 8 and 9 present the same variables, but for each period, to see the evolution over time.

Table 7: Summary Statistics – Control Variables – Both Periods

Variable		Mean	SD	Min	Max	N	Type
Individual-level							
Mother's age						23803	Categorical
	Under 25	RC	RC	RC	RC		
	25 to 40 years old	0.621	0.485	0	1		
	above 40 years old	0.075	0.265	0	1		
Mother 's race is white		0.37	0.482	0	1	23803	Dummy
Father's age							Categorical
	Under 25	RC	RC	RC	RC		
	25 to 40 years old	0.622	0.484	0	1		
	above 40 years old	0.175	0.380	0	1		
Father 's race is white		0.365	0.481	0	1	23803	Dummy
Father has income		0.849	0.357	0	1	23803	Dummy
Household level							
Clean Water		0.762	0.425	0	1	23803	Dummy
Sanitation Service		0.547	0.497	0	1	23803	Dummy
Number of residents		4.6	1.700	2	20	23803	Continuous
Household's income		1423.55	3541.908	0	385250.7	23803	Continuous
Household's income - quintile						23803	Categorical
	Poorest	RC	RC	RC	RC		
	Second Poorest	0.226	0.418	0	1		
	Middle	0.176	0.381	0	1		
	Second Wealthiest	0.146	0.353	0	1		
	Wealthiest	0.123	0.329	0	1		
Community level							
Urban		0.717	0.450	0	1	23803	Dummy
Region						23803	Categorical
	North	RC	RC	RC	RC		
	Northeast	0.391	0.488	0	1		
	Southeast	0.171	0.377	0	1		
	Southeast	0.101	0.302	0	1		
	Central-West	0.147	0.354	0	1		
Year		0.459	0.498	0	1	23803	Dummy

RC = Reference Category

Table 8: Summary Statistics – Control Variables – 2002-2003

Variable	Mean	SD	Min	Max	N	Type
Individual-level						
Mother's age					12859	Categorical
Under 25	RC	RC	RC	RC		
25 to 40 years old	0.6	0.488	0	1		
above 40 years old	0.07	0.266	0	1		
Mother 's race is white	0.38	0.485	0	1	12859	Dummy
Father's age					12859	Categorical
Under 25	RC	RC	RC	RC		
25 to 40 years old	0.623	0.484	0	1		
above 40 years old	0.175	0.380	0	1		
Father 's race is white	0.38	0.484	0	1	12859	Dummy
Father has income	0.85	0.350	0	1	12859	Dummy
Household level						
Clean Water	0.7	0.450	0	1	12859	Dummy
Sanitation Service	0.58	0.490	0	1	12859	Dummy
Number of residents	4.74	1.780	2	18	12859	Continuous
Household's income	1110.273	3974.748	25	385250	12859	Continuous
Household's income - quintile					12859	Categorical
Poorest	RC	RC	RC	RC		
Second Poorest	0.227	0.419	0	1		
Middle	0.179	0.383	0	1		
Second Wealthiest	0.145	0.352	0	1		
Wealthiest	0.118	0.323	0	1		
Community level						
Urban	0.721	0.448	0	1	12859	Dummy
Region					12859	Categorical
North	RC	RC	RC	RC		
Northeast	0.41	0.492	0	1		
Southeast	0.15	0.355	0	1		
Southeast	0.1	0.302	0	1		
Central-West	0.15	0.358	0	1		

RC = Reference Category

Table 9: Summary Statistics – Control Variables – 2008-2009

Variable		Mean	SD	Min	Max	N	Type
Individual-level							
Mother's age						10944	Categorical
	Under 25	RC	RC	RC	RC		
	25 to 40 years old	0.64	0.480	0	1		
	above 40 years old	0.07	0.262	0	1		
Mother 's race is white		0.358	0.479	0	1	10944	Dummy
Father's age						10944	Categorical
	Under 25	RC	RC	RC	RC		
	25 to 40 years old	0.62	0.484	0	1		
	above 40 years old	0.17	0.380	0	1		
Father 's race is white		0.35	0.364	0	1	10944	Dummy
Father has income		0.84	0.375	0	1	10944	Dummy
Household level							
Clean Water		0.83	0.375	0	1	10944	Dummy
Sanitation Service		0.498	0.500	0	1	10944	Dummy
Number of residents		4.42	1.587	2	20	10944	Continuous
Household's income		1791.645	2910.767	0	69037.37	10944	Continuous
Household's income - quintile						10944	Categorical
	Poorest	RC	RC	RC	RC		
	Second Poorest	0.226	0.418	0	1		
	Middle	0.172	0.378	0	1		
	Second Wealthiest	0.148	0.355	0	1		
	Wealthiest	0.129	0.335	0	1		
Community level							
Urban		0.71	0.452	0	1	10944	Dummy
Region						10944	Categorical
	North	RC	RC	RC	RC		
	Northeast	0.36	0.482	0	1		
	Southeast	0.19	0.399	0	1		
	Southeast	0.10	0.302	0	1		
	Central-West	0.14	0.350	0	1		

RC = Reference Category

6.5 Limitations

The data do not allow more precise analysis of distant factors related to community and environmental characteristics. As previously mentioned, the only control variables at community level were related to geographical location (urban or rural and Brazilian regions). Thus, the role of the federal government, an important distant determinant for child nutritional status (Marmot, 2007; Smith et al., 2014), will not be evaluated.

One proxy for the government's role could have been evaluated through looking at the characteristics of public health services - their availability, accessibility, acceptability and quality (AAAQ) for the population, as well as, how tangible these services are, especially for the families from lower social class.

Another proxy could have been to look at households that have any family member integrating a social safety-net program provided by the government like 'Bolsa Família', mentioned previously. This would investigate whether these types of programmes do play a role upon child health, exemplified by Fernald et al. (2008), who evaluated the impact of the conditional cash transfer (CCT) program in Mexico, known as 'Oportunidades' (formerly 'Progressa'), in existence since 1998. His findings show that the role of cash transfer has a positive impact on children's health, with good results across the anthropometric indicators.

In addition, the POF data lack information over proximal factors related to diseases (cases of malaria) and family medical history, such as how many times the child or the mother was hospitalized in the last year. Within a household, family members have many characteristics in common (genetics, environment and/or lifestyle). Hence, combining these aspects can give a better picture of their medical conditions, demonstrating whether there are patterns of disorders that could be a risk to infants and children. For example, Heard and Martienssen (2014) explain that parents with a history of health disorders can jeopardize their child's development from the neonatal stage on.

As for diseases, there are many studies that measure the relationship between malaria and child undernutrition. It would be important to assess this relationship, to see if it is relevant for the government to extend the malaria surveillance system and control actions. This is particularly relevant, as in early 2000s, more the 50% of malaria cases in absolute numbers in the Americas were detected in Brazil (Oliveira-Filho et al., 2009). Furthermore, according to the epidemiological update by the Pan American Health Organization (PAHO) released in 2018, there has been an increase in the number of cases in the region during 2016 and 2017.

7 Methodology

The goal is to verify whether women's empowerment measured through proxies of mother's SES variables (income and labor status, mainly) is a key determinant of a child's nutritional health in terms of undernutrition, and to measure the relative strength of impact in Brazil, looking at two periods in the early 2000s. In doing so, several steps will be taken to ensure that the empirical results are as reliable and accurate as possible. Thus, sets of ordinary least squares (OLS) modelling techniques will be run. The investigation will use the statistical software STATA version 13. Also, to process the raw data of POF to STATA, the STATA packages were used that are provided by the Portal Data Zoom, a project developed by the Department of Economics at PUC-Rio University.

The principle of the regression models will be as described below:

$$Yi = \alpha + \beta 1MSESi + \beta 2Pi + \beta 3Hi + \beta 4Ci + \varepsilon i$$

The outcome variable is Y, which corresponds to the Z-score of interest (weight-for-age or height-for-age) of child i. $\beta 1MSESi$ as the independent variable represents a set of variables related to the SES of the child's mother. As for $\beta 2Pi$, $\beta 3Hi$ and $\beta 4Ci$, these are the control variables that represent a set of variables related to the characteristics of the child's parents, household and community respectively.

The Z-scores of WAZ and HAZ indicate undernutrition when their values are below - 2 standard deviations from the mean. Positive coefficients of the independent and control variables indicate a positive effect on the child nutritional status. The higher the coefficient value, the lower is the risk of a child being undernourished.

