RELATIONSHIP BETWEEN HOUSEHOLD STRUCTURE, MATERNAL AUTONOMY AND UNDERNUTRITION IN BRAZILIAN CHILDREN

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ABSTRACT OF THE THESIS

Relationship between household structure, maternal autonomy and undernutrition in Brazilian children

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Child malnutrition is a problem in many countries, but especially in poorer communities. Stunting, an outcome of chronic undernutrition, contributes to poor quality of life, morbidity and mortality. Biological and socioeconomic factors contribute to malnutrition with recent studies focusing on aspects of maternal autonomy as an influencing factor. Maternal autonomy (defined as a woman's personal power in the household and her ability to influence and change her environment) is likely an important factor influencing child care, and ultimately, infant and child health outcomes. To examine the relationship between maternal autonomy and child stunting in Brazil, we analyzed data from the Women's National Demographic and Health Survey (Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher , PNDS 2006). Cross-sectional demographic, health and anthropometric data for mothers and their youngest child <60 months (n=3390) were used from PNDS. Maternal autonomy was estimated by the decision-making power of each woman in their household. Logistic regression analyses were used to test for associations between indicators of maternal autonomy and the risk of having a stunted child. Women with high autonomy indicated by the final say on what

items are to be cooked [odds ratio (OR) = 1.856; 95% confidence interval (CI) 1.004, 3.433] were significantly more likely to have a stunted child compared to women with low autonomy, after controlling for individual (education, work status) and household (wealth) level factors in the adjusted model. There was general lack of a strong and significant relationship between maternal autonomy variables and childrens' HAZ scores. In a national sample, such as the PNDS 2006, the number of stunted children is very low, as is the number of low-income households. In this scenario, maternal autonomy may not be the most significant variable since other structural variables, such as household wealth that may explain its effects. It is suggested that more research on women's autonomy and its effect on children's health and nutrition should be conducted in low income populations, where wealth status is not a confounding variable.

ABBREVIATIONS

DHS: Demographic and Health Survey

GDP: Gross Domestic Product

IUGR: Intrauterine Growth Restriction

LANPOP: Laboratory of Nutrition Evaluation of Populations

MDG: Millennium Development Goals

NCCD: Non-Communicable Chronic Diseases

PNDS: Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher

SD: Standard Deviation

SES: Socioeconomic Status

SPSS: Statistical Package for the Social Sciences

UNICEF: United Nations International Children's Emergency Fund

WHO: World Health Organization

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1 INTRODUCTION

Approximately 10.5 million children under five years of age worldwide die every year and 98% of these deaths reported to occur in developing countries (1). Early child mortality is the primary reason why four out of the eight United Nations' Millennium Development Goals (MDGs) focus on improving child health outcomes of malnourished children under-five years of age. The reduction of malnutrition is an important indicator of the progress of the MGD in the overall reduction of child mortality as it contributes to over one-half of child deaths (1). Undernutrition encompasses stunting, wasting, and malnutrition in two forms; deficiencies of essential vitamins and minerals as one form, and with obesity or over-consumption of specific nutrients as another form (2). Recent global estimates from 2007 show that 25% of the children under-five years of age were underweight, 28% were stunted, and 11% were wasted. Projections of current trends to 2015 point to declines in the prevalence of both stunting (3) and underweight among children (4), although such declines will still fall short of the 50% reduction in undernutrition established as an indicator for fulfilling the first Millennium Development Goal (MDG-1), to eradicate hunger (5).

Stunting is a measure of chronic undernutrition and a failure to achieve one's genetic potential for height and is caused by poor nutrition often compounded by infectious diseases (6,7). Children can reach their growth potential if they are nurtured in healthy environments and their caregivers follow recommended health, nutrition and care practices. The main causes of stunting include intrauterine growth retardation, inadequate nutrition to support the rapid growth and development of infants and young children and

frequent infections during early life (8). Although a child may not be classified as ‘stunted’ until 2–3 years of age, the process of becoming stunted typically begins in utero as a result of maternal malnutrition, which also leads to low-weight births (9). The end result, short stature, reflects the cumulative effects of poor nutrition and other deficits over several generations. Other factors that influence a child’s nutritional status are both biological and socioeconomic such as: nutritional status of the mother during pregnancy, the number of siblings the child has in the household, gender, wealth of the family, the society’s view of women, the educational status of the mother and father, and the occupations of the mother and father (2,10-13).

Recent studies have focused on other psychosocial factors that may influence childhood nutrition. One such factor is maternal autonomy, defined as the level of independence in her actions and control over resources a mother has within her household. Yet, there is limited data to understand this relationship. Given that a number of factors contribute to maternal autonomy, the aim of this study was to determine which socioeconomic determinants associated with maternal autonomy are also associated with childhood nutritional status, such as age, sex, birth order, level of education, work status, and household’s wealth.

In developing countries, such as Brazil, malnutrition is highly prevalent and is a major public health concern due to the unequal social and economic challenges (14) . Thus, using data from 2006 Children’s and Women’s National Demographic and Health Survey (Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher , PNDS), the following hypothesis were tested:

1 Women with higher autonomy are less likely to have stunted children.

2 Maternal autonomy - child stunting relationship is influenced by individual (education, work status) and household (wealth) level factors.

2 REVIEW OF THE LITERATURE

2.1 Overview of Nutrition and Health in Developing Countries

According to UNICEF, child malnutrition remains a major public health problem in developing countries where one third (178 million) of children under-five years of age are stunted (height-for-age below –2 standard deviation of reference values) (15). Thirty six countries with a stunting prevalence of 20% or more are located mostly in Africa and Asia which accounts for 90% of all stunted children worldwide; of the 52 countries with prevalence of less than 20%, the majority them are found in Latin America and the Caribbean with 16% prevalence (1,2,15). In developing countries, stunting is more prevalent than underweight (low weight for age, 20%) or wasting (low weight for height, 10%) possibly because height gain is even more sensitive to dietary quality than is weight gain (9).

Stunting often goes unrecognized by families who live in communities where short stature is so common that it seems normal. Even among health workers, stunting generally does not receive the same attention as underweight or wasting (low weight for height), especially if height is not routinely measured as part of community health programs (9). Many families, health workers and policy makers are unaware of the consequences of stunting so it may not be viewed as a public health issue.

2.1.1 Public Health Significance of Undernutrition

Among non-income measures of welfare, children's nutritional status is arguably one of the most important and widely used. Children's nutritional status is important

because it provides critical information about the living conditions of some of the most vulnerable members of society: young children (16). The World Health Organization (WHO) estimates that child malnutrition contributes to over 30% of under-five deaths from acute respiratory diseases, diarrhea, and other neo- or perinatal deaths (17). This is because malnutrition increases the risk of and duration of childhood illnesses such as tuberculosis, measles, diarrhea, and malaria via a decrease in cellular immunity (18). A recent UNICEF report indicates that reducing the prevalence of malnutrition in developing countries is probably the most significant preventive measure we could take to reduce child mortality from acute respiratory infections and diarrheal diseases (19).

Children who are malnourished are at greater risk for impaired brain development and body function, which decreases their ability to accrue life skills, in turn reducing their chances at survival and productivity (10,20). Well nourished children are more likely to start school at an earlier age, repeat fewer grades in school, and will either enter the labor force earlier or will complete more years of school, or both, and can achieve as much as 46% higher earnings than their undernourished counterparts (21,22).

