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Impact of the Family Health Program in Vespasiano, Brazil
on the Nutritional Status of Children Five Years and Younger

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Impact of the Family Health Program in Vespasiano, Brazil
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Background: Increasingly, the dual burden of both under-nutrition and over-nutrition has been an issue in rapidly developing countries such as Brazil. [1] Brazil's Programa Saúde da Familia (PSF) is aimed at supporting the primary healthcare system. There is a need to assess the role of this program in preventing childhood malnutrition.

Goal: The goal of this study was to examine the prevalence and determinants of nutritional indicators, including stunting, wasting, underweight, overweight-obesity, and anemia among children under five in Vespasiano, Minas Gerais, Brazil and to assess the impact of the status of enrollment in the PSF on these nutritional indicators.

Methods: To address these goals, in 2010, children under the age of five years were sampled from households, through a cross-sectional design, to quantify the prevalence of nutritional status indicators in Vespasiano. In 2011, children under five were sampled from clinics, through a case-control design to evaluate the influence of enrollment in the PSF on nutritional status indicators.

Results: We found lower prevalence of all indicators in 2010 and most in 2011, compared to recent data on the municipality of Vespasiano, with the exception of stunting and underweight in 2011 No significant prevalence differences were found between PSF and non-PSF enrolled families. Significant associations between indicators and adjusted risk factors included negative associations between female gender and overweight-obesity (OR=0.20 (95%CI 0.05,0.83)), female gender and stunting (OR=0.31 (95%CI 0.11,0.89)), and number of siblings and overweight-obesity (OR=0.32 (95%CI 0.11,0.92)). Positive associations were found between siblings and stunting (OR=1.62 (95%CI 1.13,2.30)) and between low birth-weight (LBW) and stunting (OR=4.17 (95%CI 1.24,14.03)), wasting (OR=34.2 (95%CI 2.263,515.909)) and anemia (OR=4.8 (95%CI 1.24,18.64)).

Conclusion: We conclude from these data that there was no significant effect of the PSF on the nutritional status of children under five in Vespasiano. Determinants that did have a significant effect on malnutrition included gender, age, LBW, and number of siblings.

Implications: We suggest that regardless of the PSF, efforts be made to improve the assessment and prevention of stunting and underweight status among children under five in Brazil. Particular attention should be given to nutritional intake of boys and LBW children.

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LITERATURE REVIEW

The World Health Organization's (WHO) Millennium Development Goal 4 is to reduce the global under-five mortality rate by two-thirds between 1990 and 2015. [2] Malnutrition is a known factor contributing to child mortality. [3, 4] According to the WHO, more than one-third of all child deaths are linked to malnutrition. Estimated at 25% in 1990, the prevalence of underweight children under the age of five had decreased to 16% in 2010. [5] In 2010, about 32% of world's children under five were stunted, and an estimated 10% were wasted. [6]

Under-nutrition is most commonly seen in developing countries, but there is an emerging dual burden of both under-nutrition and over-nutrition in countries with rapidly developing economies (reviewed in Popkin *et al*. 2012). [1, 7] Due to increased household income, access to processed and prepared food, and shifts in diet and physical activity, there has been an increase in the prevalence of obesity in low- and middle-income countries. Both types of malnutrition are caused by an energy imbalance – under-nutrition resulting from lower energy intake, coupled with higher energy expenditure, and over-nutrition being a consequence of an excess of energy intake and less expenditure (reviewed in Reilly *et al*. 2002). [8] A study published in the American Journal of Clinical Nutrition reported that the global prevalence of overweight and obesity among children under five was 6.7% in 2010, up from 4.2% in 1990. [9] This prevalence is expected to rise to 9.1%, or 60 million children, by 2020.

Prevalence

According to the World Bank, in 2007, the prevalence of deficits (z <–2, WHO-2006 standard) in Brazilian children under five for underweight (low weight-for-age) was 2.2%, the prevalence of wasting (low weight-for-height) was 1.6%, and the prevalence of stunting (low height-for-age) was 7.1%. [10] Studies of anemia in Brazil have varied but have all shown high prevalence. The Demographic Health Survey in 2006 reported a prevalence of 20.9% for country-wide anemia in children under five. However, regional differences do exist, ranging from 10.4% in the North to 25.5% in the Northeast. [11] The prevalence of combined overweight and obesity (weight-for-height z >2, WHO-2006 standard) in Brazilian children under five was 7.3%. This is compared to a prevalence of 6.6% for overweight and obesity in the 1990s. [12]

This study took place in the municipality of Vespasiano in the Southeastern state of Minas Gerais in Brazil. The population size of Vespasiano was 106,685 in 2010, of which there were 7906 children between the ages of 0-59 months. In 2010, this per-urban city had a poverty rate of 20.9%, similar to its surrounding municipalities. [13] Data collected from government health clinics (Brazil's National Program of Nutritional and Food Surveillance, or SISVAN, and the Unified Health System database DATASUS) showed Vespasiano-specific indicator prevalence rates for children under five from 2010 and 2011: underweight was at 2.4% in 2011, down from 3.4% in 2010, stunting was at 6.1% in 2011, down from 7.3% in 2010, wasting was at 2.7% in 2011, down from 4.0% in 2010, overweight was at 8.7% in 2011, up from 5.8% in 2010 and obesity was at 11.7% in 2011, interestingly down from 15.3% in 2010. [14] There was no Vespasiano-specific government data available for the prevalence of anemia.

Risk Factors

There are several risk factors for malnutrition, many of which overlap for under- and over-nutrition. Socioeconomic status (SES) factors, including mother's and father's education level, family income, employment status of the head of household, number of siblings, and race have all been shown to be associated with indicators of under-nutrition, including underweight, stunting and wasting. [15, 16] Victora *et al.* (1986) show that parental employment, higher parental education levels, and higher family income levels were protective against under-nutrition. Having fewer siblings was also protective against under-nutrition. These same factors have been shown to impact overweight and obesity, though not necessarily in the same trends. [16-18] Studies have shown that increased parental education and family income are both contributors to obesity, and having fewer siblings is also positively associated with obesity status. Chen and Escarce (2010) found that American children, from kindergarten through grade five, with no siblings, were at higher risk for obesity than those with siblings. These authors also report that the children from this cohort with single parents were at a higher risk for the condition than those with both parents.