While formulating the OLS models, all of these variables will be added gradually to guarantee that the analysis will detect if the outcomes are more or less significant. For this matter, three aspects were taken into consideration. First, it is the value of the adjusted R square. Adjusted R square has two parts: gets higher with more significant coefficients but gets also lower the more coefficients are added (penalty for including too many control variables). Second, it is the probability value, also known as the p-value. A p-value of each variable included in the equation that is equal or lower than 0.05 suggests that the hypothesis behind the OLS model has strong

evidence and that the null hypothesis (no statistical significance) can be rejected. Finally, the third aspect to be considered is the value of the coefficients (the slope parameters of the regressors). The coefficient shows the economic significance between the dependent variable and one of the other variables, if there is a positive or negative association and to what degree.

Moreover, the Variation Inflation Factor (VIF) procedure will be done to spot multicollinearity, which is the correlation among the variables in the equation that can lead to errors in the outcomes. If the VIF's value is equal to 1, there is no multicollinearity; between 1 and 5, it is cautiously correlated, and above 5, it is highly correlated.

To encounter the problem of multicollinearity mothers' education and mother's labor status will not be run in the same model because they are highly correlated. This is because there has been an ongoing worldwide trend of women investing in qualified education to amplify their professional skills and to give them access to better job opportunities in the labor market (Smith et al., 2014).

In addition, the Breusch-Pagan test will be run to detect arbitrary forms of heteroskedasticity (residuals are not normally distributed). If heteroskedasticity is found, robust standard errors will be applied.

8 Empirical Results

This section presents the empirical results from the Ordinary Least Squares (OLS) Method - multiple regression models - that were created based on the research questions formulated previously. Each model was run six times, considering first as the dependent variable the WAZ, child's weight-for-age Z score, then considering the HAZ, child's height-for-age Z-score, for each period (2002-2003 and 2008-2009) and then a pooled OLS including both periods in one regression to reach a consistent estimate in the presence of time constant attributes of individuals. 42 model specifications with a mixed set of independent and control variables of interest were run. Tables in the appendix will show their outcomes. As the section over the theoretical framework already leveraged the possible determinants to child's undernourishment, the OLS models aim to investigate specially the effects of women's empowerment over child's undernutrition, mother's SES being the independent variables.

Mother's employability and wealth and child nutritional status

In this first models, the analysis aims to see if mothers that have income - mothers that are employed and receive a monetary wage - affect their child nutritional status positively. The control variables chosen for this model are parent's race, number of residents inside the household and geographical location of the household (urban or rural and the Brazilian region).

Table 10 and 11 present results from the OLS regression analysis. For all of them, the model statistics show that the R-squared stands at 5%, 5% and 6% for WAZ for periods 2002-2003, 2008-2009 and years combined, respectively. As for HAZ, the R-squared stands at 3%, 2% and 4%. For all regressions, the F-statistics indicate the hypothesis that all slope coefficients are equal to zero. Tests for multicollinearity were run and appeared to be stable for every variable, with the VIF's mean oscillating from 1.38 to 1.41.

In 2002-2003, mothers that had income from labor activities increased the child's WAZ by on average 0.111 points. In 2008-2009, the increase was 0.02 points higher (0.131 points). As for their effect over child's HAZ, it seems to be the opposite situation. The association remains positive, but it decreases from 0.199 (2002-2003) to 0.176 (2008-2009). The race/ethnicity of

parents being white has a positive effect over child's WAZ and HAZ. The coefficient for the number of residents is negative for both z-scores and in both periods and it is statistically significant at 1%. This coefficient presents a less negative effect in the second period for WAZ and HAZ, which can be associated with the fact that the mean of number of residents per household is lower in 2008-2009, it is 4.42 against 4.78 in the previous period.

The coefficient for when the household is located in an urban area has a positive association for both child's WAZ and HAZ. In the second period, the value of this coefficient is similar for both z-scores, with 0.131 and 0.133, respectively. In respect of the regions' coefficients, North region of Brazil is the reference category. Thus, for WAZ, in the first period, children living in the Southeast have the strongest positive association. The coefficient for those living in the Northeast is statistically positive significant at 5%, while the other regions are at 1%. The significance changes in the second period and the coefficient for Northeast becomes significant at 1%. Also, the Southern region has the strongest association in the second period. As for HAZ, the same occurs related to which region has the strongest association. First, it is with children living in the Southeast region, then in 2008-2009, it is with the South region. All associations are statistically significant at 1% in both periods.

In models 5 and 6, there is a dummy variable for the year to be able to analyse both periods in a pool. The effect of this variable over a child's WAZ is positive with an increase by on average 0.284 points, when the period is 2008-2009. As for its effect over a child's HAZ, it is also positive and very strong, when compared with the other variables in the regression model, with 0.524 points.

Tabel 10. Models for Child's WAZ and HAZ in 2002-2003 & 2008-2009 - Mother's employability

VARIABLES	(1) WAZ 2002-03	(2) WAZ 2008-09	(3) HAZ 2002-03	(4) HAZ 2008-09
Mother has income	0.111***	0.131***	0.199***	0.176***
	(0.0278)	(0.0260)	(0.0392)	(0.0365)
Mother's race is white	0.107***	0.0493*	0.101**	0.0451
	(0.0294)	(0.0287)	(0.0414)	(0.0402)
Father's race is white	0.114***	0.0630**	0.103**	0.117***
	(0.0302)	(0.0292)	(0.0421)	(0.0407)
Number of Residents	-0.110***	-0.0921***	-0.114***	-0.0903***
	(0.00761)	(0.00810)	(0.0108)	(0.0114)
Urban	0.144***	0.131***	0.125***	0.133***
	(0.0290)	(0.0277)	(0.0398)	(0.0390)
Region = 1, North	RC	RC	RC	RC
Region = 2, Northeast	0.0819**	0.110***	0.145***	0.169***
	(0.0377)	(0.0358)	(0.0538)	(0.0509)
Region = 3, Southeast	0.294***	0.311***	0.459***	0.274***
	(0.0477)	(0.0418)	(0.0664)	(0.0596)
Region = 4, South	0.256***	0.429***	0.362***	0.245***
	(0.0540)	(0.0522)	(0.0783)	(0.0728)
Region = 5, Central-West	0.241***	0.277***	0.349***	0.300***
	(0.0480)	(0.0446)	(0.0690)	(0.0640)
Constant	0.218***	0.423***	-0.475***	-0.000557
	(0.0589)	(0.0548)	(0.0818)	(0.0800)
Observations	11,776	9,941	11,776	9,941
R-squared	0.046	0.046	0.031	0.023

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Tabel 11. Models for Child's WAZ and HAZ in a pool 2002-2009 - Mother's employability

VARIABLES	(5) WAZ 2002-09	(6) HAZ 2002-09
Mother has income	0.120***	0.189***
	(0.0192)	(0.0269)
Mother's race is white	0.0815***	0.0740**
	(0.0207)	(0.0291)
Father's race is white	0.0917***	0.109***
	(0.0212)	(0.0295)
Number of Residents	-0.103***	-0.105***
	(0.00560)	(0.00792)
Urban	0.137***	0.127***
	(0.0201)	(0.0280)
Region = 1, North	RC	RC
Region = 2, Northeast	0.0926***	0.152***
	(0.0262)	(0.0374)
Region = 3, Southeast	0.296***	0.361***
	(0.0317)	(0.0448)
Region = 4, South	0.332***	0.307***
	(0.0378)	(0.0540)
Region = 5, Central-West	0.257***	0.326***
	(0.0331)	(0.0476)
year = 1, 2008_09	0.284***	0.524***
	(0.0182)	(0.0255)
Constant	0.189***	-0.488***
	(0.0426)	(0.0601)
Observations	21,717	21,717
R-squared	0.059	0.048

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Mother's Education and child nutritional status

In the second set of models, the analysis aims to see if the mother's education has a stable positive effect on a child nutritional status. From models 7 to 10, the control variables chosen are the same as in the previous set of models, parents' race, the number of residents inside the household and geographical location of the household (urban or rural and the Brazilian region). Later on, other variables are included, such as water and mother's age.

Table 12 and 13 present the OLS regression results. The model statistics show that the R-squared stands at 5% for WAZ for the periods 2002-2003 and 2008-2009, respectively. As for HAZ, it stands at 5% and 3%. The F-statistics indicate the hypothesis that all slope coefficients are equal to zero. Tests for multicollinearity were run and appeared to be stable for every variable, with the VIF's mean oscillating from 1.41 to 1.42.