Addressing malnutrition will help achieve at least three of the eight Millennium Development Goals (MDGs) by reducing the proportion of people suffering from hunger (Goal 1), improving the number of children who are able to complete primary school (Goal 2), and reducing the under-five mortality rate (Goal 4) (5).

2.1.2 Nutrition Transition and Socioeconomic Challenges in Brazil

Nutrition transition is a shift from high prevalence of undernutrition to predominance of diet-related non-communicable chronic diseases (NCCD). It has been

associated with the rapid process of urbanization and economic growth through technological changes and innovations that lead to reduced physical activity in the work place and at leisure time, and changes in food patterns and dietary intake, including increased consumption of energy-dense processed foods (23). Rapid and broad economic, demographic, environmental and cultural changes have occurred over the last quarter of the 20th century in most developing countries, but the effect of these changes on the nutritional profile of populations remains to be fully assessed (24).

The prevalence of undernutrition is declining in most countries and regions in the world. Of seventy low- or middle-income countries that conducted two or more surveys between 1971 and 1999, 42 showed a decline in child stunting, 17 showed no major change over the period, and 11 (9 of them in Africa) showed an increase (25) . In Brazil, three national health and nutrition surveys conducted between 1974–75 and 1996 have pointed to declining trends in the prevalence of stunting (26,27) . At the same time, a socioeconomic inequality analysis showed pronounced within-country socioeconomic inequalities in child stunting, particularly in Latin America and the Caribbean, and Brazil ranked fifth among these 47 low- and middle-income countries in terms of such inequality (28). The level of poverty is significantly above the norm for a transitional country since social inequality and wide income disparities are still a major problem.(29). Earnings of women are 29% lower than men on average even when working women receive on average an additional year of education (30). More recently, between 1995 and 2004, the prevalence of poverty decreased by 8 percent and was attributed to an increase in the gross domestic product (GDP) and improvements in income distribution (31). This socioeconomic development coupled with equity-oriented public policies have been

accompanied by marked improvements in living conditions and a substantial decline in child undernutrition, as well as a reduction of the gap in nutritional status between children in the highest and lowest socioeconomic status, but the problem still persists (32). This is why it is important to further study the different factors which influence children's nutritional deficiencies.

2.2 Consequences of Stunting

Nutritional requirements to support rapid growth and development are very high during fetal life and the first 2 years after birth. In many developing countries average height-for-age z-scores at birth are already low (below 0, the standard score) and decline sharply during the first 24 months of life but show no further decline or any improvement thereafter (33). Therefore, children who are stunted usually grow up to be stunted adults (34). Childhood stunting is related to long-term consequences in two ways: a direct cause of short adult height and suboptimal function later in life, and as a key marker of the underlying processes in early life that lead to poor growth and other adverse outcomes.

There is growing evidence of the connections between slow growth in height in early life and impaired health and educational and economic performance later in life. The Maternal and Child Undernutrition Study Group (10) reviewed cohort studies from five low-income and middle-income countries: Brazil, Guatemala, India, Philippines and South Africa. The studies involved long-term follow-up of children into late adolescence and adulthood. The study group concluded that small size at birth and childhood stunting were linked with short adult stature, reduced lean body mass, less schooling, diminished

intellectual functioning, reduced earnings and lower birthweight of infants born to women who themselves had been stunted as children.

A woman is considered to be stunted if they are less than 145 cm or 4′7″. This may represent increased risks of survival, health and development of her offspring. It can restrict uterine blood flow and growth of the uterus, placenta and fetus. Intrauterine growth restriction (IUGR) is associated with many adverse fetal and neonatal outcomes (2,35,36). During pregnancy, IUGR may lead to chronic fetal distress or fetal death. Infants with IUGR often suffer from delayed neurological and intellectual development, and their deficit in height generally persists to adulthood (2). In a recent analysis of 109 Demographic and Health Surveys (DHS) conducted between 1991 and 2008 in 54 countries, children (under 5 years of age) who were born to the shortest mothers (<145 cm) had a 40% increased risk of mortality after adjusting for multiple factors (37). Furthermore, effect of short maternal stature on child mortality was comparable to being in the poorest 20% of households or the effect of having no education.

Growth restriction in early life is linked not only to short adult height but also to certain metabolic disorders and chronic diseases in adulthood. Data from the Maternal and Child Undernutrition Study Group (10) indicate that lower birth weight (which is strongly correlated with birth length) and undernutrition in childhood are risk factors for high glucose concentrations, blood pressure and harmful lipid profiles in adulthood after adjusting for adult height and BMI. Hoffman *et al*. found that stunted children are more likely to deposit fat centrally when entering puberty, a significant risk factor for chronic diseases (38) . The ‘developmental origins of health and disease’ hypothesis suggests that the intrauterine and early post-natal environment can modify expression of the fetal

genome and lead to lifelong alterations in metabolic, endocrine and cardiovascular function (39). This suggests that the process of stunting is harmful, not only necessarily short adult height itself but also the increased risk for metabolic disorders and chronic diseases in adulthood.

The process of becoming stunted, due to restricted nutrient supply and/or frequent infection, is likely a common cause of both short stature and structural and functional damage to the brain, resulting in delay in the development of cognitive functions as well as permanent cognitive impairments (40). In young children, underweight and stunting are also associated with apathy, less positive affect, (41) lower levels of play, and more insecure attachment (42) than in non growth-retarded children. Longitudinal studies show more problems with conduct, poorer attention, and poorer social relationships at school age (6,43-45, 98) . The Maternal and Child Undernutrition Study Group, using the same pooled cohort mentioned above, found that being stunted at 24 months was associated with a reduction in schooling of 0.9 years, an older age at school enrollment and a 16% increased risk of failing at least one grade in school after controlling for confounding variables such as sex, socioeconomic status and maternal schooling (46). Evidence from other developing countries also indicates that being stunted between 12 and 36 months of age is associated with poorer cognitive performance and lower school achievement in middle childhood (47). Furthermore, Thomas & Strauss found a link between short stature and lower economic productivity in a large cross-sectional study in Brazil, a 1% increase in height was associated with a 2.4% increase in wages (48) .

The studies discussed above provide strong evidence that stunting matters for two reasons. First, it strongly affects adult height, which has an impact on health among