In addition to SES factors, biological predictors are also associated with malnutrition. Children with low birth-weight (LBW) (< 2500 g) or those who are large for gestational age (LGA) (≥ 4000 g) were also at high risk for both types of malnutrition. [19] Tome *et al*. (2007) showed that 14% of school children born with LBW had a BMI z-score of less than 5, while 9.5% of these LBW children had a BMI z-score of 85 or greater (overweight or obese). Similarly, 3% of children born LGA had a BMI z-score of less than 5, while over 24% of these LGA children were overweight or obese. LBW infants are also generally considered a risk group for early iron deficiency due to low iron stores at birth. [20]

Findings were more inconsistent for breastfeeding as a risk factor for malnutrition, especially over-nutrition. The WHO recommends exclusive breastfeeding until six months of age (reviewed in Butte *et al*.). [21] Most studies showed the benefits of exclusive breastfeeding for six months as providing an adequate amount of iron to the child and also reported exclusive breastfeeding as the ideal method of preventing infections and other illnesses, thereby reducing child mortality (reviewed in Jones *et al*. 2003). [22, 23] While some studies have found breastfeeding protective of obesity [24-26], others have found no significant association [27, 28]. Simon *et al*. (2008) studied overweight and obesity among pre-school children in the Southeastern city of São Paolo, Brazil. These authors found that both exclusive breastfeeding and breastfeeding past two years of age were both protective against overweight and obesity. Parental overweight and obesity status and overweight-obesity status during infancy are also known risk factors for obesity. [29, 30] Whitaker *et al*. (1997) showed that the risk of a very obese child aged 1-2 years becoming very obese in young adulthood is 14% and for a child aged 3-5 years is 33%. This risk jumps to 40% in children 1-2 years of age and 83% for children 3-5 years of age if at least one parent is obese.

Inappropriate introduction of complementary foods is also associated with malnutrition. [31, 32] Monte *et al*. (2007) reported that early breastfeeding shortens the duration of breastfeeding and interferes with the uptake up nutrients from breast milk. Likewise, late introduction of complementary foods deprives the infant of essential nutrients like iron, vitamin A, and zinc, which breast milk alone cannot provide at this stage in the infant's life. Nielsen *et al*. (1998) found that children breastfed for seven months or longer gained less weight and length compared to those breastfed less than seven months. As such, it seems reasonable that late introduction of complementary foods has been shown to be protective of obesity status. [33] A diet consisting of diverse foods during complementary feeding has been shown to be improve nutritional status, [34] whereas processed and pre-packaged foods, fast food, and sugary drinks have been shown to be associated with excess weight gain. [35] As evidenced, diet – quantity and quality of food consumption – plays an important role in the energy imbalance that leads to malnutrition. [36]

Linked with biology, demographic factors, such as gender and age, add on to the list of predictors leading to malnutrition. Studies have shown that the prevalence and severity of malnutrition increases with age. Hameed and Paracha (1999) studied a cohort of children from birth to 15 months in Pakistan. At birth, 5.3% of the babies were underweight, 3.2% were stunted and 11.1% were wasted, while at 15 months, 40% of boys and 33.3% of girls were underweight, 33.3% of boys and 22.2% of girls were stunted and 20% and 11% of girls were wasted. [37] In China, another country in rapid economic transition, Jiang *et al*. (2006) found that overweight and obesity also increases with age among children aged two to six. [38] These authors also found that the prevalence of overweight-obesity was higher among boys (10.7%) than girls (4.2%). Barros *et al*. (2008) examined three cohorts of one-year-olds in Pelotas, Southern Brazil – from 1982, 1993 and 2004. [16] The only significant difference between males and females was in the 1982 cohort, which showed that males were more overweight and more stunted than females from the same cohort. There were no differences in underweight and wasting status in any of the three cohorts. Interestingly, however, there was a significant increasing linear trend among overweight in females over time, while the prevalence remained relatively stable among males. The opposite was true for stunting, where the prevalence decreased significantly in one-year-old boys over time, while there was no significant trend seen for the prevalence of stunting in girls of the same age. A study by Florêncio *et al*. (2007) in Maceió, a northwestern city in Brazil, found that among adolescents, female gender is more positively associated with both stunting and obesity. [39] On the other hand, Duncan et al (2011) found that in the northeast city of São Paulo, boys aged 7-18 are more overweight and obese than girls of the same age. [40] Nevertheless, there are still other studies that have found no association between gender and nutritional indicators including stunting and overweight status. [41, 42]

Effects

Malnutrition is linked to several adverse outcomes such as impaired cognitive development and chronic disease [3] and exacerbates the effects infectious diseases [43]. Malnutrition also has a far-reaching impact on child mortality – a report in The Lancet in 2008 stated that nutrition-related factors including stunting, wasting, intrauterine growth restriction, vitamin deficiencies, and suboptimal breastfeeding were together responsible for 35% of under five child deaths and 11% of the global disease burden. [3] Co-morbidities are often found with obesity, including diseases like type II diabetes, cardiovascular disease, high blood pressure and stroke. [17, 44, 45]. More than one type of malnutrition is also possible in an individual. [39] Several studies have found early childhood stunting being a risk factor for later obesity. [39, 46] A study by Florêncio *et al*. (2007) in Maceió, a northwestern city in Brazil, found that among the adults surveyed, 30% of those who were stunted were also overweight or obese and 16% of stunted adults were also underweight.

Economic status

Considered an upper middle income country by the World Bank, Brazil has achieved rapid growth in its economy over the past few decades. [10] Despite the recent recession, the country was able to rebound quickly, making it one of the first global markets to begin recovery. [47] The consequence of Brazil's robust economy was the continuation of the decreasing rate of mortality in children under five. In 1990, the under-five mortality rate in Brazil was 59 per 1000 live births and in 20 years, this mortality rate had fallen well below the MDG 4 goal of two-thirds to 19 per 1000 live births. [48] However, there is still room for improvement through reduction of malnutrition. To add, transition economies like Brazil face the rapid increase in obesity prevalence, hitting the richer households first and catching up with the poor as cheap fast food restaurants and other such markets take hold in the growing economy. [49] While in the 1990s the prevalence of both overweight and obesity combined for children under five was at 6.6%, the most recent data from the government estimates obesity prevalence alone between 6.2% and 9.7%. [13]

PSF

The Brazilian Unified Health System (SUS) faced restructuring in 1994 when the Programa Saúde da Familia (Family Health Program, PSF) was launched and was adopted as the structure for national primary care in 1998. [50] Over half the national population was covered by 2009 (50.7%). [51] In 2011, 36.2% of Vespasiano, in the southeastern state of Minas Gerais, was enrolled in the PSF. [52] Based out of a community health clinic, a team of one physician, one nurse, one nurse assistant, and 4-6 community health workers offers basic primary care from the clinic and through home visits. Each team serves an area of approximately 3,400 people. The team also engages in preventative education and outreach efforts to promote the health of their communities. [53] For child nutrition, the PSF has been tasked to monitor child development, promote appropriate infant and young child feeding practices including breastfeeding, and carrying out regular monitoring of child anthropometric measurements for the national database.

Large national studies have shown the efficacy of the PSF program in several areas, including the reduction of mortality caused by acute respiratory illness and diarrheal illness among children under five. [54] The program has also shown a decrease in the rate of hospitalizations, preventable by primary care across all states and age groups. [55] Less is known about the impacts of nutritional information and services offered by the PSF.