First considering the models 7 to 10, in the first period (2002-2003), the coefficient of mother's education has a strong effect for child's WAZ and HAZ with 0.203 and 0.179, respectively. But in the second period (2008-2009), this association decreases to 0.017 and 0.079. All the coefficients are statistically significant at 1%. Also, mother's race as white is not significant in any model (the p-value is higher than 10%) and father's race as white becomes insignificant in the second period for child's WAZ.

When the variable water is included in models 11 to 14, the variable urban/rural becomes statistically insignificant. The value of water's coefficient oscillates from 0.25 to 0.34. Then, mother's age is included in models 15 to 18, its coefficient is strong and statistically significant at 1% for child's WAZ and HAZ in both periods. Additionally, from the three categories of mother's age (under 25, 25 to 40 and above 40), mothers' which are older than 40 years have always the stronger association. To illustrate, in the second period, it is 0.230 for child's WAZ and 0.273 for child's HAZ.

Tabel 12. Models for Child's WAZ and HAZ in 2002-2003 & 2008-2009 - Mother's education

VARIABLES	(7) WAZ 2002-03	(8) WAZ 2008-09	(9) HAZ 2002-03	(10) HAZ 2008-09	(11) WAZ 2002-03	(12) WAZ 2008-09	(13) HAZ 2002-03	(14) HAZ 2008-09	(15) WAZ 2002-03	(16) WAZ 2008-09	(17) HAZ 2002-03	(18) HAZ 2008-09
Mother's education	0.203***	0.0718***	0.179***	0.0799***	0.178***	0.0618***	0.143***	0.0717***	0.173***	0.0548***	0.132***	0.0659***
	(0.0209)	(0.0170)	(0.0296)	(0.0233)	(0.0211)	(0.0170)	(0.0299)	(0.0234)	(0.0209)	(0.0171)	(0.0297)	(0.0232)
Mother's race is white	0.0746**	0.0411	0.0735*	0.0368	0.0674**	0.0355	0.0628	0.0322				
	(0.0296)	(0.0288)	(0.0418)	(0.0404)	(0.0296)	(0.0288)	(0.0417)	(0.0404)				
Father's race is white	0.1000***	0.0561*	0.0936**	0.110***	0.0928***	0.0465	0.0830**	0.102**	0.107***	0.0451	0.0942**	0.0992**
	(0.0301)	(0.0293)	(0.0421)	(0.0409)	(0.0300)	(0.0293)	(0.0420)	(0.0409)	(0.0289)	(0.0284)	(0.0406)	(0.0396)
Number of Residents	-0.0927***	-0.0881***	-0.101***	-0.0865***	-0.0874***	-0.0806***	-0.0929***	-0.0804***	-0.102***	-0.0974***	-0.114***	-0.0988***
	(0.00780)	(0.00827)	(0.0111)	(0.0116)	(0.00785)	(0.00828)	(0.0112)	(0.0116)	(0.00848)	(0.00888)	(0.0120)	(0.0123)
Clean Water					0.256***	0.290***	0.378***	0.237***	0.247***	0.301***	0.343***	0.257***
					(0.0353)	(0.0380)	(0.0498)	(0.0536)	(0.0328)	(0.0364)	(0.0457)	(0.0507)
Urban	0.0990***	0.138***	0.0992**	0.147***	0.00798	0.0607**	-0.0353	0.0839**				
	(0.0294)	(0.0276)	(0.0405)	(0.0386)	(0.0316)	(0.0289)	(0.0441)	(0.0412)				
Region = 1, North	RC	RC	RC	RC	RC	RC	RC	RC	RC	RC	RC	RC
Region = 2, Northeast	0.113***	0.108***	0.177***	0.167***	0.106***	0.0810**	0.166***	0.144***	0.103***	0.0731**	0.157***	0.137***
	(0.0376)	(0.0357)	(0.0538)	(0.0509)	(0.0375)	(0.0357)	(0.0537)	(0.0511)	(0.0375)	(0.0357)	(0.0535)	(0.0512)
Region = 3, Southeast	0.311***	0.307***	0.486***	0.271***	0.229***	0.233***	0.364***	0.210***	0.225***	0.224***	0.358***	0.200***
	(0.0475)	(0.0418)	(0.0661)	(0.0597)	(0.0486)	(0.0429)	(0.0680)	(0.0615)	(0.0485)	(0.0426)	(0.0678)	(0.0613)
Region = 4, South	0.292***	0.437***	0.404***	0.255***	0.211***	0.359***	0.285***	0.192***	0.219***	0.354***	0.285***	0.183**
	(0.0539)	(0.0522)	(0.0783)	(0.0729)	(0.0548)	(0.0531)	(0.0800)	(0.0744)	(0.0543)	(0.0521)	(0.0790)	(0.0730)
Region = 5, Central-West	0.250***	0.266***	0.356***	0.286***	0.179***	0.188***	0.252***	0.223***	0.183***	0.184***	0.257***	0.217***
	(0.0479)	(0.0446)	(0.0690)	(0.0640)	(0.0488)	(0.0460)	(0.0706)	(0.0658)	(0.0487)	(0.0458)	(0.0705)	(0.0656)
Mother's age = 1, Under 25									RC	RC	RC	RC
Mother's age = 2, 25 to 40									0.136***	0.137***	0.183***	0.137***
									(0.0295)	(0.0291)	(0.0418)	(0.0418)
Mother's age = 3, Above 40									0.148**	0.230***	0.278***	0.273***
									(0.0577)	(0.0565)	(0.0781)	(0.0724)
Constant	-0.251***	0.291***	-0.862***	-0.138	-0.296***	0.143**	-0.928***	-0.258***	-0.277***	0.185***	-0.911***	-0.207**
	(0.0764)	(0.0685)	(0.108)	(0.0968)	(0.0767)	(0.0705)	(0.108)	(0.0991)	(0.0764)	(0.0708)	(0.109)	(0.0994)
Observations	11,776	9,941	11,776	9,941	11,776	9,941	11,776	9,941	11,776	9,941	11,776	9,941
R-squared	0.053	0.046	0.032	0.021	0.057	0.051	0.037	0.023	0.058	0.053	0.038	0.025

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Tabel 13. Models for Child's WAZ and HAZ in a pool 2002-2009 - Mother's education

VARIABLES	(19) WAZ 2002-09	(20) HAZ 2002-09	(21) WAZ 2002-09	(22) HAZ 2002-09	(23) WAZ 2002-09	(24) HAZ 2002-09
Mother's education	0.134***	0.126***	0.116***	0.105***	0.111***	0.0955***
	(0.0134)	(0.0187)	(0.0134)	(0.0188)	(0.0134)	(0.0186)
Mother's race is white	0.0619***	0.0568*	0.0553***	0.0489*		
	(0.0208)	(0.0293)	(0.0208)	(0.0293)		
Father's race is white	0.0798***	0.100***	0.0716***	0.0904***	0.0796***	0.0946***
	(0.0212)	(0.0296)	(0.0211)	(0.0295)	(0.0204)	(0.0286)
Number of Residents	-0.0928***	-0.0971***	-0.0861***	-0.0889***	-0.101***	-0.108***
	(0.00571)	(0.00807)	(0.00575)	(0.00811)	(0.00619)	(0.00867)
Clean Water			0.274***	0.334***	0.274***	0.324***
			(0.0260)	(0.0365)	(0.0244)	(0.0339)
Urban	0.118***	0.123***	0.0316	0.0171		
	(0.0202)	(0.0281)	(0.0215)	(0.0303)		
Region = 1, North	RC	RC	RC	RC	RC	RC
Region = 2, Northeast	0.105***	0.165***	0.0902***	0.147***	0.0851***	0.138***
	(0.0262)	(0.0374)	(0.0261)	(0.0373)	(0.0261)	(0.0373)
Region = 3, Southeast	0.300***	0.371***	0.223***	0.277***	0.217***	0.266***
	(0.0317)	(0.0447)	(0.0324)	(0.0459)	(0.0323)	(0.0458)
Region = 4, South	0.350***	0.330***	0.270***	0.233***	0.275***	0.231***
	(0.0377)	(0.0540)	(0.0384)	(0.0551)	(0.0379)	(0.0543)
Region = 5, Central-West	0.251***	0.320***	0.177***	0.229***	0.179***	0.230***
	(0.0331)	(0.0476)	(0.0339)	(0.0488)	(0.0338)	(0.0487)
year = 1, 2008_09	0.276***	0.520***	0.247***	0.485***	0.237***	0.475***
	(0.0182)	(0.0255)	(0.0184)	(0.0258)	(0.0183)	(0.0258)
Mother's age = 1, Under 25					RC	RC
Mother's age = 2, 25 to 40					0.134***	0.160***
					(0.0209)	(0.0297)
Mother's age = 3, Above 40					0.177***	0.269***
					(0.0407)	(0.0538)
Constant	-0.0994*	-0.738***	-0.181***	-0.837***	-0.147***	-0.797***
	(0.0527)	(0.0743)	(0.0532)	(0.0746)	(0.0532)	(0.0748)
Observations	21,717	21,717	21,717	21,717	21,717	21,717
R-squared	0.062	0.048	0.066	0.052	0.068	0.053