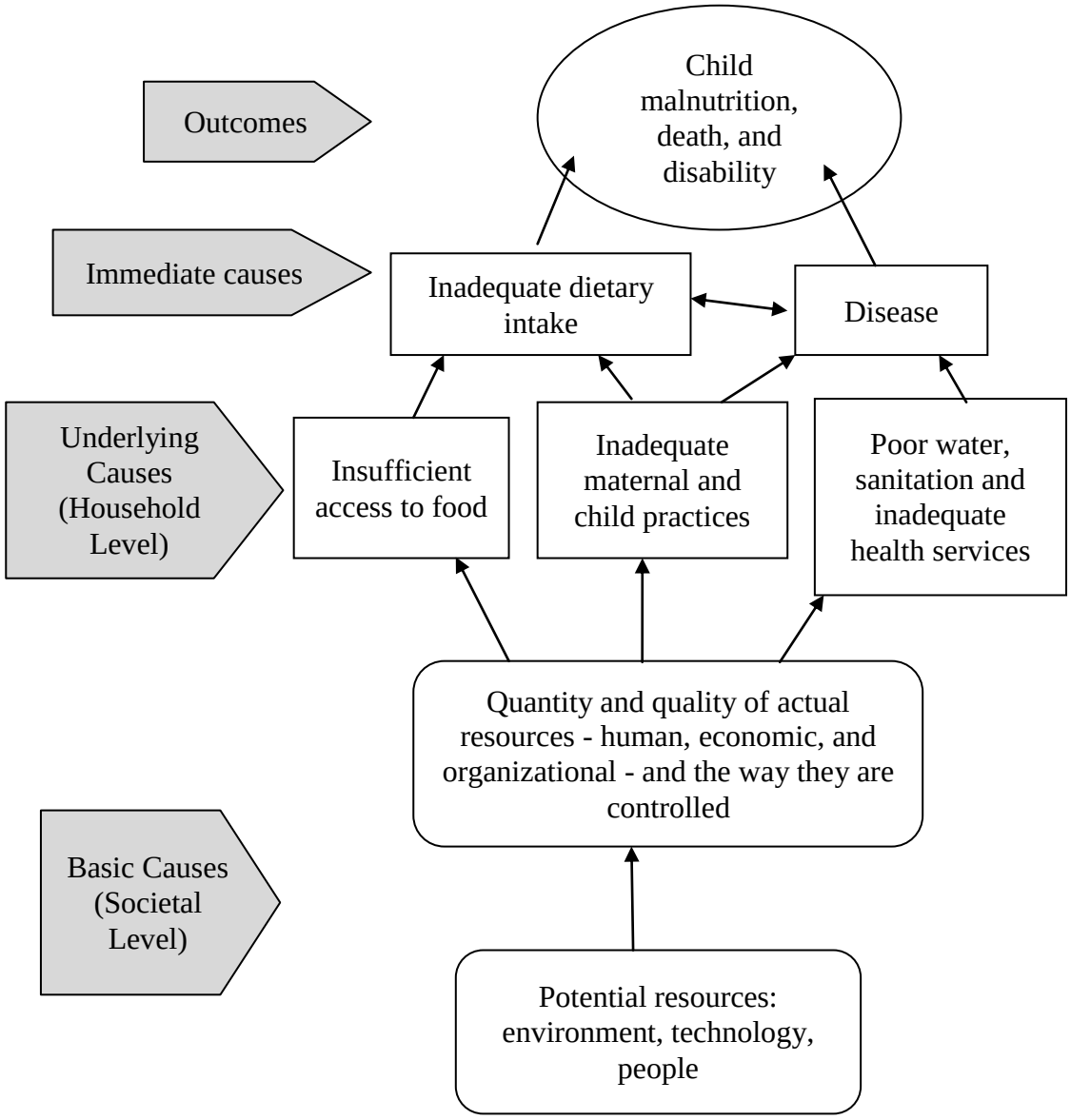
women and survival of their children, as well as their own reproductive health, and has been linked to economic productivity among men. Second, the process of stunting reflects damage that affects health and development over the long term.

2.3 Etiology of nutritional deficiencies

There have been numerous studies over the years researching what factors impact child malnutrition. These factors can be classified into two categories: biological and social determinants. Biological determinants include such factors as child sex, and birth order, while social determinants include factors such as family socioeconomic status (SES), place of residence, parental education, parental employment, and the status of women.

The United Nations Children's Fund's conceptual framework for the causes of child malnutrition, death, and disability (49) lays out the immediate (most proximate), underlying, and basic (most distant) causes of child malnutrition (Figure 1). The two immediate causes are inadequate dietary intake and disease. Children can become malnourished either because they do not eat sufficient food of the appropriate form or quality or because they are sick. Illness depresses a child's appetite and inhibits the absorption of nutrients. It also diverts nutrients away from contributing to a child's growth and toward fighting the illness (13). The underlying causes of malnutrition, which manifest themselves at the household level, are food insecurity, inadequate maternal and child care practices, and poor health environments and services.

Figure 1 The causes of child malnutrition, death, and disability



Adapted from- *The State of the World's Children 1998* UNICEF (49)

Care can be defined as the practices of caregivers that affect nutrient intake, health, and cognitive and psychosocial development of a child (50). Although the actual amount of food ingested by a child is closely related to food security, it is critically

dependent on the care-related feeding behaviors of the child's caretaker, such as breastfeeding, complementary feeding, and food preparation. Similarly, a child's health is linked to the health environment in the community in which the child lives, but ultimately it is dependent on the caregiver's use of facilities and services to optimize the child's health (51). The ability of caretakers, usually their mothers, to provide care to children ultimately rests upon the quality of the care they themselves receive.

In this framework, women's autonomy can be considered both an underlying and a basic cause of child malnutrition. The effects of women's autonomy ultimately manifesting themselves at the household level and potentially influencing children's nutritional status via food security, maternal and child care, and health environment and service, such as health clinics.

2.4 Biological and Social Determinants of Nutrition

2.4.1 Family SES

The primary causes of undernutrition are low economic resources (poverty) and low food availability. Food insecurity is defined as "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (52). Availability may influence how much food is in a given household but not how it is distributed within (53). Baig-Ansari results show that there is a significant variability in child nutritional status, even among very-low income families living in the same household and neighborhood (54), and improved nutritional status has been linked to culturally driven beliefs and practices about feeding children (55,56). These findings suggest that it is not only economic disadvantage and food

availability that influence adequacy of children's diet, there are other non-economic factors that influence as well.

2.4.1.1 *Maternal education*

Maternal education is defined by the number of years of schooling completed by the mother in the public school system. However, there are other dimensions of education that relate to child nutrition, different pathways by which maternal education affects caregiving practices (50) . Such pathways include a mother's ability to process information, ability to acquire skills and ability to model behaviors (50).

Education, however measured, has a complex relationship with care practices. It increases both the ability to earn income and the ability to appreciate the importance of care-giving (50). It is also important to recognize that even though maternal education is associated with family economic resources, associations between maternal education and offspring nutrition occur even after controlling for family economic resources (57). Many studies use breastfeeding as a nutrition-related outcome. Research in developing countries report an association between maternal education and breastfeeding but in both directions. Some studies reported that more educated women have shorter durations of breastfeeding or less exclusive breastfeeding (58,59), while others found that more educated women have longer and more exclusive breastfeeding periods (60,61). Other related outcomes from developing countries relate higher levels of maternal education to better physical growth in infancy and early childhood (62-64).

A number of alternative mechanisms have been proposed through which higher levels of maternal education may translate into better offspring nutrition, aside from economic factors (65). For example, more educated women may be more involved in

promoting their child's nutrition and health and take an active role in family decisions about food purchases than less educated women (57). Mothers might have more input into decisions for resource allocation with their gained knowledge and verbal skills (66), or that education may increase a mother's empowerment through increasing her access to outside resources like job opportunities (67).

Recent studies also suggest that big and literate social networks are associated with better child nutrition, especially among the poor (68) . These patterns may be explained by the tendency of women to take up outside employment and thereby foster new links with people – largely other women – whom they would otherwise not have met (68). A study by Moestue et al. in India, found a positive association between child's height-for-age z-score and mother's social network size and social network literacy rate. The association with social network literacy was stronger among the poorest households. Women commonly reported seeking or receiving health advice from social network members.