Goal and Aims

To address gaps in the knowledge, this present study seeks to focus on the following goal: to describe the prevalence of malnutrition and assess the predictors for malnutrition in children ages zero to five in Vespasiano in 2010 and 2011. Specific aims to address this goal are:

1. To evaluate whether or not there is a meaningful prevalence of under-nutrition in the population (underweight, wasting, stunting, anemia);

2. To evaluate whether or not there is a meaningful prevalence of over-nutrition in the population (overweight and obesity);

3. To evaluate predictors of underweight, wasting and/or stunting and anemia (including the PSF); and

4. To evaluate predictors of overweight and/or obesity (including the PSF) and assess potential confounders

Significance

This research will help identify the extent of the dual burden on this community caused by the concurrent presence of under- and over-nutrition, thereby characterizing the nutritional transition taking place in Brazil as well as several other countries around the globe. Apart from the prevalence of underweight, stunting, wasting, anemia, overweight and obesity, this study will also assess potential risk factors associated with these indicators from two separate studies. Furthermore, the findings will help identify the extent of the effect of the PSF on child nutrition status, which will help inform future research and interventions that seek to address these indicators and risk factors as well as child mortality. If this research demonstrates that the program is making a positive impact on the children of the families it serves, it will validate its effectiveness as an early intervention to prevent various chronic diseases.

INTRODUCTION

Malnutrition is a global burden, contributing to over a third of child deaths each year. [3] Under-nutrition is a problem faced by many developing countries. Apart from child mortality, lack of ample nutrients during the first few years of life can lead to physical and cognitive impairments, which are often irreversible. Recently, with the expansion of world trade and increased access to food in rapidly developing countries, there has been a rising concern for overweight and obesity (reviewed in Popkin *et al*. 2012). [1] Latin American countries are particularly at risk for this transition due to the adoption of the "Western" diet, including high fat and carbohydrate-dense foods and more sedentary lifestyles. [56] Brazil, in particular, is being afflicted with the dual burden of both under- and over-nutrition; in 2007 the World Bank estimated the prevalence of stunting to be 7.1%, while in 2006, the World Health Organization (WHO) estimated the combined overweight-obesity burden at a comparable 7.3%. [10, 12] Underweight (2.2%) and wasting (1.6%) also continue to plague the country, especially among the poor.

There are several predictors of malnutrition, most of which contribute to both under- and over-nutrition. In this study, we assessed biological as well as socio-demographic predictors for malnutrition. Biological determinants are most directly associated with the outcomes of interest, which include underweight, stunting, wasting, overweight, obesity and anemia. These predictors include diet, physical activity, gender, race, age, birth weight and genetics and have been validated by several studies as factors associated with both under- and over-nutrition (reviewed in Jones *et al*. 2003). [19, 22, 30, 36-38] Socio-demographic factors such as SES and family characteristics, including number of parents and siblings, parental education, income, and employment status as well as marital status, have also been shown to be associated with indicators of malnutrition, including overweight, obesity and anemia. [15, 16, 18] These factors all play a role in determining access to and consumption of appropriate amounts of high quality foods. To our knowledge, all of these risk factors have not been combined in an adjusted model to determine their associations with the nutritional indicators for any state in Brazil.

The main exposure we sought to examine in this study was the status of enrollment in the PSF. This program was adopted as the structure for national primary care in 1998 and involves a team of health workers including physicians, nurses to provide primary care services in local health facilities as well as community health workers to make home visits to promote health through education in preventative measures such as proper breastfeeding, prenatal care, immunization and the management of infectious disease and diarrhea. [50, 57] By 2009, over half the population of Brazil was covered by the PSF (50.7%). [51] In 2011, 36.2% of Vespasiano (our study site), in the southeastern state of Minas Gerais, was enrolled in the PSF. [52] There is a need to understand the impact of the PSF on the nutritional indicators among children under the age of five. Prevalence data for under- and over-nutrition indicators have only been collected from government-affiliated clinics (SISVAN and DATASUS databases); to our knowledge, no prevalence data has been collected directly from household surveys. [14] Further, there was no data on the prevalence of anemia. The Brazilian Ministry of Health conducted an evaluation of PSF implementation in 2001 and 2002. They found that that about 54% of the PSF teams throughout the country conducted medical visits to monitor the growth and development of children under two, 89.6% of the teams assessed the nutritional status of children and 70% of the teams made appointments for medical treatment of undernourished children. [58] Apart from the government-based prevalence of indicators and the extent of services of the PSF teams, the authors were not aware of an epidemiological assessment of the impact of the PSF on the nutritional status of children in Brazil.

To address these needs, the goal of this study was to assess the prevalence of nutritional indicators in areas covered by the PSF in 2010 and to examine the extent of the difference of the program in 2011 in Vespasiano, MG, Brazil. Specifically, the study aimed to address this goal, which included confirming the prevalence of the nutritional indicators of underweight, stunting, wasting, overweight and obesity, determining the prevalence of anemia, and examining the predictors, including enrollment in PSF, for each of these indicators.

METHODS

The peri-urban municipality of Vespasiano lies 27 kilometers from Belo Horizonte, capital of Minas Gerais state, Brazil. The total population of Vespasiano was 106,685 in 2010, and among children between the ages of 0-59 months it was 7,906. [13] The city has a poverty incidence of 20.9%, comparable to surrounding municipalities. Two separate studies were conducted in Vespasiano, Minas Gerais, Brazil. Both sample populations consisted of children five years of age and under and their primary caretakers. The first population was collected from randomly selected households covered by the Programa de Saúde da Família (PSF), or Family Health Program, in July 2010 and the second study drew participants from families seeking care at government clinics between July and August 2011. Human research ethics approval for both studies was granted by Emory University Internal Review Board (IRB) and Faculdade da Saúde e Ecologia Humana, Vespasiano, MG, Brazil (FASEH) IRB.

Study Populations

2010

The 219 households that participated in this first study were drawn from all ten of the PSF unit coverage areas in Vespasiano: Celvia, Jardim da Glória, Morro Alto 1, Morro Alto 2, Morro Alto 3, Nova Pampulha, Nova York, Oeste, Suely, and Vila Esportiva. A list of all PSF covered households with at least one child five years of age or younger (N=2,017) was compiled for each PSF unit. A random number generator was used to initiate the random stratified sampling method that proportionally allocated a sample of 265 households by PSF unit. [59] Apart from all households containing at least one child under the age of five, they also had a caretaker above the age of 18. Households with children who had turned five within the past month were included (5 years and 30 included, 5 years and 31 days excluded). If a household had more than one child under five, the child with the next upcoming birthday was selected. If a household had moved but another child under 5 covered by the PSF with a caretaker was present, they were considered eligible for the survey.