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Mother's income versus father's income for child nutritional status

With the intention to see how is the interaction between mothers which have an income and fathers which have an income, as well, affects a child's health, a set of models were made only including children that had both parents living in the same household (21,717 observations). Considering both periods, the dataset contains 4.4% observations with both parents not having income, 2.3% only with mothers having income, 59% only with fathers having income and 34.3% with both parents having income. Tables 14 and 15 show the OLS regression analysis.

The coefficient for fathers which have an income is insignificant for a child's WAZ in both periods (Models 25 and 26). Meanwhile, child's HAZ is insignificant only in 2002-2003 (Model 27). In 2008-2009 (Model 28), the coefficient is significant at 5%. In this model, its value is 0.151 against 0.177 for mothers who have income. In all models, counting the pooled OLS models as well, the value of the coefficient for mothers who earn an income is always higher than the coefficient for father with income. Tests for multicollinearity were run and appeared to be stable for every variable.

Tabel 14. Models for Child's WAZ and HAZ in 2002-2003 & 2008-2009 - Parents with income

VARIABLES	(25) WAZ 2002-03	(26) WAZ 2008-09	(27) HAZ 2002-03	(28) HAZ 2008-09
Mother has income	0.111***	0.131***	0.200***	0.177***
	(0.0278)	(0.0260)	(0.0391)	(0.0365)
Father has income	0.0209	-0.0374	0.0586	0.151**
	(0.0544)	(0.0481)	(0.0762)	(0.0637)
Mother's race is white	0.106***	0.0495*	0.100**	0.0440
	(0.0294)	(0.0287)	(0.0414)	(0.0402)
Father's race is white	0.114***	0.0630**	0.103**	0.117***
	(0.0302)	(0.0292)	(0.0421)	(0.0407)
Number of Residents	-0.110***	-0.0925***	-0.114***	-0.0886***
	(0.00762)	(0.00810)	(0.0108)	(0.0114)
Urban	0.143***	0.132***	0.124***	0.126***
	(0.0290)	(0.0278)	(0.0399)	(0.0392)
Region = 1, North	RC	RC	RC	RC
Region = 2, Northeast	0.0823**	0.109***	0.146***	0.175***
	(0.0378)	(0.0359)	(0.0538)	(0.0510)
Region = 3, Southeast	0.294***	0.311***	0.459***	0.271***
	(0.0477)	(0.0418)	(0.0664)	(0.0596)
Region = 4, South	0.256***	0.431***	0.361***	0.240***
	(0.0540)	(0.0522)	(0.0784)	(0.0728)
Region = 5, Central-West	0.240***	0.278***	0.347***	0.295***
	(0.0480)	(0.0446)	(0.0690)	(0.0640)
Constant	0.198**	0.458***	-0.533***	-0.144
	(0.0782)	(0.0703)	(0.110)	(0.100)
Observations	11,776	9,941	11,776	9,941
R-squared	0.046	0.046	0.031	0.023

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Tabel 15. Models for Child's WAZ and HAZ in a pool 2002-2009 - Parents with income

VARIABLES	(29) WAZ 2002-09	(30) HAZ 2002-09
Mother has income	0.120***	0.189***
	(0.0191)	(0.0269)
Father has income	-0.00763	0.0990**
	(0.0365)	(0.0499)
Mother's race is white	0.0815***	0.0734**
	(0.0207)	(0.0291)
Father's race is white	0.0917***	0.109***
	(0.0212)	(0.0295)
Number of Residents	-0.103***	-0.104***
	(0.00559)	(0.00794)
Urban	0.137***	0.124***
	(0.0202)	(0.0280)
Region = 1, North	RC	RC
Region = 2, Northeast	0.0924***	0.155***
	(0.0263)	(0.0374)
Region = 3, Southeast	0.296***	0.360***
	(0.0317)	(0.0448)
Region = 4, South	0.333***	0.305***
	(0.0378)	(0.0540)
Region = 5, Central-West	0.257***	0.323***
	(0.0332)	(0.0476)
year = 1, 2008_09	0.284***	0.526***
	(0.0183)	(0.0255)
Constant	0.197***	-0.584***
	(0.0546)	(0.0771)
Observations	21,717	21,717
R-squared	0.059	0.048

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Mother's work occupation for child nutritional status

A set of models was run to see how the child nutritional status is influenced by the work occupation that the mother possesses. First, the OLS regressions were run with all types of work occupation that POF's data considers; then the models were run again, but now they did not consider internships and volunteer work, household duties and self-consumption. As explained before, the government agency responsible for elaborating the household survey considers these three last categories as work occupation, even if there is no income involved. Those categories apply to the mothers of 15% of children in the dataset. Tables 16 and 17 show the OLS regression analyses. Tests for multicollinearity were run and appeared to be stable for every variable.

Considering the whole dataset, only half of the children have mothers employed and these mothers work mainly in the private sector (13% of the total observations) or public sector (7%) or as a domestic worker (8%) or are self-employed (10%). From all categories of the

independent variable in question, one of the strongest associations exists for the category when the child's mother is the employer, with an increase by on average 0.457 and 0.390 for child's WAZ in first and second period (Models 31 and 32), respectively and by 0.632 and 0.672 for child's HAZ (Models 33 and 34). There are in total only 167 observations with this aspect and 80% of them belong to the wealthiest household income quintile.

In addition, the percentage of children under the age of 5 with mother inserted in the labor market varies per region. The Central-West region has the lower rate. Only 39% of the observations located in that region have mothers possessing any kind of work occupation. Follow by the North and Northeast regions, which have similar rates with 44% and 47%, respectively. As for the Southeast and South, they are regions with more children having mothers employed than the other way around, with 52% and 55%, respectively.

According to Models 39 and 40 that combine both periods, only the categories domestic worker, temporary work in rural area, internship and household duties are not statistically significantly associated with the child's WAZ. As for child's HAZ, temporary work in rural areas and household duties are not statistically significant, meanwhile domestic worker is significant at 5% and internships at 1%. For children who have mothers who work in the private sector the child's WAZ increases by on average 0.123 points, and the child's HAZ increases by 0.194 points. At the same time, the child's WAZ increases by on average 0.235 and the HAZ increases by 0.308 for children whose mothers work in the public sector. For children with self-employed mothers the child's WAZ increases by on average 0.098 and the child's HAZ increases by 0.158. While the association of the child's WAZ and their mother being a domestic worker is negative, the association of the child's HAZ is positive and by 0.110 of the mean.