2.4.1.2 *Maternal Employment*

There are two basic pathways in which maternal employment can affect child nutritional status. It can decrease the risk of malnutrition if it results in greater decision-making authority in the home and more money which can be spent on food and resources for child care (12,69). On the other hand, it can increase the risk of malnutrition if the mother has to work away from home, thus taking away from time she would spend taking care of her children and looking after their feeding (69). Women who work are more likely to stop breastfeeding and use milk substitutes, and may have to leave their children

to substitute caretakers (69,70). However, several studies have shown maternal employment as a protective factor for child nutrition status (12,71).

2.4.2 Child Gender

There is an interesting trend in the association between child gender and nutritional status. Studies show the influence of gender upon differences in dietary intake or nutritional status is highly variable. For example in Asia, female children tend to be more malnourished than male children (72,73),while other studies report no relationship between gender and child nutrition (74). The varying results may be moderated by different factors, such as birth order (75) or number of male and female children in the family (56,57) and household decisions on how to allocate supplementary food resources (57).

2.4.3 Family and birth order

The role of family is an important influence for nutritional status of children and it has been reinforced by the household production function perspective, that is defined as "a dynamic process that occurs within the household to allow family members to combine their knowledge, resources and patterns of behaviors, either to promote, recover, or maintain health status" (76,77).

The dimensions of family structure also play an important role in determining the nutritional status of children. In a recent study among Mexican low income urban families, higher risk of malnutrition was associated with a longer duration of parents' union (75). This could be explained by the economic and social burden on poor families

with several children, which may lead the mother to give less attention to her younger children, whose nutritional status suffers as a consequence (75). Madharavan noted that children in South Africa who had more siblings and more older siblings were more likely to be undernourished than children with fewer siblings and fewer older siblings, even when controlling for age (78). Regarding birth order, studies show that children with more siblings were more likely to be stunted than their siblings because of the increased competition for food (69,79).

2.4.4 Maternal Social Status

No consensus has been reached on a single definition of the widely employed term "women's status." It has been associated with women's autonomy, power, empowerment, authority, valuation, and "position" in society, and also simply with women's well-being (13) . Sometimes these components are considered in an absolute sense and sometimes relative to men. This failure to define is not an obstacle to understanding the impacts of women's status, but it makes it especially important to clearly specify what is meant each time it is used (13).

The International Food Policy Research Institute's report of 2002, "The Importance of Women's Status for Child Nutrition in Developing Countries," states that women's status affects child nutrition in three main ways: food security, caring practices for women and children, and quality of the health environment. The report measured maternal status by looking at two variables: societal gender equity, and women's decision–making power. Researchers determined that women's decision-making power had a significant, positive effect on height-for-age, weight-for-height, and weight-for-age

in Sub-Saharan Africa, while societal gender equality did not (13). In addition, women's decision-making power has a stronger effect on child nutritional status in poorer household than in richer ones, because influencing decisions over the allocation of resources is more important when those resources are few (13). Furthermore, an ethnology study of Balinese culture highlighted the fact that "the ability to make decisions endows the decision-maker, man or woman, with a sense of independence and command of his or her own destiny"(80). These results can be translated into an improved child nutritional status when a mother has greater independence.

2.4.4.1 *Maternal Autonomy*

A recent UNICEF report states that eliminating gender discrimination and empowering women will have a profound and positive impact on the survival and well being of children (1). More of the current studies are looking at the impact of maternal autonomy on child nutrition. This is because maternal autonomy, described in this study as how much control a mother has within her household to access resources and behave independently, determines how well a mother is able to act in a manner which best promotes the survival and growth of her children. According to Brunson *et al* (2009), studying maternal autonomy is important for two main reasons—the first being that autonomy gives empowerment, which is a basic human right, and the second being that autonomy gives a perspective into theories of "parental investment." The premise for this is that it is in the best interest of males to produce as many children as they can (offspring quantity) while it is in the best interest of females to invest in the children they currently have by taking care of them to the best of their ability (offspring quality) (81).

Autonomy and control of resources gives caregiver's the ability to play a role in decisions made within the household and the community. Allowing the mother whom in most cases is the caregiver to gain control of, and access to resources and makes her more likely to provide effective child nutrition and ultimately impact child growth. Several studies have observed specific dimensions of maternal autonomy impact child growth. Begin et al. found that a caregiver's decision-making abilities was associated with child feeding practices and child stunting after controlling for household structure, income generating activities and social support (82). Another study found children to be significantly less stunted in a female-headed vs. male-headed households, suggesting that income generated by women is being allocated for adequate dietary intake (83). Studies have also observed that a woman's autonomy influences her health behaviors, thus contributing to her overall health status, (84) and with strong connections to maternal health care utilization (85) . A recent study by Shroff et al. observed that maternal autonomy was inversely related to child stunting in India (86) and Adhikari et al. showed that infant mortality in Nepal was significantly lower among those mothers who were involved in decisions regarding their own health care compared to those who were not (87).

Autonomy is a multidimensional concept, with four key elements: decision-making capacity inside and outside the house; mobility outside the house; financial independence; and attitude towards domestic violence (88-92). Previous studies have found that each of these domains have independent effects on health behaviors and outcomes. Therefore the use of a single index to represent autonomy is discouraged, since it dilutes the true effects of each dimension (90,92-94). As described above, there is a

direct and a complex indirect pathway in the relationship between women's autonomy and health outcomes, such as child growth and survival.

3 SUMMARY AND HYPOTHESIS

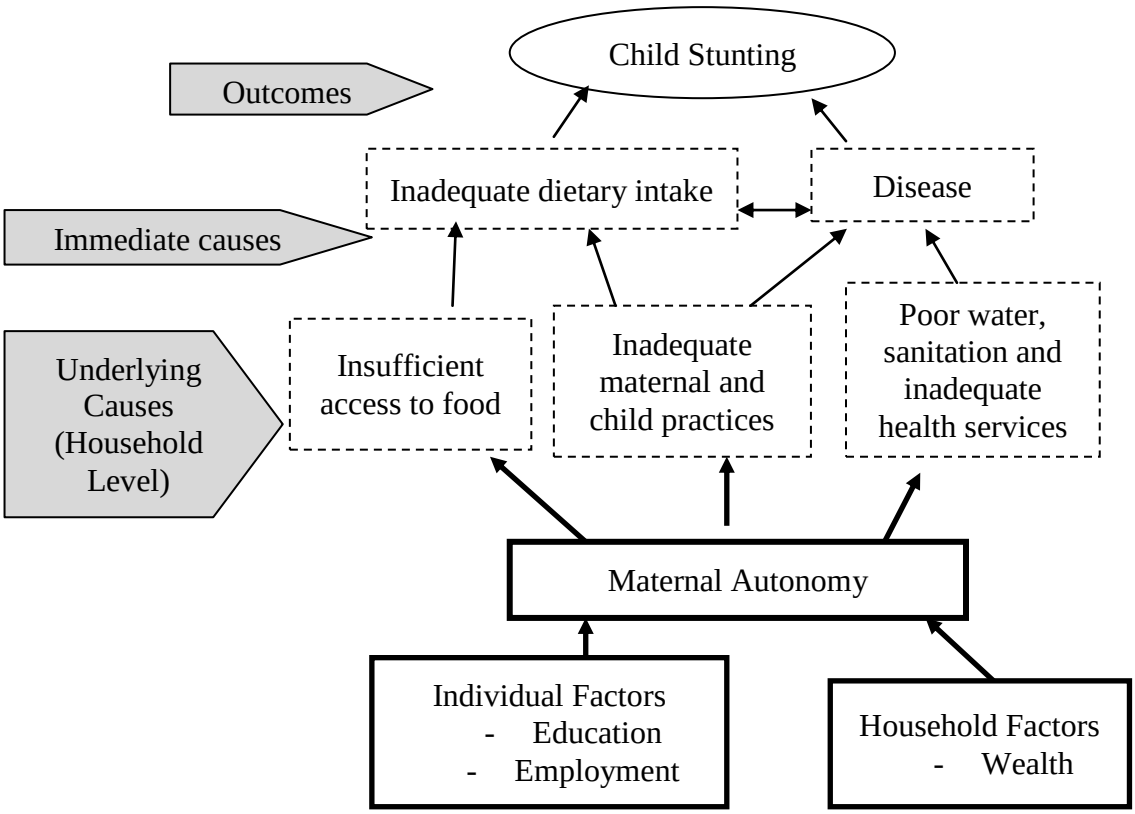
According to the UNICEF conceptual framework (50), underlying factors, such as feeding and care practices, maternal autonomy, household food security and community health services, affect dietary intake, morbidity and nutritional health status. Maternal autonomy can be considered as a determining factor for stunting by the concept that mothers are the primary caregivers of their children in many developing countries. Yet, there is limited data to understand this relationship and is the focus of this study. Given that a number of factors contribute to maternal autonomy, the aim of this study was to determine which socio-economic determinants associated with maternal autonomy are also associated with childhood nutritional status, such as age, sex, birth order, level of education, work status, and household's wealth (Figure 2). In this adapted framework, women's autonomy can be considered both an underlying and a basic cause of child malnutrition. Its effects can ultimately manifest themselves at the household level and potentially influence children's nutritional status via food security, maternal and child care, and health environment and service.