Enumerators were equipped with over ten hours of nutrition, anthropometric, and survey training sessions. The purpose of the study was explained to eligible and interested caretakers and oral consent to participate was obtained from the respondent and documented on the consent form from the enumerator before the survey took place. A copy of the study description was given to each respondent. Survey instruments were revised as a result of pilot tests held at the Celvia health post pediatric unit; feedback of study participants and PSF staff members were taken into account before final surveys were conducted in the field. Of the 265 households attempted, 9.1% were found to be ineligible (family had moved, primary caretaker was under 18, or the child was older than 5 years), and 8.3% were unreachable. Households were considered unreachable after two attempts with a community health agent present failed. The final sample contained 219 households, with a response rate of 82%.

2011

298 study participants were drawn from a convenience sample of adult caretakers and children ages 6 up to 59 months seeking care at government (SUS or PSF-affiliated) clinics. Ten such clinics were selected from the sixteen in Vespasiano. The remaining six were excluded due to inadequate patient volume. Five of these ten clinical study sites served both patients PSF enrolled and non-PSF enrolled patients. Clinic staff was not involved in participant recruitment.

Patients were approached either while waiting to see a health worker or after their visit. Children and siblings accompanying the patient were also included. Following consent, they were interviewed by one of three Brazilian medical students who all underwent training on informed consent, survey methods and interviewing, anthropometric measurement, and hemoglobin testing. Each participant received a study information sheet and verbally explained the purpose of the study, its voluntary nature, and potential risks. They were also informed that they had the right to refuse any single component of the study, including hemoglobin testing and measurements of parent or child. Of 305 caretakers who consented, a total of 298 study participants were included in the study. Three declined participation following consent, three had incomplete anthropometric measurements, and one did not complete the interview. Hemoglobin testing was delayed pending local approval by the Ethical Committee. A subset of 254 from the 298 participants was offered hemoglobin testing of which 13 refused (a refusal rate of 5%) and a total of 236 were tested.

Data Collection

2010

Surveys were conducted in Portuguese by trained medical students, and included sections on socioeconomic status, access to healthcare and the PSF post, nutrition and food intake and sanitation and hygiene. Birth dates were recorded as per the date on a government issued informational booklet when the child was born (Caderneta de Saúde da Críanca). The team of students performed anthropometric measurements of the children in the presence of the master trainer. Apart from weight, the team measured recumbent length of children up to the age of 23 months and the height of children up to the age of 59 months. The equipment used included international standard portable SECA scales for weight and SHORR boards for height (Arthur S. Shorr & Associates, Inc. Woodland Hills, CA). Measurements were taken twice for inter-observer reliability, unless the child was non-compliant (crying or fussing). A highly accurate Spearman’s rho correlation coefficient was found between the measurements of Observer 1 and Observer 2 (99.9%).

2011

Another trained team of medical students collected data this following year, supervised by the study coordinator. Surveys were again administered in Portuguese a member of the study team and included questions on socio-demographics, enrollment status in PSF as well as 13 questions that included components to estimate a wealth index. [60] Attempts were made to adapt questions from validated including the Demographic Health Survey. Additional questions were included to assess nutritional status of the child and the caretaker, including access to health care, infant and young child feeding practices and parental attitudes and self efficacy regarding overweight and child nutritional status. The questionnaire was piloted locally and revised before being implemented.

Similar anthropometric measurements were made in 2011 as in 2010. Measurements were also taken from one parent, if present. Children under the 24 months of age were weighed in the arms of the previously weighed parent by taring the scale. Equipment used included a digital scale for weight (Seca Corp, Hanover MD, USA) and a SHORR board for height and length (Irwin Shorr Productions, Olney MD, USA). Measurements were repeated in 75% of participants for inter-observer reliability. Measurements were repeated a third time in the case of a discrepancy greater than 2mm and the final value was recorded.

For iron deficiency testing, Hemoglobin (Hb) concentration of each participant was obtained using a portable HemoCue 301 instrument (HemoCue AB, Angelholm, Sweden). Photometry analysis was run on blood collected in a microcuvette via fingerprick and analyzed on the spot. Results were recorded and provided to the participant immediately. The researchers used WHO guidelines to define anemia as less than 11.0 g/dL (WHO, UNU, UNICEF, 2001). Participants with anemic children were informed of their status and were given a written referral for clinical care.

Data Management

For both years, anthropometric results were entered and saved into a WHO Anthro (version 3.2.2, World Health Organization, Geneva, Switzerland) database, which yielded z-scores for nutritional indicators including, weight-for-age, weight-for-height, and height-for-age and were then exported into Microsoft Excel (version 8.0). De-identified survey data was entered into Epi Info (version 3.5.1, provided by the CDC Atlanta, GA) in 2010 and into Microsoft Excel (version 8.0, Microsoft Inc., Redmond, Washington) in 2011. All surveys were double entered by separate staff in and cleaned using the compare features of Epi Info in 2010 and Excel in 2011. Inconsistencies were resolved by validating the database entry against the original questionnaires. Finally, approximately 5% of the questionnaires were randomly selected for comparison to the original database. Since no errors were found, a subsequent 100% data-check was deemed unnecessary. The master database from 2010 was transferred to Excel and imported into SAS (9.3 SAS Institute Inc., Cary, NC) for further analysis.

Statistical Analysis

Using the 2006 Child Growth Standards of the World Health Organization (WHO Anthro 3.2.2, Geneva, Switzerland), children were classified as stunted (height/length-for-age z-score or HAZ/< -2), wasted (weight-for-height/length z-score/WHZ< -2) or underweight (weight-for-age z-score or WAZ< -2) (<3% of the reference population). [51, 61] Overweight (weight-for-height z-score/WHZ>2) and obesity (weight-for-height- z-score/WHZ>3) were also determined using this method. All children less than six months of age were excluded from nutritional analysis as pre-mature status of infants was not assessed in the survey data. A wealth index was created using principal components analysis according to the method based on the 2000 Brazilian demographic health survey described by Barros. [60] Chi square tests, t-tests and multivariate linear and logistic models were used to analyze the data. The dependent variables of interest were stunting status, underweight status, wasting status, and combined overweight and obesity status (WHZ>2) (no prevalence of wasting was found in the 2011 data and was thus excluded from the analysis). Continuous independent variables in the models included ages of both child and caretaker, age of weaning, monthly income, and wealth index scores. The binary independent variables were status of PSF enrollment, gender, marital status of the parent, race (Black vs. non-Black), education level (0-7 years, 8-10 years and >10 years of schooling), employment status, low birth-weight (< 2500 g), large for gestational age (≥ 4000 g), exclusive breastfeeding for six months and late introduction of complementary foods (post six months). Number of siblings was the only ordinal variable. The exposure variable was undefined for the 2010 models since all determinants of nutritional status were being analyzed equally. The main exposure variable for the 2011 models was status of enrollment in the PSF program. All probable interaction terms with the exposure variable were checked for significance, collinearity was assessed, and all potential confounders were considered while building the model. The gold standard models, consisting of all potential confounders were used as the final logistic models for all outcome indicators as they provided the most precise odds ratios. Data analysis was conducted using SAS 9.3 (SAS Institute Inc., Cary, NC). An α=0.05 was used to determine significant results.