Tabel 16. Models for Child's WAZ and HAZ in 2002-2003 & 2008-2009 - Mother's work occupation

VARIABLES	(31) WAZ 2002-03	(32) WAZ 2008-09	(33) HAZ 2002-03	(34) HAZ 2008-09	(35) WAZ 2002-03	(36) WAZ 2008-09	(37) HAZ 2002-03	(38) HAZ 2008-09
Work Occupation = 0, unemployed	RC	RC	RC	RC	RC	RC	RC	RC
Work Occupation = 1, private sector	0.136***	0.112***	0.217***	0.171***	0.138***	0.115***	0.222***	0.179***
	(0.0436)	(0.0374)	(0.0658)	(0.0518)	(0.0437)	(0.0375)	(0.0660)	(0.0518)
Work Occupation = 2, public sector	0.278***	0.194***	0.368***	0.251***	0.277***	0.193***	0.366***	0.260***
	(0.0560)	(0.0478)	(0.0756)	(0.0651)	(0.0561)	(0.0479)	(0.0757)	(0.0652)
Work Occupation = 3, domestic worker	-0.0654	0.0172	0.0989	0.109	-0.0644	0.0181	0.102	0.111
	(0.0553)	(0.0496)	(0.0746)	(0.0708)	(0.0554)	(0.0496)	(0.0747)	(0.0707)
Work Occupation = 4, temporary_rural	-0.261*	0.0716	-0.222	0.197	-0.259*	0.0709	-0.215	0.200
	(0.135)	(0.203)	(0.167)	(0.267)	(0.135)	(0.203)	(0.167)	(0.267)
Work Occupation = 5, employer	0.457***	0.390***	0.632***	0.672***	0.463***	0.394***	0.636***	0.676***
	(0.140)	(0.140)	(0.209)	(0.174)	(0.140)	(0.140)	(0.210)	(0.173)
Work Occupation = 6, self-employed	0.0797*	0.123***	0.176***	0.135**	0.0799*	0.122***	0.176***	0.140**
	(0.0442)	(0.0420)	(0.0610)	(0.0589)	(0.0442)	(0.0420)	(0.0610)	(0.0590)
Work Occupation = 7, internship_voluntary	0.128	-0.229	0.657***	1.132				
	(0.206)	(0.536)	(0.254)	(0.741)				
Work Occupation = 8, household duties	-0.0403	-0.0833	0.0377	0.00267				
	(0.0574)	(0.0579)	(0.0795)	(0.0772)				
Work Occupation = 9, self-consumption	-0.121*	-0.224***	0.104	0.117				
	(0.0726)	(0.0825)	(0.0916)	(0.104)				
Mother's race is white	0.0980***	0.0423	0.0934**	0.0367	0.0962***	0.0375	0.0840*	0.0304
	(0.0294)	(0.0288)	(0.0415)	(0.0404)	(0.0309)	(0.0298)	(0.0435)	(0.0420)
Father's race is white	0.108***	0.0595**	0.0970**	0.114***	0.0983***	0.0625**	0.103**	0.112***
	(0.0302)	(0.0292)	(0.0422)	(0.0408)	(0.0316)	(0.0301)	(0.0440)	(0.0423)
Number of Residents	-0.108***	-0.0901***	-0.114***	-0.0894***	-0.109***	-0.0908***	-0.114***	-0.0818***
	(0.00764)	(0.00816)	(0.0109)	(0.0115)	(0.00844)	(0.00877)	(0.0122)	(0.0125)
Urban	0.121***	0.113***	0.127***	0.139***	0.133***	0.114***	0.144***	0.131***
	(0.0307)	(0.0287)	(0.0426)	(0.0407)	(0.0321)	(0.0297)	(0.0444)	(0.0422)
Region = 1, North	RC	RC	RC	RC	RC	RC	RC	RC
Region = 2, Northeast	0.0919**	0.105***	0.148***	0.172***	0.0865**	0.102***	0.146**	0.156***
	(0.0378)	(0.0359)	(0.0541)	(0.0511)	(0.0401)	(0.0382)	(0.0577)	(0.0546)
Region = 3, Southeast	0.318***	0.309***	0.471***	0.281***	0.307***	0.307***	0.455***	0.252***
	(0.0480)	(0.0423)	(0.0673)	(0.0603)	(0.0503)	(0.0437)	(0.0707)	(0.0626)
Region = 4, South	0.274***	0.435***	0.373***	0.251***	0.247***	0.410***	0.321***	0.206***
	(0.0542)	(0.0527)	(0.0788)	(0.0733)	(0.0565)	(0.0551)	(0.0825)	(0.0773)
Region = 5, Central-West	0.250***	0.274***	0.357***	0.309***	0.232***	0.273***	0.332***	0.286***
	(0.0482)	(0.0451)	(0.0692)	(0.0645)	(0.0496)	(0.0465)	(0.0715)	(0.0669)
Father has income						-0.0431	0.0514	0.184***
						(0.0520)	(0.0876)	(0.0691)
Constant	0.224***	0.445***	-0.488***	-0.0136	0.233***	0.492***	-0.539***	-0.192*
	(0.0595)	(0.0558)	(0.0823)	(0.0816)	(0.0635)	(0.0760)	(0.123)	(0.109)
Observations	11,776	9,941	11,776	9,941	10,783	9,297	10,783	9,297
R-squared	0.049	0.048	0.032	0.024	0.043	0.040	0.029	0.021

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

Tabel 17. Models for Child's WAZ and HAZ in a pool 2002-2009 - Mother's work occupation

VARIABLES	(39) WAZ 2002-09	(40) HAZ 2002-09	(41) WAZ 2002-09	(42) HAZ 2002-09
Work Occupation = 0, unemployment	RC	RC	RC	RC
Work Occupation = 1, private sector	0.123***	0.194***	0.126***	0.201***
	(0.0285)	(0.0414)	(0.0286)	(0.0415)
Work Occupation = 2, public sector	0.235***	0.308***	0.235***	0.311***
	(0.0370)	(0.0501)	(0.0370)	(0.0501)
Work Occupation = 3, domestic worker	-0.0230	0.110**	-0.0223	0.113**
	(0.0372)	(0.0514)	(0.0372)	(0.0514)
Work Occupation = 4, temporary_rural	-0.158	-0.0943	-0.157	-0.0867
	(0.113)	(0.143)	(0.113)	(0.143)
Work Occupation = 5, employer	0.419***	0.653***	0.424***	0.657***
	(0.0993)	(0.135)	(0.0992)	(0.135)
Work Occupation = 6, self-employed	0.0986***	0.158***	0.0983***	0.159***
	(0.0307)	(0.0426)	(0.0307)	(0.0425)
Work Occupation = 7, internship_voluntary	0.0836	0.711***		
	(0.191)	(0.244)		
Work Occupation = 8, household duties	-0.0579	0.0189		
	(0.0414)	(0.0566)		
Work Occupation = 9, self-consumption	-0.160***	0.116*		
	(0.0543)	(0.0683)		
Mother's race is white	0.0732***	0.0659**	0.0699***	0.0580*
	(0.0207)	(0.0292)	(0.0216)	(0.0304)
Father's race is white	0.0866***	0.105***	0.0820***	0.107***
	(0.0212)	(0.0296)	(0.0220)	(0.0307)
Number of Residents	-0.101***	-0.105***	-0.102***	-0.101***
	(0.00562)	(0.00798)	(0.00614)	(0.00883)
Urban	0.116***	0.132***	0.122***	0.137***
Region = 1, North	RC	RC	RC	RC
	(0.0211)	(0.0295)	(0.0219)	(0.0307)
Region = 2, Northeast	0.0973***	0.155***	0.0922***	0.148***
	(0.0262)	(0.0374)	(0.0280)	(0.0401)
Region = 3, Southeast	0.310***	0.371***	0.301***	0.348***
	(0.0318)	(0.0450)	(0.0333)	(0.0472)
Region = 4, South	0.344***	0.316***	0.318***	0.269***
	(0.0380)	(0.0543)	(0.0397)	(0.0571)
Region = 5, Central-West	0.261***	0.334***	0.250***	0.312***
	(0.0333)	(0.0478)	(0.0344)	(0.0495)
year = 1, 2008_09	0.280***	0.523***	0.283***	0.522***
	(0.0183)	(0.0256)	(0.0191)	(0.0269)
Father has income			-0.0166	0.114**
			(0.0402)	(0.0557)
Constant	0.202***	-0.499***	0.227***	-0.612***
	(0.0431)	(0.0608)	(0.0595)	(0.0848)
Observations	21,717	21,717	20,080	20,080
R-squared	0.061	0.049	0.054	0.046

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
RC = Reference Category

9 Discussion

By analysing the child features, the findings show that the undernutrition rates are very low with less than 5% of children under 5 years old showing any type of undernourishment. Undernutrition affects boys and girls in similar ways: 2,7% and 2%, respectively. This portrait goes along with the statement that Brazil is currently a worldwide reference as a developing country that is managing to overcome undernutrition with a sustainable political commitment in progress since the 1980s but with a stronger effort from the government and civil society at the beginning of the 2000s (IFPRI, 2016).