Using data from 2006 Children's and Women's National Demographic and Health Survey (Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher , PNDS), the following hypothesis were tested:

1- Women with higher autonomy are less likely to have stunted children

2- Maternal autonomy - child stunting relationship is influenced by individual (education, work status) and household (wealth) level factors

Figure 2 Hypothesis - Causes for stunting



Adapted from - *The State of the World's Children 1998 UNICEF (49)*

4 METHODS

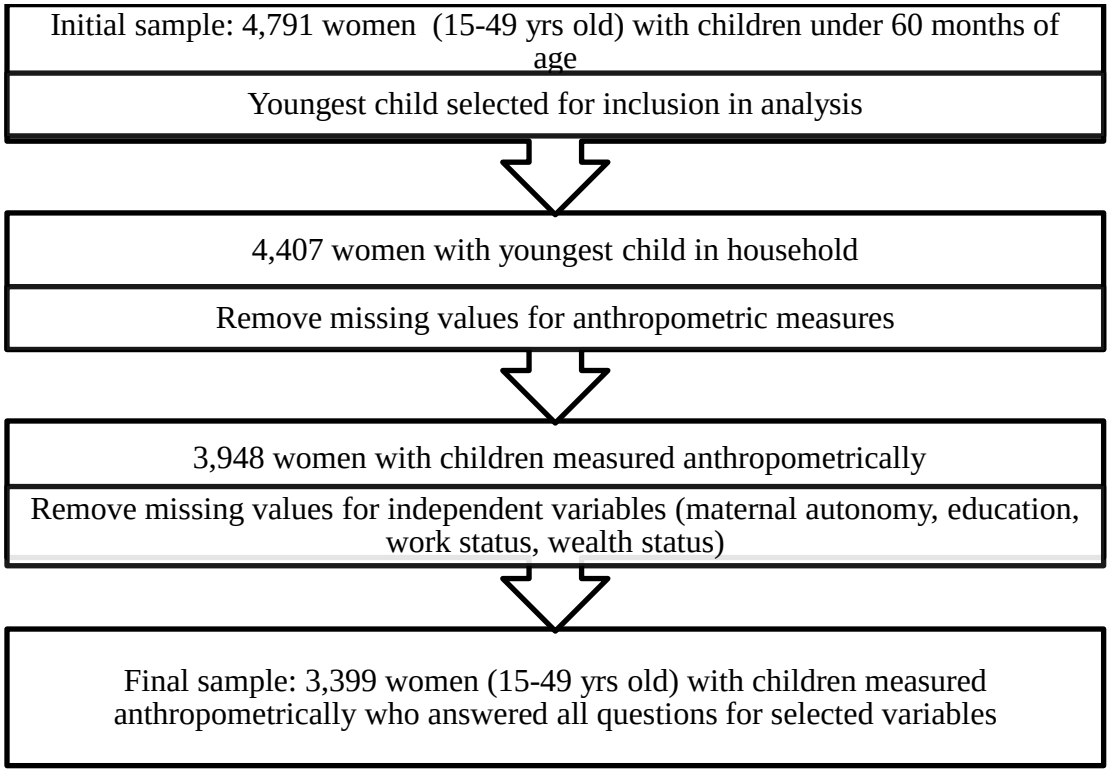
The data is derived from the third edition of the Children's and Women's National Demographic and Health Survey (PNDS), conducted in 2006, in Brazil. It is a population-based investigation with household inquiry in a representative sample of women of reproductive age (15 – 49 years) and mothers of children younger than 5 years of age. The PNDS project was approved by the Research Ethics Committee of the Sexually Transmitted Diseases/AIDS Reference and Training Center of the Health Secretariat of the state of São Paulo. This is a cross-sectional study, with complex sampling and national representativity. The sample units were selected in two stages from within each stratum (five different macro-geographical regions of Brazil: North, Northeast, Southeast, South, and West–Central, differentiated between urban and rural areas): primary units, which are the census sectors themselves; and secondary units, which are the private residential units. The fieldwork began in November 2006 and ended in May 2007, collecting data from 14,617 households, further details about the data collection and sample stratification are reported elsewhere (95).

4.1 Participants

PNDS child, woman, and household databases were merged and organized. This survey covered 15,575 women. For these participants, there were 27,477 children under 18 years. For the purpose of this study, information pertaining to women with children <60 months of age (n=3,948), who had complete anthropometric data were extracted. Where households included more than one eligible child, the youngest child was selected

for inclusion in our analysis to ensure that the observations were not clustered within households. The final sample consisted of 3,399 mother-child dyads. (Figure 3)

Figure 3 Flow chart of sample selection



4.2 Measures

4.2.1 Dependent Variable

The 2006 PNDS included an anthropometric component. The measurement of weight and height of women and children and waist circumference of the women was carried out according to WHO recommendation (96). The weight and height of every child were measured twice to minimize measurement errors and increase precision by using their average value. Weight measurements were obtained on an electronic scale accurate to the nearest 100 g. For children younger than 2 years of age, length was

measured to the nearest millimeter in the recumbent position using an infantometer . Children older than 2 years were measured in a standing position using a stadiometer. All instruments were calibrated daily. Training of anthropometric measurements was performed in two steps. At first, team coordinators were trained in the Laboratory of Nutrition Evaluation of Populations (LANPOP) at the Department of Nutrition in the University of Sao Paulo. Benchmarking was performed by each coordinator, after obtaining satisfactory performance; each coordinator was responsible for training a group under his/her responsibility.