RESULTS

The overall goal of this study was to examine the prevalence and determinants of nutritional status indicators, including stunting, wasting, underweight, overweight-obesity, and anemia among children under the age of five in Vespasiano, Minas Gerais. A sub-goal was to assess the impact of the status of enrollment in the Programa Saúde da Familia on children's nutritional indicators. To address these goals, in 2010, children under the age of five years were sampled from households, through a cross-sectional design, to quantify the prevalence of nutritional status indicators in Vespasiano. In 2011, children under five were sampled from clinics, through a case-control design to evaluate the influence of enrollment in the PSF on nutritional status indicators.

In 2010, through a stratified cross-sectional design, 207 caregivers, and their children, were surveyed in their homes. The average monthly household income was 981R but with a large variance among the homes surveyed (± 582 R) (Table 1). The average age of the respondents was 33 (± 11) years, 93% were female, and mothers were the main constituents (69%). 78% of the respondents were married and 25% were Black. Of all the respondents, 68% were employed, either full-time or part-time and 30% had over 10 years of education. The average age of the children in the study was 31 (± 16) months. 46% were female, 40% of those aged six months and older were breastfed exclusively for six months and the average age of weaning was 5 (± 3) months.

In 2011, through a case-control design, 298 caregivers, and their children, were surveyed while visiting the health clinics in Vespasiano. For each nutritional indicator, cases were defined as children who had the condition and controls were defined as children who did not. The main exposure was enrollment in the PSF. From these data, socioeconomic status was indirectly measured using a wealth index score, calculated from 13 questions comprising elements for principal component analysis (see Methods). [60] The median score in this sample population was 442 ± 153 (Table 2). The average age of the respondents was 30 (± 9) years, 96% of the respondents were female and close to 81% were married or partnered. 32% of respondents were Black. 41% of the respondents (excluding heads of household) had over ten years of education (data not shown), while the same level of education was achieved by only 31.1% of the heads of household (chi square p-value <0.01, data not shown). Over half of the parents (54.1%) were overweight or obese (BMI ≥ 25). Among the children surveyed in 2011, the average age was 27 (± 15) months. 52.7% were female, 38.9% of those aged six months and older were exclusively breastfed, 11.6% were low birth weight and 5.2% were large for gestational age. The average age of weaning was 5 (± 10) months. None of the caretaker and child characteristics were significantly different between the PSF and non-PSF enrolled participants.

To quantitatively assess the nutritional status of children five years of age and under, anthropometric measurements were taken and recorded for both 2010 and 2011 populations. In the population sampled in 2010, which consisted of children surveyed from randomly selected households, the prevalence of underweight status among children was 2% and of stunting status among children was 4.5% (Table 3). In the population sampled in 2011, data was collected from families who visited the clinics, a population that may have different characteristics from the 2010 sample. As such, a similar prevalence of 2.7% was found for underweight status but there was a higher prevalence of stunting status at 8%. There was no wasting found in the 2010 study population, whereas the prevalence in 2011 was at 1.3%. The prevalence of overweight status among children was the highest among all indicators for both sample populations, at 5% in 2010 and 8.5% in 2011, while obesity status was at 2.5% across both samples. Hemoglobin levels were also measured in 2011, and a 12.3% prevalence of anemia was found among the children tested. There was no significant difference in nutritional status indicators by PSF status in 2011 (Table 3). These results illustrate that there was both under- and over-nutrition of both types within areas of Vespasiano where families are enrolled in the PSF program and that these results show similar trends between the 2010 and 2011 study samples. There was also no significant difference in these indicators between PSF and non-PSF enrolled participants.

Logistic and linear regression models were developed using the 2010 data. None of the variables in the logistic models (monthly income, self-reported material status, marital status, respondent education, gender of child, age of child, exclusive breastfeeding for six months, late introduction of complementary foods, and access to PSF during open hours) were significant for any of the outcomes (data not shown). In the linear models, only one variable, parental marital status, was found to be significant for WAZ and HAZ scores of the children: children with single parents (whether never married, separated, divorced, or widowed) had, on average, higher WAZ scores (0.523, $p = 0.009$) and higher HAZ scores (0.70, $p < 0.001$). From these data, we can conclude that there is no significant effect of any variable, apart from marital status, on the nutritional indicators in this sample population.

To examine the association between the status of enrollment in the PSF, among other factors, and each nutritional status indicator, we ran logistic regression models on the 2011 data to obtain odds ratios. The status indicators included a combined category of overweight and obese, stunting, underweight, and wasting (Table 4). We found no significant difference in any of the outcome indicators for the PSF exposure status. However, other factors were significant in these adjusted models. We found that boys were five times more likely to be overweight or obese (OR (95% CI): 0.20 (0.05, 0.83)) than girls. Boys were also three times more likely to be stunted (OR (95% CI): 0.31 (0.11, 0.89)) than girls. Age in months was a significant factor in the overweight or obese model (OR (95% CI): 1.06 (1.01, 1.10)) as well as in the anemia model (OR (95% CI): 0.93 (0.88, 0.97). We also found that the odds of overweight-obese status for children were 3.13 times lower with each increase in sibling number (95% CI: 0.11, 0.92), while the odds of stunting status were 1.62 times higher with each increase in sibling number (95% CI: 1.13, 2.30). Low birth weight (LBW) children were 4.17 times more likely to be stunted (95% CI: 1.24, 14.03) and 34.2 times more likely to be wasted (95% CI: 2.263, 515.909) than children born at a normal weight. The wide confidence interval for the wasting value was most likely due to a small number of children within this outcome group. LBW children were also 4.8 times more likely to be anemic than their normal weight counterparts.

Linear models were also regressed for the 2011 continuous z-score outcome variables: WAZ, WHZ and HAZ (data not shown). All of the independent variables were included in these models and some were found to be significant. LBW was a significant determinant for all three z-scores; children born at a birth weight less than 2500 grams had, on average, lower WHZ scores (-0.51, p = 0.024), WAZ scores (-0.70, p=0.002) and HAZ scores (-0.65, p = 0.004) than children born at a normal weight. On the other hand, WAZ scores (0.95, p = 0.004) and HAZ scores (1.00, p = 0.002) were, on average, significantly higher for children born large for gestational age. Average WHZ scores (-0.40, p = 0.018) and WAZ scores (-0.37, p = 0.027) were significantly lower for children exclusive breastfed for six months, compared to those who were not exclusively breastfed for six months. Lastly, children with an overweight or obese parent had, on average, a WHZ score 0.31 (p = 0.002) higher than those born to non-overweight or non-obese parents.