Nevertheless, the total elimination of undernourished children still has a long way to go. First, the mean of child's height-for-age Z score decreased substantially from 2002-2003 to 2008-2009, but still, it remains below the standard population reference with the value of -0.016. Second, considering the 2008-2009 data, the prevalence of undernourished children under the age of 5 years is mainly concentrated in the poorest and second poorest household income quintile (64% of the undernourished children), which can be assumed to represent the most vulnerable population. Even so, the others household income quintiles also have their share of undernourished children, which can be related to the fact that the country suffers from high income inequality and not necessarily all the households in these quintiles have enough resources to guarantee food security to all their family members. This scenario is more common in low-income countries (such as Honduras and Laos), where a high prevalence of stunting (growth faltering) can be detected in the wealthiest quintile, a share of around 20% of households (Black et al., 2013).

The household's geographical location (urban/rural and Brazilian regions) is also of great importance to understand the epidemiological scenario of child undernutrition. Because they can be considered as proxies to socio-economic conditions of the Brazilian families and their accessibility to goods and services. Overall, the results show that living in rural areas is a discriminant factor for child's WAZ and HAZ. Additionally, the outcomes in Brazilian regions confirm again that undernourishment is correlated with poverty. Because as the country is configured with regional income disparity, children living in the poorest regions (North and

Northeast) have higher risks of undernourishment than those from the richest (South, Southeast and Central-West) (Oliveira et al., 2013).

Also, the average number of residents in households with undernourished children is 5. Additionally, the OLS regression model results showed the higher the number of people living in a household, the higher the risk of childhood undernutrition. So, it is possible to assume that this is because there are more people to feed and not enough income to guarantee the purchase of the necessary healthy food. To illustrate, Figure 7 shows the income inequality of Brazil from 2001 to 2015 regarding pre-tax national income. In 2008, 10% of the richest retained 56% of the pre-tax national income against the share of 13% from 50% of the poorest (WID, 2018). Moreover, since mid-2014 the country has been facing a deep economic recession with a rise in the rates of unemployment, income inequality and poverty (Paula et al., 2017), which will probably lead to a rise of acute and chronic undernutrition.

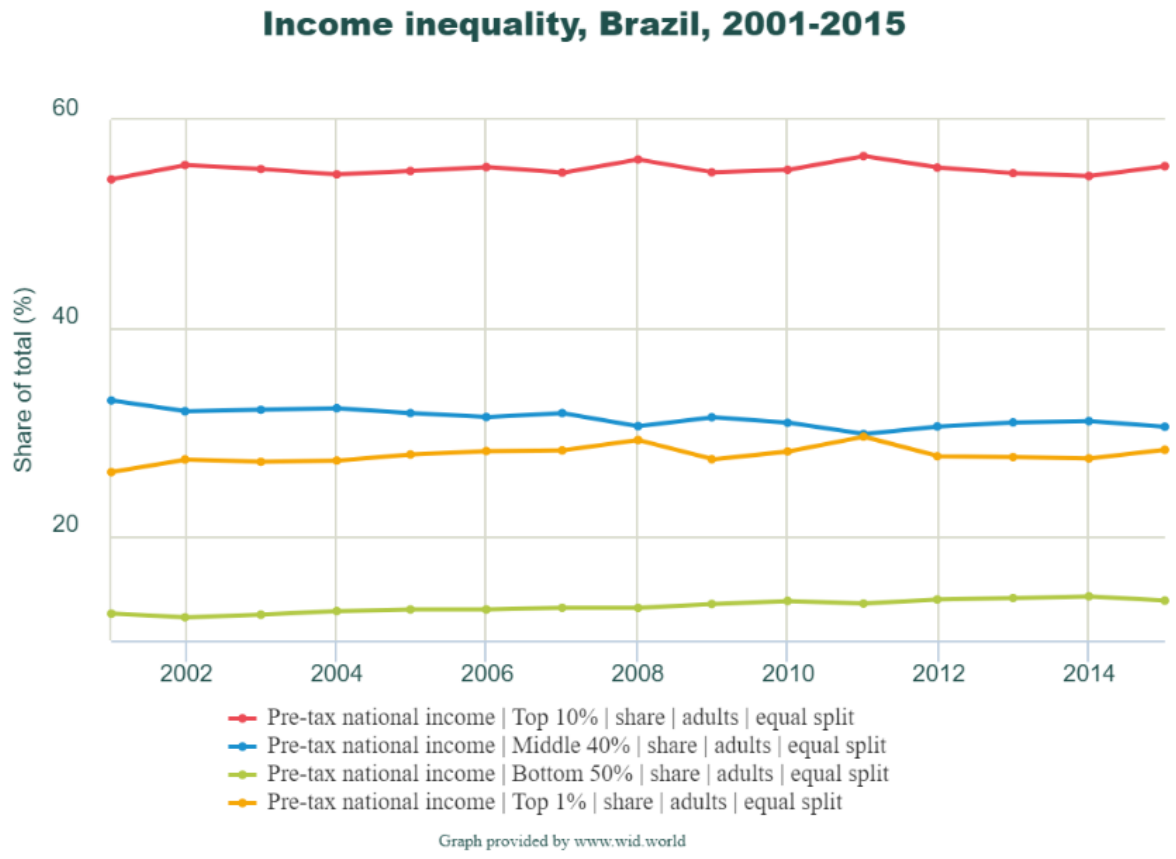

Figure 7 - Share of Pre-tax-income in Brazil, 2001-2015
Data Source: Author's calculation from WID - World Inequality Database, 2018

Household living conditions demonstrated by control variables are of great importance to child undernutrition. Basic sanitation services can be translated to access to clean water and access to systems with proper treatment of sewerage and waste. Its aim must be to preserve or enhance the living conditions in order to prevent diseases and promote health, improve the quality of living and the productivity of human capital (facilitating economic and educational activities) (Ngure et al., 2014). Furthermore, regarding the households where the undernourished children live, 30% of them have no access to clean water, and 44% do not have a proper sewerage system. Thus, promotion of nutrition-sensitive programs related to water, sanitation, and hygiene (WASH) is very important to fight the perpetuation of undernutrition.

Moreover, when access to clean water and urban/rural variables are combined in the OLS regression models, the urban/rural variable becomes statistically insignificant, which may be due to the fact that both variables are related to infrastructure and access to efficient public services. Thus, as the proportion of undernourished children living in rural areas is 30%, just the same percentage as for those without access to clean water, it can be assumed that residing in rural areas is a discriminant factor as it narrows basic sanitation service, among other things. This does not only occur in Brazil; residing in rural areas has proved to be a discriminant factor elsewhere in the world (Van de Poel et al., 2008). In addition, Ahmed et al. (2010) shows living in rural areas can also be a discriminant factor for women's empowerment, as in Bangladesh there are signs of a higher gender pay gap in rural compared urban areas.

Women's empowerment

Estimations of women's SES variables identify them as crucial indirect determinants for the child nutritional status. Following the vast literature on maternal education, as the education level of the mother increases, the percentage of undernourished children is reduced. One remark when comparing 2002-2003 to 2008-2009 is that there has been an increase of 12.8% of children with mothers holding an education degree higher than the primary level. This follows the assumption that individuals with low levels of education tend to work in low-income jobs that demand physical strength from the workers instead of knowledge (Goldin & Katz, 2009:1-8). In 2002-2003, 80% of mothers working within domestic service had only completed the primary level of education, and in 2008-2009 this figure was 62%, and the average income of this pool was BRL 155 and BRL 286, respectively.

Children of more educated mothers have a lower risk of becoming undernourished, because mothers that invest in their own education are more capable of accessing and absorbing new information (Rosenzweiz, 1995). Thus, mothers acquire knowledge over the best approach to raise the child with regards to feeding, hygiene and overall well-being (Ngure et al., 2014). Also, the returns of schooling in the context of wealth are high and even higher for women than for men (Montenegro et al., 2014). With investments in education and training systems, women boost their human capital (their economic value as an individual in terms of production), becoming more qualified to work in knowledge-intensive industries that offer job opportunities with higher wages and better working conditions (Sianesi et al., 2003).