For this information, Z-scores were tabulated for height-for-age in order to show units of deviation from the mean as an indicator of stunting. A z-score less than -2 standard deviations (SD) for height-for-age indicated stunting based on the World Health organization/National Center for Health Statistics reference (97). A binary variable was created to define stunting, "not stunted" (Z-score greater than -2 SD) and "stunted" (Z-score less than and equal to -2SD).

4.2.2 Independent Variables

The primary independent variable used in our analysis was maternal autonomy. The decision-making power included final say on (1) own healthcare, (2) final say on child's healthcare, (3) making household purchases for daily needs, (4) foods to be cooked each day, (5) visits to family or relatives, and (6) making large household purchases. Response options were: a) respondent alone; b) respondent and husband/partner; c) respondent and other person; d) husband/partner alone; e) someone else. The value of 0 (low autonomy) was assigned if the response was (d) and (e), that is,

low involvement of the respondent, or 1 (high autonomy) was assigned to (a), (b) and (c) for respondent alone or some involvement.

Covariates considered in the models exploring the relationship between maternal autonomy and child stunting comprised of: (1) individual maternal factors – education which was measured by a binary scale based on highest level of education (basic and no schooling (0 -6 yrs) or secondary (7+more), and work status (working or not working). (2) Household level factor – family's position in the wealth index (Poorest, Poorer, Middle, Richer, Richest quintiles based on scores of household assets).Child variables included age, sex, and birth order (1, 2, 3, 4+).

4.3 Statistical Methods

Statistical analyses were carried out using SPSS v. 19. PNDS child, household, and woman datasets were merged and organized according to strata and primary sampling unit. Using the "sample weight" variable of the PNDS database, cases were weighted to correct oversampling of subgroups and non-response bias.

In SPSS, the complex samples package was used to account for weighting. Bivariate analysis with Chi-square statistics was performed to test the independence of distribution between independent variables. The first one was done between stunting and socio-demographic factors (Table 2) and the second between autonomy variables and stunting (Table 3).

The final logistic regression models were done with HAZ (binary) as a dependent variable to assess the net effect of each maternal decision-making variables on stunting. The first models contained the individual and household variables related to maternal

autonomy, maternal education, work status, and wealth score. The final models contained other demographic and socioeconomic characteristics (child's sex, age and birth order). The associations between covariates and main explanatory variables were considered to be statistically significant when $P < 0.05$.

5 RESULTS

After excluding respondents with missing values for any of the examined variables, the final sample population was 3,399 mothers who completed the PNDS survey with most-recently born children under five years old who were measured anthropometrically. Table 1 presents the descriptive statistics for child, mother and household variables. Children's age ranged from 0-59 months with both sexes represented equally (male=51%), more than half of children were 1st or 2nd born (69%). The anthropometric measures show that 251 (7%) of the children had a height-for-age Z-score under -2 SD.

The majority of mothers were between 25-34 years of age (48.4%), had achieved the primary education level (58.3%) and only 36.7% of the mothers worked. Looking at household characteristics, they were all pretty much evenly distributed between (19.4% - 20.8%) in the wealth index and the majority of the households were located in rural areas (66%).

Bivariate association among socio-demographic factors and stunting are shown in Table 2. Child's age was significantly associated with stunting, ($p<0.05$), with higher rates of stunting among younger children and the highest in children 12-23 months of age. Mother's level of education was also statistically significant; rates of stunting was lower for the higher educational level. Table 3 represents the proportions of stunting by different maternal autonomy variables. Only "has final say on what items are to be cooked" was significantly associated with stunting (P= 0.022).

Table 1 Characteristics of mother and child dyads in Brazil (n=3,399)

Characteristics	n	Percentage
Children		
Age, month		
0-11	795	23.40
12-24	742	21.80
24-35	696	20.50
36-47	621	18.30
48-59	545	16.00
Sex		
Boys	1734	51.00
Girls	1665	49.00
Birth Order		
1	1323	38.90
2	1022	30.10
3	563	16.60
4+	491	14.40
Anthropometric measures	**n**	**Mean (SE)**
Weight(kg)		
0-11 months	791	7.50 (0.08)
12-23 months	739	10.94 (0.06)
24-35 months	692	13.30 (0.07)
36-47 months	621	15.48 (0.10)
48-59 months	545	17.68 (0.12)
Height (cm)		
0-11months	791	65.25 (0.25)
12-23 months	739	80.3 (0.19)
24-35 months	692	89.68 (0.18)
36-47 months	621	97.58 (0.20)
48-59 months	545	105.17 (0.21)
Height-for-age Z-score	3399	-0.32 (0.02)
Weight-for-age Z-score	3399	0.14 (0.02)
Weight-for-height Z-score	3399	0.54 (0.02)
Stunting		
<-2 SD height-for-age Z-score	251	-2.60 (.04)
≥ -2 SD height-for-age Z-score	3148	-.14 (.02)

Table 1 Continued

Characteristics	n	Percentage
Mothers		
Age, years		
15-24	1229	36.20
25-34	1646	48.40
35-49	524	15.40
Education		
Basic (0-6 yrs)	1981	58.30
Secondary (7+ more)	1418	41.70
Work status		
Non-working	2151	63.30
Working	1248	36.70
Household Variables		
Wealth Index		
Poorest	670	19.70
2	706	20.80
3	693	20.40
4	669	19.70
Wealthiest	661	19.40
Place of Residence		
Rural	2242	66.00
Urban	1157	34.00

Table 2 Bivariate associations of stunting with socio-demographic factors

	n	% Stunted	P-value
Children			
Age, month			.000*
0-11	795	7.0	
12-23	742	10.5	
24-35	696	8.0	
36-47	621	6.6	
48-59	545	3.7	
Sex			.095
Boys	1734	7.7	
Girls	1665	7.0	
Birth order			.073
1	1323	5.4	
2	1022	6.0	
3	563	9.4	
4+	491	13.2	
Mothers			
Age, years			.072
15-24	1229	8.6	
25-34	1646	6.0	
35-49	524	7.8	
Education			.010*
Basic (1-6 yrs)	1981	9.5	
Secondary (7+ more)	1418	4.4	
Work status			.456
Non-working	2151	7.7	
Working	1248	6.7	
Socioeconomic			
Wealth Index			.062
Poorest	670	11.0	
2	706	7.2	
3	693	6.6	
4	669	6.9	
Wealthiest	661	5.3	
Place of Residence			.901
Rural	1157	8.3	
Urban	2242	6.8	

*Significant difference indicated by $p<0.05$, based on weighted chi-square statistic

Table 3. Bivariate associations of stunting with maternal autonomy

Autonomy Variables	Categories	N	% Stunted	P-value
Decision-making power				
Has final say on:				
Own healthcare	Respondent decides plays a role	3204	7.1	.074
	Respondent doesn't play a role	195	12.3	
Childs healthcare	Respondent decides plays a role	3184	7.4	.884
	Respondent doesn't play a role	215	7.4	
Making household purchases for daily needs	Respondent decides plays a role	2484	7.4	.861
	Respondent doesn't play a role	915	7.3	
What foods are to be cooked each day	Respondent decides plays a role	2972	7.4	.022*
	Respondent doesn't play a role	427	7.5	
Visits to family or relatives	Respondent decides plays a role	2800	7.1	.780
	Respondent doesn't play a role	599	8.5	
Making large household purchases	Respondent decides plays a role	2096	7.3	.766
	Respondent doesn't play a role	1303	7.6	

*Significant difference indicated by $p<0.05$, based on weighted chi-square statistic

The results of the final logistic regression analysis are found in Table 4. The only autonomy variable that remained significant associated with stunting, even after controlling for maternal education, employment and household wealth, was "final say on what foods are to be cooked". According to these results, a mother having a high level of autonomy to decide what foods are to be cooked each day was 1.9 times more likely to have a stunted child. The socio-demographic covariate that maintained significant association with child stunting was child's age (older children had a protective effect) in all models (Appendix A- F).