We conclude from these data that there was no significant effect of the PSF on the nutritional status of children under five years of age in this area; however, there are other significant determinants that are contributing to the malnutrition of these children including gender, age, low birth weight and number of siblings.

DISCUSSION

This study sought to assess the prevalence of the indicators of nutritional status in children under five in Vespasiano, Minas Gerais. These indicators included stunting, wasting, underweight, overweight, and obesity, and anemia. An additional goal was to assess the risk factors, including the status of enrollment in the Programa Saúde da Familia for these indicators. Through this study, we found lower prevalence of all indicators, compared to recent data on the municipality of Vespasiano. No significant differences were found in the prevalence of any indicator between the PSF enrolled and non-PSF enrolled families. There were significant associations between several indicators and risk factors in an adjusted logistic regression model. This included a positive association between male gender and overweight and obesity as well as male gender and stunting, a negative association between number of siblings and overweight and obesity and a positive association between siblings and stunting, and lastly, positive associations between low birth weight with stunting, wasting and anemia.

Our study examined the prevalence of all indicators from 2010 and 2011 as well as the impact of the PSF in 2011. The 2010 data, collected from households in Vespasiano, resulted in consistently lower prevalence of nutritional indicators compared to the national prevalence of these indicators according to 2007 estimates from the World Bank. The 2011 data collection method was similar to the government clinic monitoring databases, SISVAN and DATASUS. Compared to the data on Vespasiano from these databases, the prevalence of stunting in the 2011 study (8%) was higher than the Vespasiano-specific government data from 2011 (6.1%) and the national prevalence estimated by the World

Bank in 2007 (7.1%). The prevalence of underweight (2.7%) was lower than the government estimated Vespasiano-specific prevalence of 3.5% from 2011 but higher than the national prevalence from 2007 (2.2%). Wasting status in the 2011 study (1.3%) was also lower than government data (2.7%) and the national prevalence in 2007 (2.2%). Overweight status from our 2011 study (8.5%) was similar to the Vespasiano-specific government estimate from 2011 (8.7%) but the prevalence of obesity (2.5%) was considerably lower than the Vespasiano-specific data from 2011 (11.7%). The prevalence of anemia (12.9%) was lower than country-wide DHS estimates (20.9% in 2006). In relation to the global community, Brazil and Vespasiano, in particular, have low percentages of under-nutrition indicators and low obesity status but high overweight status in children under the age of five. Trends in the decreased prevalence of under-nutrition in recent decades have been attributed to increases in maternal education as well as expanded coverage of the healthcare system and sanitation, even more so than the purchasing power of households. [62] However, the increased economic success of the country, which has made it easier to access cheap prepared meals and processed foods, has increased the prevalence of overweight and obesity, especially among the poor. [49]

The Programa Saúde da Familia was designed to include an informational component for the prevention of child malnutrition. [53] This study sought to examine whether or not the PSF made a significant difference in the nutritional status indicators of the children in Vespasiano. From our analysis using chi square tests as well as linear and logistic regression models, we found no significant difference between the PSF and non-PSF enrolled families for any of the studied indicators. With a sample size of 298 subjects, we had the ability to detect a significant difference of 6% or greater between the prevalence of indicators in the intervention group (PSF) and control group (non-PSF). [63] Our results showed differences ranging from 0.8% to 2.2% between the PSF and non-PSF households for the prevalence of these indicators. Since other studies assessing nutritional interventions have been able to detect differences in status indicators greater than 6% between intervention and control groups, our study design, sample size, and power were sufficient for detecting a meaningful difference with regards to the impact of the program. [64, 65] Therefore, the PSF program made no significant difference in the nutritional status indicators of the children in Vespasiano.

One hypothesis to explain this lack of a difference may be due to the priorities of the PSF team or their communities; since the prevalence of the nutritional indicators is relatively low, the PSF team may be giving less attention to education and prevention efforts for malnutrition, especially since they are salaried and not incentivized, and community needs are most likely greater in other areas of health. Another hypothesis is that in providing services to the underserved neighborhoods, the PSF may be assisting in narrow the gap in socioeconomic status (SES), or other demographic factors, between those served and those who did not choose the service. Our data revealed that there was no difference in any of the socio-demographic characteristics between PSF and non-PSF enrolled participants (Table 2). However, there may be other unknown factors that we did not adjust for, including beliefs and practices, that could be linked with nutrition that the PSF may or may not be indirectly improving. On the other hand, these underlying factors may also be hindering the PSF team from making any improvements in the prevalence of these nutritional status indicators, regardless of its best efforts.

In general, we found more significant associations of adjusted risk factors with the nutritional indicators that had higher prevalence. In the 2010 data, all of the indicators had a prevalence of 4.5% or less and we observed no significant associations of the risk factors in our adjusted models with the nutritional indicators. In contrast, in the 2011 study, the prevalence of anemia was 12.3%, stunting was 8.0% and of overweight-obesity was 6.7% – for these indicators, we observed several significant associations with adjusted risk factors, while there were almost no risk factors associated with underweight and wasting, each of which had a prevalence under 3%. Logistic modeling tends to underestimate the probability of rare events; if there are only a small percentage of children with a certain condition in a given sample (~1%), the logistic regression will yield underestimations of the associations. [66]

In our 2011 study, boys were more likely to be stunted and overweight-obese than girls. In general, while underweight and wasting are caused by low caloric intake, stunting and overweight-obesity can be caused by the intake of foods that are energy dense but low in nutritive value. [3, 67] According to the WHO, appropriate growth in height is a better indicator of a well-nourished child than is weight gain. [67] There may be several differences to explain differences in gender that may lead to unequal outcomes in stunting and overweight-obesity status. Favoring of boys over girls has been apparent across cultures, which leads to more food and sometimes higher quality food being offered to the boy over the girl in the family. [68] A possible mechanism could be that mothers are feeding boys more food that is energy dense but not necessarily nutritious compared to girls, who may be getting less food but a more varied diet. Fat patterning is also different between males and females at different ages, leading to differences in nutrition status. [69] According to Cooke and Wardle (2005), girls preferred fruits and vegetables more than boys did, while boys liked fatty, sugary foods as well as processed meat products. [70] Additionally, boys were more “picky” eaters at an earlier age than girls, which likely led to consumption of more processed and packaged foods. These foods are high in energy and low in nutrients (micronutrients and vitamins), which can lead to deceleration in growth of height as well as excessive weight gain.