But even though maternal education has proven to be a key determinant to child undernutrition and is clearly correlated with wealth and labor status, it is also important to focus on these other two factors separately. First, because as Mincer (1974) explains with his wage equation, earnings are the result of the returns of schooling with working experience. In other words, he shows that formal education matters, but the knowledge obtained with daily work and on-the-job training also contributes to higher wages. Second, gender discrimination is a worldwide issue that hinders women from receiving the same treatment and opportunities as men in the work environment, leading to a discrepant gender pay gap (Blackden et al., 2006) – among other things -, even when the women have the same level of education as men. Lastly, the approach towards women's wealth and labor status contributes to a more holistic picture of all the maternal aspects that are relevant for the child nutritional status and the measures that government, institutions and civil society can address to strengthen them.

Moreover, women's empowerment benefits all of those that surround them. By being inserted in the labor market and earning income from their labor force, women tend to give a greater share of their income to household matter than men (Thomas, 1997; Hazarika & Guha-Khasnobis, 2008), such as food, education, health service expenses. Some OLS regression models were run with the interaction of the dummy variables of both parents having income or not. In all models, the outcomes are in line with the literature, mothers with income have a much higher positive impact on child's WAZ and HAZ than fathers with income. An interesting remark is that households with mother and father with earning income, the mean of mother's income was of BRL 556 and the father's income was of BRL 975, a 43% difference and yet, mother's income is more relevant than the father's.

Furthermore, a point that can help explain why women who earn an income have a stronger impact than men who earn an income is the statement that women perform multiple roles inside and outside of their households simultaneously (Blackden et al., 2006; FAO, 2010). On the one hand, they are normally the ones responsible for executing the household tasks, by taking care of the household and the family members living there. On the other hand, they are also part of the economically active population inside the production system, even when they are unemployed. As for men, they also have multiple roles, however they are freer to focus first on their performance in the working environment, then they perform the other roles in sequence. This is probably one of the reasons the questionnaire of the household survey POF considers household duties and self-consumption as work occupations, because it involves economic matters, even when income is not involved. In 2006, a study (Blackden et al., 2006) compared daily time use for women and men in four Sub-Saharan African countries. His outcomes showed that in all countries, women spent more time at work and performing household duties than men. Additionally, he noticed that men spent more time in leisure activities than women.

Mothers that work in the private and public sector have a strong and positive impact on their child's WAZ and HAZ, but only a small proportion of mothers. Most mothers are unemployed (52%) or work as domestic worker or are self-employed. Self-employment has a negative association for the child's WAZ, probably because self-employed workers are normally undertaking informal work. By not having stable working conditions and a regular income, mothers who are self-employed cannot assure regular time to provide childcare and food security in the long term. On the other hand, mothers who are employer have the strongest positive association to child's WAZ and HAZ. This can be because they are the opposite of self-employed mothers, they must have economic stability to be able to run their business and hire employees.

Mothers that are older than 40 years appear to have the higher positive and significant impact on weight and height-for-age scores when compared to mothers of age under 25 years and between 25 and 40 years. Kozuki et al. (2013) have also highlighted that a low age of the mother can be a predictor of stunting prevalence for children under the age of 5, particularly when the mothers are less than 18 years old. Perhaps, the reason why so many young females have children is the lack of knowledge about contraceptive methods, which can be related to reduced access to education and also weak government family planning intervention programs. Moreover, the reason why women that are older tend to have healthier children may be due to

the fact that before deciding to become a mother, they focus on pursuing a career in the labour market. Then, with a stable economic situation, they are motivated to take reproductive decisions, as they will be more capable of addressing the needs involving raising a healthy child. Even though, studies point out the dangers related to late pregnancy (for instance, higher chances of perinatal mortality) (Jacobsson et al., 2004), the favorable social and environmental conditions prepared by the mothers can overcome these dangers (Barclay et al., 2016).

Parent's Race/Ethnicity

When running possible OLS models, at first the variable 'race' was also categorical. In POF's questionnaire, the individual declares the race/ethnicity that she or he believes to belong to, having to choose from more than 4 categories. So, of all mothers asked in the survey, in 2002-2003, 38% declared as white, 6% as black, 55% as dark-skin (or white-black mixture) and 1% as minorities (e.g., indigenous). The proportions were quite similar for 2008-2009, with 36% white, 8% black, 54% dark-skin and 2% minorities. A slight increase is noted for black and minorities categories. The same trend is observed when looking at the race of the father. Perhaps, this is not due to a change in the distribution of race/ethnicity in the country, but because more people are changing their perspective on which race/ethnicity they belong to. As Brazil is a mix-culture country with slavery and colonization in the composition of its history, discrimination towards and among the black population is a problem that many times is too subtle and intrinsic to be able to fight against in daily life (Nunes, 2014). But in Brazil and worldwide, governments and civil society are taking actions to promote awareness and to combat racism (e.g., racial quotas to enter university), these are slowly getting more attention and consequently are helping people to better understand the issue and its roots, particularly among the black community (Nunes, 2014).

The reason why the variable was changed from categorical to dummy variable - indicating if a person considered her or himself as white or not - was that the slopes' results for black and dark-skin were very similar. Thus, the change was not only made to facilitate the calculation, but also because it is reasonable to assume that there are people that claim to be dark-skin, but in reality, their race/ethnicity is black because they neglect this fact or are not aware of it. Now, looking at the outcomes of the OLS models, children with parents that see themselves as belonging to the race/ethnicity white have less risk of undernutrition than children with parents from black, darker-skin or minorities race/ethnicity. The father being white has a slightly stronger impact than the mother being white for a child's health. This reinforces the studies that

indicate how discrimination towards the black community and other disadvantaged ethnic groups (e.g., indigenous communities) creates barriers to a fair income distribution, access to basic sanitation service and to the education system (Cardoso et al., 2005). Hence, race/ethnicity is also a significant correlate of the risk of undernutrition.

Next steps

All of these outcomes could be used for advocacy purposes, as they present a clear portrait of how vital women's economic independence and social emancipation can be for the well-being of everyone inside the household and of society as a whole. Nevertheless, if people do not have the resources to guarantee a healthy child nutritional status, then the government is responsible for guaranteeing protection on the most vulnerable population. In Amartya Sen's concept (1999), the most vulnerable are those that lack of freedom as development (exclusion of power and of basic rights), particularly mothers and children. The government must give them access to effective nutrition-sensitive interventions, as well as of broader developmental programmes, such as the creation of socioeconomic opportunities for mothers. The establishment of stronger public policies towards the mothers' rights to fair working conditions will enhance the fight against gender inequality and the maternity protection at work. Such policies will have real effects on the betterment of child nutritional status.

10 Final Considerations

One possible reason why there has been a lack of variation in the figures concerning child's undernutrition in Brazil is the short time gap between the period that the two surveys used for the dataset were done (6 years of difference from one to another). Thus, it should be taken into account that different outcomes normally start to appear in a slow and gradual path. It will probably be more visible to detect the changes when comparing these two periods with the next edition of POF that will cover the current consumption habits of Brazilians families (data collected from 2017 to 2018). The new survey is expected to be released in 2019. However, IBGE (2017), the public agency responsible in collecting the data, already announced that the new edition will not collect anthropometric data (height and weight of the household members). So, for those that are interest in using POF as their data to evaluate child's undernutrition over time in Brazil nowadays should consider another type of method, perhaps the dietary intake (eating patterns).

As the country has been in an economic recession since mid-2014 and due to a couple of million Brazilians were push back below the poverty line (World Bank, 2017) it is preferable to look for traces of stunting (height-for-age) than of underweight, while trying to identify child's undernutrition evolution in the last two decades. Because, as explained, stunting reflects a chronic malnutrition, while underweight can be either an outcome of recent and acute or of chronic malnutrition.

Even though, being overweight and obesity are also child malnutrition issues that are increasing worldwide, with the rates of overweight children under the age of 5 rising toward similar levels seen in child wasting (low weight for height) (IFPRI, 2016), this study did not measure them in our group age. This is because in Brazil those are health issues that tend to appear in children older than 5 years old and especially among teenagers (IBGE, n.d.). With the increased consumption of ultra-processed foods, instead of preparing meals of healthy fresh and regional foods at home, it will be necessary to see if in the new edition of POF these issues also concern children under the age of 5.

11 Conclusion

This paper delineated an analytical theoretical framework to understand what the causes for child undernutrition are in Brazil, a middle-income country that has two sides. On the one hand, it managed to become a worldwide reference in the fight against poverty and undernutrition during the beginning of the 21st century (IFPRI, 2016). On the other hand, it is also known for its high level of economic and gender inequality within socio-economic opportunities (OXFAM, 2017).