Table 4 Associations between maternal autonomy variables and stunting – using weighted logistic regression results for height-for-age

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI) ‡	
	OR (CI)	SE	OR (CI)	SE
Has final say on own healthcare				
Low	Ref	-	Ref	-
High	.455 (.156 – 1.324)	.545	.417 (.144 – 1.207)	.541
Has final say on child's healthcare				
Low	Ref	-	Ref	-
High	1.017 (.393 – 2.632)	.485	.995 (.381 – 2.602)	.490
Has final say on daily purchases				
Low	Ref	-	Ref	-
High	1.081 (.603 – 1.941)	.298	1.080 (.592 – 1.970)	.307
Has final say on what foods are to be cooked				
Low	Ref	-	Ref	-
High	1.981* (1.098 – 3.576)	.301	1.856* (1.004 – 3.433)	.313
Has final say on visits to family/relatives				
Low	Ref	-	Ref	-
High	1.089 (.647 – 1.834)	.266	1.010 (.587 – 1.739)	.277
Has final say on making large household purchases				
Low	Ref	-	Ref	-
High	1.116 (.669 – 1.862)	.261	1.020 (.595 – 1.750)	.275

*Statistical significance based on 95% confidence interval not crossing 1, ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. (Appendix A-F – coefficients of the variables are found in the appendix)

6 DISCUSSION

Recent literature suggests that women's autonomy may be one of the important social variables responsible for influencing child nutritional status (81, 86). In particular, Begin *et al.* found that mothers' higher decision-making power surrounding child feeding is a significant predictor of improved height-for-age z-scores (82). Therefore mothers with greater autonomy may also benefit in other ways that indirectly affect their child.

In this study, child stunting was positively associated with mothers who reported having high "final say on what foods are to be cooked", after adjusting for individual (education, work status) and household (wealth) level factors in the crude model. This result might be related to the fact that Brazilian mothers of high income do not play a role in deciding that to cook each day since they most likely have help in the house who decide that. Therefore low income mothers with higher autonomy to decide what items are to be cooked may be the mothers who also have children who are stunted.

Turning to the socio-demographic variables, the odds of stunting decreased with child age. These results may be explained because after six months children start supplemental feeding and by twelve months most children can eat the same types of foods that the rest of the family consumes (99). Therefore an older child might have more options of food to eat which in turn maintains their health.

The general lack of a strong and significant relationship between maternal autonomy variables and their children's HAZ scores was not entirely surprising. In a national sample such as the PNDS 2006, the number of stunted children is very low and so is the number of low-income households. In this scenario, maternal autonomy might

not be the most significant variable because there are other structural variables such as household wealth that trumps its effects. Brunson *et al.* found strong correlations between women's autonomy levels and their older children's WHZ scores in poorer lowland communities; while weak correlations between women's autonomy levels and their older children's WHZ scores were found in wealthier highland locations (81). Furthermore, previous researchers (100,101) have suggested that greater levels of women's autonomy would have a significant effect on children's health under conditions of resource constraint, but less of an effect on their children's health when resource availability was high. This study has a broad spectrum of wealth status in the sample, which might be the reason why we did not find significant results in this study.

6.1 Applications for studying women's autonomy

The importance of studying women's autonomy and the effects that this variable has on women's lives is important. First of all, autonomy provides a measure of empowerment among women, which is an issue of basic human rights. In many societies women are constrained in their freedom of movement, their decision-making abilities, and their freedom of expression (81). In order for women's positions to be improved in these societies, it is essential for researchers, policy makers, and even the women themselves, to understand their positions within society and how these in turn impact their ability to control their own lives (81). Assessing women's autonomy—within relevant cultural frameworks—can provide a first step towards accomplishing this goal (102).

Second, studies of women's autonomy can provide insights into different theoretical perspectives, including theories on "parental investment" (81). Apparently, it is in the best interest of males to produce as many children as they can (offspring quantity) while it is in the best interest of females to invest in the children they currently have by taking care of them to the best of their ability (offspring quality) (81). Autonomy and control of resources gives caregiver's the ability to play a role in decisions made within the household and the community. This allows the mother, who is in most cases the primary caregiver, to gain control of and access to resources and makes her more likely to provide effective child nutrition and ultimately impact child growth. Therefore resource distribution within households is directly impacted by the abilities of individual household members to make decisions about how such resources are used (101). More explicit and qualitative research into women's autonomy would shed light on the importance of womens' control over household resources is and their ability to invest in their children.

6.2 Limitations

Our study into women's autonomy suffers from a number of limitations. This study used a secondary dataset which, while providing a very large sample size, limited the availability of variables specifically associated with the research questions. Thus, we were not able to represent the four maternal autonomy domains. There may have seen a greater impact of some of these domains if there had been a greater variety of questions pertaining to autonomy so that we could have compiled factor scores and analyzed domains rather than individual items. There were also factors, such as child care practices

that may be important mediators of the effect of maternal autonomy on child stunting, such as health care practices related to child nutrition and growth that were not covered in the present study due to the limited questions available. Understanding the association of autonomy with these factors is an important next step for researchers to design appropriate intervention tools.

Since the PNDS is based on a questionnaire and uses self-reported information, this limits us to subjects to recall bias. In addition, the survey is cross-sectional, which allows for a snapshot of information at a moment in time but which can only establish association, not causality.

Another limitation of this study was that only women were interviewed. While this is a common occurrence in studies of women's decision making, it overlooks the male perspective which can both support and refute claims made by women. Recent research (100) has suggested that measurements of women's autonomy change depending on whom—a woman or her husband—was interviewed. Obviously including a male perspective in assessments of women's autonomy is important, and like Ghuman et al. and Brunson *et al*., it is suggested that this should be a vital part of future studies.

6.3 Conclusion

"Final say on what items are to be cooked" was the only maternal autonomy variable that was significantly associated with child stunting, indicating that decision-making power regarding items to be cooked each day increases the odds of having a stunted child. This result might be related to the fact that Brazilian mothers of high income do not play a role in deciding that to cook each day since they most likely have

help in the house who decide that. Therefore low income mothers with higher autonomy to decide what items are to be cooked may be the mothers who also have children who are stunted.

These results indicate that policy-makers and public health professionals may want to look into avenues by which maternal autonomy can be enhanced. Further research should focus on culturally-acceptable means of increasing awareness regarding the importance of maternal decision-making power for her children's healthcare.