We observed an association between stunting and obesity with number of siblings. As number of siblings increased, the likelihood of stunting status increased, while the likelihood of overweight-obesity decreased. The distribution of resources may be one hypothesis to explain this result. [18] With more people in the household, there are fewer resources to go around and less time spent by the parent(s) on each child, especially in low SES households. Furthermore, higher numbers of pregnancies and births can deplete the mother of nutrients and in turn have consequences in the child’s birth-weight and nutrient stores. [71] Chen and Escarce (2010) also discuss social influences of siblings that may lead to increased physical activity. This chronic type of malnourishment often leads to stunting. [18] Another mechanism for the stunting outcome with exposure to many siblings is through the spread of infectious disease within a crowded household. [71] Infectious diseases can be a consequence of poor nutrition, which causes suppression of the immune system. [43] However, infectious diseases can also cause or further malnutrition by inducing loss of appetite and preventing absorption of nutrients from food. Conversely, having less siblings or children in the household increases the risk of over-nutrition since there is more food to go around, parents are able to offer more attention to the child and there is less social influence on the child at home. [18]

In our study, we observed positive associations between low birth weight with stunting, wasting and anemia. LBW has been linked with a variety of adverse health outcomes in infants, including mortality as well as later life morbidities. LBW has been reported as a principal risk factor for stunting and wasting in children under five. [72, 73] Babies born small tend to remain small throughout childhood and have lower prenatal stores, dietary intake, and basal metabolism. They also have a harder time absorbing nutrients, though catch-up growth is possible with the proper intervention and during the right period of development. [74] The confidence interval surrounding the odds ratio estimate for wasting status was very wide, however, and was most likely due to a rare event situation (prevalence of wasting in 2011 was only 1.3%). Similarly, there was no significant association found between LBW and underweight status, most likely due to the low prevalence of the indicator. LBW is also a known risk factor for anemia. Rapid growth during child development requires a large amount of iron. [75] Thus, LBW babies usually have low iron stores at birth, putting them at great risk for iron deficiency anemia.

This study had numerous strengths. A major strength of the 2010 study was the randomization of the sample population, which was thus representative of the population of Vespasiano covered by the PSF. Furthermore, this sample was chosen using a stratified sampling frame, which allowed for an equal representation of population size. The 2011 study included all children under five who came to the clinics, whether they were patients or accompanying patients, in order to limit selection bias. In both studies, trained enumerators collected high quality data and anthropometric measurements with international standards and equipment. Also, for both studies, gold standard linear and logistic regression models were used, including several important demographic and biological variables, which adjusted for potential confounders.

The study also had several limitations. In both the 2010 and 2011 studies, the questionnaire portion of the interviews was based on self-reporting, which could have created reporting or recall bias since there was no way of validating the data. Moreover, the length of enrollment in the PSF program was not determined and therefore could not be assessed and may have confounded our analysis. Another main limitation of both studies was the sample size of the study population. An increased sample size would have allowed for better detection of rare cases, especially for underweight and wasting status. One main limitation of the 2010 study was that the household list created for the random sampling method was drafted by PSF community agents, leaving room for human error and bias; selection bias could have possibly occurred if the agents left out pockets of unreachable or undesirable areas. Some lists were also found to be outdated or illegible. Another source of bias may have come from the requirement of a community agent to accompany the enumerators. Although the agents stepped outside during the interview process and the participants were assured the researchers were not associated with the government, there may still have been some respondent bias. The principal limitation of the 2011 study was that it employed convenience sampling, as it only sampled children whose families visited the government clinic and thus may not have been representative of the entire population. A final limitation was the lack of continuity between the two sample populations, which would have allowed for a longitudinal analysis.

Our findings support the assertion that, in Vespasiano, there is still room for improvement in the prevention and treatment of the under-nutrition indicators, especially stunting and anemia. Anemia could be prevented through appropriate adoption of iron supplements as established by the Ministry of Health. However, there is a pressing concern for the prevalence of overweight status, which could lead to higher prevalence of obesity in the coming years, especially since there is a high prevalence of parental overweight-obese status. Thus, there is significant value in furthering government resources to address the prevention of overweight and obesity among families in Vespasiano.

In summary, we conclude from the prevalence data that the nutritional status indicators were relatively low, in comparison to the national data, except for stunting status, anemia and overweight status. We were also able to conclude that the PSF did not have an impact on the nutritional status indicators in children under five. Additionally, the associations found between the indicators and several risk factors in our models reflect the literature to some extent and assist in the characterization of the underlying determinants of the prevalence of these indicators. This information will also prove useful in future studies and interventions that attempt to address nutritional status among children under the age of five years in Vespasiano as well as other areas in Brazil.

TABLES

Table 1 Sociodemographic Characteristics of 2010 Study Sample

Caretaker Characteristics (N=207)		n (%), mean ± SD
Household Income*		981 ± 582R
Age (years)		33 ± 11
Gender (Female)		193 (93.2)
Married or Living with Partner		162 (78.3)
Race (Black)		51 (24.6)
Full- or Part-time Employment		141 (68.1)
Education Level		
	0-7 years	97 (44.0)
	8-10 years	47 (22.7)
	>10 years	63 (30.4)
Relation to Child		
	Mother	143 (69.1)
	Grandmother	29 (14.0)
	Other**	35 (17.0)
Child Characteristics (N=207)		
Age (months)		31 ± 16
Gender (Female)		94 (46.3)
Exclusively Breast-fed for 6 months		82 (39.6)
Age of weaning (months)		5.1 ± 3.2

*1 USD=1.68 Brazilian Real at time of study

**Other relationships to child include babysitter, aunt, father, grandfather

Table 2 Sociodemographic Characteristics of 2011 Study Sample

		ALL		PSF**
Caretaker characteristics	**N**	**n (%), mean ± SD**	**N**	**n (%), mean ± SD**
Wealth Index*(median, SD)	254	442 ± 153		431 ± 143
Age (years)	298	30 ± 9	136	30 ± 9
Gender (Female)	298	288 (96.6)	136	131 (96.3)
Married or Living with Partner	298	241 (80.9)	136	116 (85.3)
Race (Black)	289	93 (31.9)	135	49 (36.3)
Education Head of Household	286		132	
<4 years		30 (10.5)		12 (9.1)
4-10 years		167 (58.4)		81 (61.3)
>10 years		89 (31.1)		39 (29.6)
Parental BMI (≥25)	246	133 (54.1)	116	66 (56.9)
Child characteristics				
Age (months)	298	27.2 ± 15.3	136	25.6 ± 14.3
Gender (Female)	298	157 (52.7)	136	73 (53.7)
Exclusively Breast-fed for 6 months	265	103 (38.9)	123	49 (39.8)
Age of weaning (months)	298	5.2 ± 9.7	136	4.9 ± 8.4
Birth weight	267			123
Low Birth weight (< 2500gm)		31 (11.6)		16 (13.0)
Large for Gestational Age (≥ 4000gm)		14 (5.2)		9 (7.3)