Then, a holistic portrait was materialized from the bivariate analyses of child anthropometry - child's weight-for-age Z score (WAZ) and child's height-for-age Z score (HAZ) to detect the prevalence of underweight and stunting, respectively. This managed to explain that no sole cause exists to explain undernourishment, but a series of factors, more precisely, biological factors being influenced by socioeconomic aspects from an individual to community level (Mosley & Chen, 1984).

Mothers' socioeconomic status (SES) have proven to be crucial determinants for optimal child development during early childhood. Mothers that have paid work have a positive impact on child nutritional status, as they tend to make more pro-nutrition consumption choices with their income. Their impact is higher than the impact of fathers that have paid work. Mothers with higher education are strongly associated with decreases in child undernutrition, following the results of other studies undertaken elsewhere (Smith et al., 2014). Advanced maternal age appeared to have a positive association with child's WAZ and HAZ.

Other indirect determinants should also be taken into consideration. Children with parents that identify their race/ethnicity as white have better child's WAZ and HAZ results. Basic sanitation services must be accessible, affordable, and of adequate quality. Geographical location can be related to access better infrastructure public services and job opportunities; children living in urban areas are less vulnerable than those in rural areas. The same goes for children who are born in the South, Southeast and Central-West regions of Brazil, who are less vulnerable than those from the North and Northeast regions.

The findings are of great significance as it can be a reference for the evaluation of the correlation of women's empowerment and child undernutrition, particularly of children under 5 years old. A special focus is made towards women's employment and income security in Brazil, because this paper aims to shed light on the importance of assuring policies that encourage women's autonomy and protect their economic, social and political rights. Moreover, interventions to promote jobs opportunities and employment protection are measures to fight gender inequality and discrimination at work, thus, guaranteeing a better child nutritional status.

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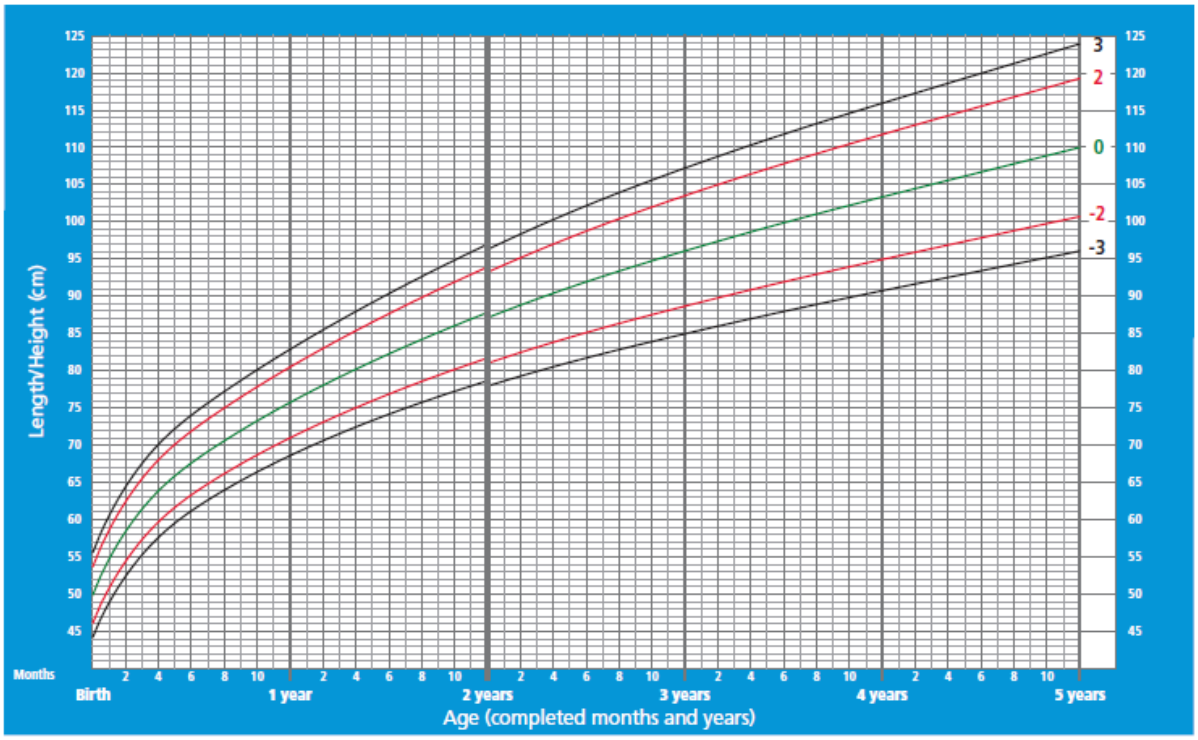
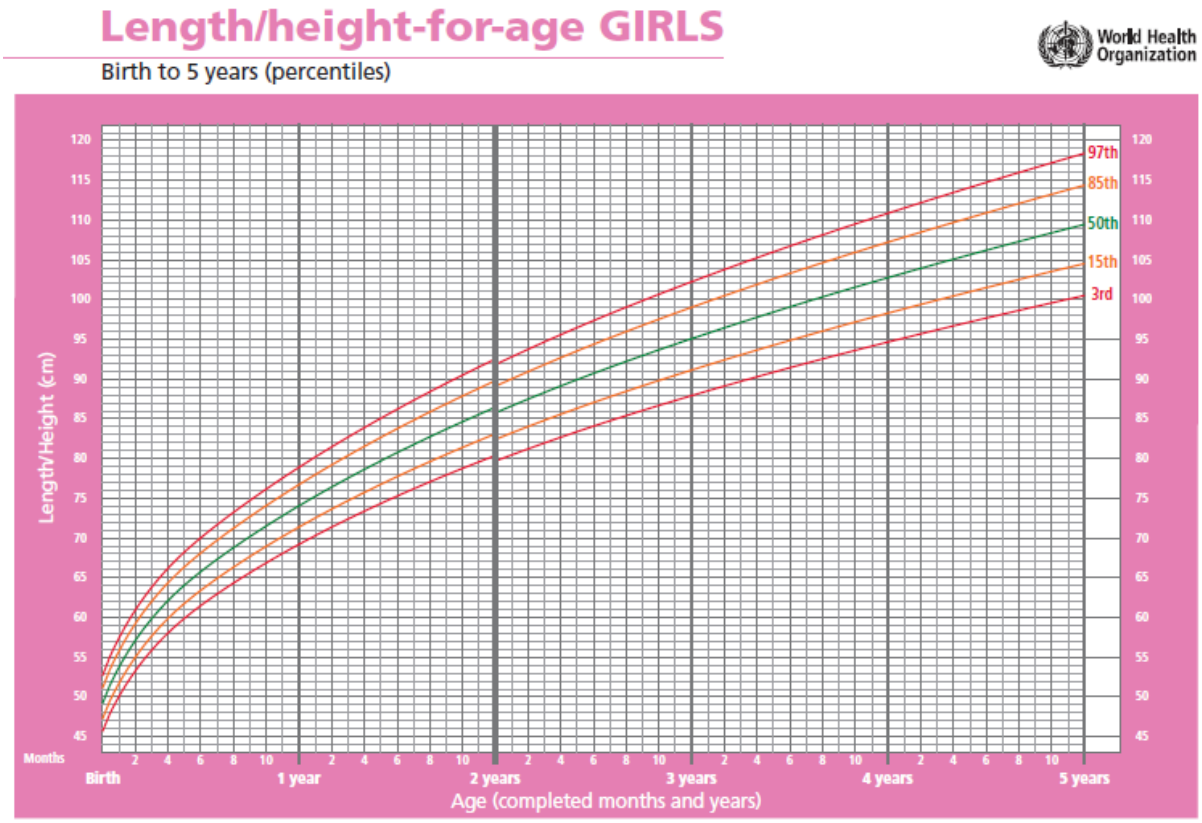
Appendix A


Length/height-for-age BOYS
Birth to 5 years (z-scores)
World Health Organization
Length/Height (cm)
Months
Birth
1 year
2 years
3 years
4 years
5 years
Age (completed months and years)
3
2
0
-2
-3
WHO Child Growth Standards

Appendix B


Length/height-for-age GIRLS
Birth to 5 years (percentiles)
World Health Organization
Length/Height (cm)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
97th
85th
50th
15th
3rd
Months
Birth
1 year
2 years
3 years
4 years
5 years
Age (completed months and years)
WHO Child Growth Standards