Conditional cash transfers (CCT) around the world share the same characteristic of selecting women as the primary recipient of the transfer. Women, in particular mothers, usually dominate caring and nurturing roles in the family. Since CCT aims to cut the intergenerational poverty trap by investing in children's health and education, it tries to ensure the maximum benefit of cash transfer be properly spent on such investment (103). Thus, the transfer is given to the women in the family because the money spent by women tends to be concentrated on goods and services that are more likely to have positive effects on the children's well-being (104). In order to increase women's roles beyond merely managing CCT funds, but also to obtain the maximum benefit from a conditional assistance program, it is perhaps necessary to link the implementation of CCT with other programs that directly or indirectly help to increase economic participation of women.

This study did not significantly show the effect of women's autonomy on children's nutritional status in a national sample; it suggested that more research on women's autonomy and its effect on children's health and nutrition should be conducted in low income population, where wealth status is not a confounding variable. In such

populations where there are these micro-differentiation in growth patterns we might be able to see how maternal autonomy comes in to play in the household.

In all, the results and conclusions determined from this study can also not only aid the improvement of future studies similar to this one but also help in directing more focused and targeted culturally-acceptable means of increasing awareness regarding the importance of maternal decision-making power for her children's healthcare.

7 APPENDIX

Table 5 Associations between maternal autonomy variables and stunting - weighted logistic regression results for height-for-age

7.1 Appendix A – Table 5A Has final say on own healthcare

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI) ‡	
	OR (CI)	SE	OR (CI)	SE
Autonomy – Has final say on own healthcare				
Low	Ref	Ref	Ref	Ref
High	.455 (.156 – 1.324)	.545	.417 (.144 – 1.207)	.541
Maternal Education	.589 (.326 - 1.065)	.301	.645 (.349 - 1.192)	.313
Mother Work	.955 (.545 - 1.675)	.286	1.013 (.560 - 1.832)	.301
Wealth Score	.883 (.765 – 1.020)	.073	.906 (.778 - 1.054)	.077
Birth Order	-	-	1.256 (1.023 - 1.542)	.104
Child Age (Months)	-	-	.987* (.975 - .998)	.006
Sex (Female =1)	-	-	.713 (.452 - 1.124)	.231

*Statistical significance based on 95% confidence interval not crossing 1, ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. For Crude Model, Nagelkerke $R2 = .03$. For Adjusted Model, Nagelkerke $R2 = .05$.

7.2 Appendix B - Table 5B Has final say on child's healthcare

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI)‡	
	OR (CI)	SE	OR (CI)	SE
Autonomy – Has final say on child's healthcare				
Low	Ref	Ref	Ref	Ref
High	1.017 (.393 – 2.632)	.485	.995 (.381 – 2.602)	.490
Maternal Education	.570 (.323 - 1.007)	.290	.610 (.342 - 1.087)	.295
Mother Work	.928 (.526 - 1.638)	.290	.998 (.551 - 1.808)	.303
Wealth Score	.886 (.769 – 1.020)	.072	.908 (.782 - 1.054)	.076
Birth Order	-	-	1.216 (.982 - 1.505)	.109
Child Age (Months)	-	-	.986* (.975 - .997)	.006
Sex (Female =1)	-	-	.731 (.473 - 1.130)	.222

*Statistical significance based on 95% confidence interval not crossing 1, ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. For Crude Model, Nagelkerke R2 = .02. For Adjusted Model, Nagelkerke R2 = .04.

7.3 Appendix C - Table 5C Has final say on daily purchases

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI)‡	
	OR (CI)	SE	OR (CI)	SE
Autonomy – Has final say on daily purchases				
Low	Ref	Ref	Ref	Ref
High	1.081 (.603 – 1.941)	.298	1.080 (.592 – 1.970)	.307
Maternal Education	.572 (.327 - 1.000)	.285	.609 (.342 - 1.084)	.294
Mother Work	.919 (.530 - 1.593)	.280	.991 (.555 - 1.768)	.295
Wealth Score	.885 (.770 - 1.017)	.071	.907 (.784 - 1.050)	.074
Birth Order	-	-	1.206 (.978 - 1.497)	.108
Child Age (Months)	-	-	.986* (.975 - .997)	.006
Sex (Female =1)	-	-	.730 (.473 - 1.127)	.221

*Statistical significance based on 95% confidence interval not crossing 1, ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. For Crude Model, Nagelkerke R2 = .02. For Adjusted Model, Nagelkerke R2 = .04.

7.4 Appendix D - Table 5D Has final say on what foods are to be cooked

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI)‡	
	OR (CI)	SE	OR (CI)	SE
Autonomy - Decision about everyday cooking				
Low	Ref	Ref	Ref	Ref
High	1.981* (1.098 – 3.576)	.301	1.856* (1.004 – 3.433)	.313
Maternal Education	.574 (.325 - 1.014)	.289	.606 (.342 - 1.074)	.292
Mother Work	.927 (.525 - 1.636)	.289	1.003 (.553 - 1.817)	.303
Wealth Score	.880 (.765 – 1.013)	.071	.903 (.780 -1.046)	.075
Birth Order	-	-	1.188 (.960 - 1.470)	.109
Child Age (Months)	-	-	.986* (.975 - .997)	.006
Sex (Female =1)	-	-	.734 (.477 - 1.131)	.220

*Statistical significance based on 95% confidence interval not crossing 1, ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. . For Crude Model, Nagelkerke R2 = .03. For Adjusted Model, Nagelkerke R2 = .04.

7.5 Appendix E - Table 5E Has final say on visits to family/relatives

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI)‡	
	OR (CI)	SE	OR (CI)	SE
Autonomy - Decision about visiting family/relatives				
Low	Ref	Ref	Ref	Ref
High	1.089 (.647 – 1.834)	.266	1.010 (.587 – 1.739)	.277
Maternal Education	.570 (.323 – 1.005)	.289	.609 (.342 - 1.084)	.294
Mother Work	.923 (.521 - 1.634)	.291	.998 (.551 - 1.807)	.303
Wealth Score	.886 (.770 – 1.020)	.072	.908 (.782 - 1.054)	.076
Birth Order	-	-	1.215 (.979 - 1.510)	.110
Child Age (Months)	-	-	.986 *(.975 - .997)	.006
Sex (Female =1)	-	-	.733 (.475 - 1.127)	.220

*Statistical significance based on 95% confidence interval not crossing 1, ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. For Crude Model, Nagelkerke R2 = .02. For Adjusted Model, Nagelkerke R2 = .04.

7.6 Appendix F - Table 5F Has final say on making large household purchases

Characteristics	Crude odds ratio (95% CI)		Adjusted odds ratio (95% CI)‡	
	OR (CI)	SE	OR (CI)	SE
Autonomy - Decision about large purchases				
Low	Ref	Ref	Ref	Ref
High	1.116 (.669 – 1.862)	.261	1.020 (.595 – 1.750)	.275
Maternal Education	.571 (.324 - 1.005)	.288	.609 (.340 - 1.091)	.297
Mother Work	.912 (.528 - 1.575)	.279	.995 (.560 - 1.769)	.293
Wealth Score	.885 (.770 – 1.019)	.071	.908 (.783 – 1.053)	.076
Birth Order	-	-	1.214 (.979 - 1.507)	.110
Child Age (Months)	-	-	.986 * (.975 - .997)	.006
Sex (Female =1)	-	-	.731 (.473 - 1.129)	.222

*Statistical significance based on 95% confidence interval not crossing 1. ‡ Adjusted for child's age, sex, birth order, mother's education, work status, and household's wealth. For Crude Model, Nagelkerke R2 = .02. For Adjusted Model, Nagelkerke R2 = .04.

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