*Calculated using method described by Barros and Victora 2005
**No significant differences were found between PSF and non-PSF characteristics

Table 3 Nutritional Status Indicators

	2010*		2011**		2011 PSF		2011 Non-PSF	
	N	**n (%)**	**N**	**n (%)**	**N**	**n (%)**	**N**	**n (%)**
Stunted	201	9 (4.5)	298	24 (8.0)	136	11 (8.1)	161†	13 (8.1)
Underweight	202	4 (2.0)	298	8 (2.7)	136	2 (1.5)	161	6 (3.7)
Wasted	201	0 (0.0)	298	4 (1.3)	136	1 (0.7)	161	3 (1.9)
Overweight	201	10 (4.5)	298	16 (8.5)	136	9 (6.6)	161	7 (4.4)
Obese	201	5 (2.5)	298	4 (2.5)	136	1 (0.7)	161	3 (1.9)
Anemia	-	-	236	29 (12.3)	109	13(11.9)	126	16(12.7)

*2010 study sample collected from households
**2011 study sample collected from clinics
†One subject did not have knowledge of PSF status

Table 4 Adjusted Logistic Models from 2011 Study Sample*

	Overweight/Obese (N=223)		Stunted (N= 253)		Underweight (N= 253)		Wasted (N= 253)		Anemic (N= 176)	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Enrolled in PSF	2.91	0.77, 10.97	1.26	0.47, 3.42	0.39	0.05, 3.22	0.31	0.02, 5.58	0.59	0.22, 1.59
Wealth Index	1.00	0.99, 1.00	1.00	0.99, 1.01	1.00	0.98, 1.00	1.00	0.99, 1.01	1.00	0.99, 1.00
Female Gender	0.20**	0.05, 0.83	0.31**	0.11, 0.89	0.32	0.04, 2.92	1.84	0.12, 28.16	0.75	0.28, 2.02
Age	1.06**	1.01, 1.10	1.00	0.95, 1.02	0.90	0.79, 1.03	1.03	0.95, 1.11	0.93**	0.88, 0.97
Number of siblings	0.32**	0.11, 0.92	1.62**	1.13, 2.30	0.98	0.47, 2.03	1.65	0.70, 3.91	1.71	0.85, 1.62
Low birth weight	-	-	4.17**	1.24, 14.03	7.32	0.83, 64.29	34.2**	2.26, 515.91	4.80**	1.24, 18.64
Complementary feeding introduced post 6 months	0.66	0.06, 7.80	2.13	0.41, 11.17	0.34	0.03, 4.66	3.72	0.21, 66.44	0.29	0.05, 1.74
Exclusively breastfed for 6 months	0.76	0.17, 3.48	0.61	0.16, 2.33	12.20	0.88, 167.47	-	-	1.15	0.39, 3.45
HoH Education	3.97	0.97, 16.20	1.05	0.33, 3.32	-	-	-	-	0.85	0.26, 2.76
Parent BMI >25	1.14	0.31, 4.18	-	-	-	-	-	-	0.95	0.36, 2.50
Large for gestational age	0.76	0.07, 8.27	-	-	-	-	-	-	-	-

*Note: Dashed lines indicate variable was not included in the model due to biological implausibility or quasi-complete separation of data
**significant at the $p < 0.05$ level

PUBLIC HEALTH IMPLICATIONS

- Regardless of the PSF, efforts must be made to improve the assessment and prevention of stunting and underweight status among children under five in Brazil. Enhanced educational efforts on adequate consumption of nutrient rich foods should be implemented through the PSF or other health promotion efforts.
- There is a concern for boys being fed less nutritious foods. This educational effort should be especially targeted to families with male children under the age of five.
- As low birth-weight was a significant predictor for many nutritional status indicators including wasting, stunting, and anemia, the nutritional status of these children as well as pregnant women should also be a target for intervention.
- There is a concern for the prevalence of overweight status, which has increased in Vespasiano and in Brazil in general in just the past year according to SISVAN/ DATASUS data. Although obesity rates among this population in Vespasiano are relatively low, overweight status puts children at risk for obesity in later life. Moreover, if the trend continues, it could lead to higher prevalence of obesity in the under-five population in the coming years. Thus, there is significant value in furthering government resources to address the prevention of overweight and obesity among children as well as parents in Vespasiano.
- We have collected baseline data that could be used for future studies. Further research may be conducted to assess the effectiveness of the PSF over time.

REFERENCES

1. Popkin, B.M., L.S. Adair, and S.W. Ng, *Global nutrition transition and the pandemic of obesity in developing countries.* Nutr Rev, 2012. **70**(1): p. 3-21.
2. *MDG 4: reduce child mortality*. World Health Organization [http://www.who.int/topics/millennium_development_goals/child_mortality/en/index.html] 2012.
3. Black, R.E., et al., *Maternal and child undernutrition: global and regional exposures and health consequences.* The Lancet, 2008. **371**: p. 243 - 260.
4. *Children: reducing mortality*. World Health Organization [http://www.who.int/mediacentre/factsheets/fs178/en/index.html] 2012.
5. *Millennium Development Goals: progress towards the health-related Millennium Development Goals*. [http://www.who.int/mediacentre/factsheets/fs290/en/index.html] 2011.
6. *Indicators for assessing infant and young child feeding practices, Part 3 Country Profiles.* World Health Organization, 2010.
7. Doak, C.M., et al., *Overweight and Underweight Coexist within Households in Brazil, China and Russia.* Journal of Nutrition, 2000. **130**: p. 2965 - 2971.
8. Reilly, J.J., *Understanding chronic malnutrition in childhood and old age: role of energy balance research.* Proc Nutr Soc, 2002. **61**(3): p. 321-7.
9. de Onis, M., M. Blossner, and E. Borghi, *Global prevalence and trends of overweight and obesity among preschool children.* Am J Clin Nutr, 2010. **92**(5): p. 1257-64.
10. *World Bank Indicators - Brazil - Nutrition* Trading Economics [http://www.tradingeconomics.com/brazil/indicators] 2012.
11. *PNDS 2006: Dimensões do processo Reprodutivo e da Saúde da Criança.*, C.B.d.A.e.P. Ministério da Saúde, Editor 2009: Brasil.
12. Aznar, L.A.M., *Epidemiology of Obesity in Children and Adolescents: Prevalence and Etiology*, L.A.M. Aznar, I. Pigeot, and W. Ahrens, Editors. 2010, Springer: New York.
13. *SISVAN, S.d.V.A.e.N.S.S.f.F.a.N.* [http://tabnet.datasus.gov.br/cgi/tabcgi.exe?ibge/cnv/popMG.def] 2011.
14. CGAN, G.C.o.F.a.N.-. *SISVAN.* Available from: http://nutricao.saude.gov.br/sisvan/relatorios_publicos/rel_consolidado_acompanhamento.php.
15. Victora, C.G., et al., *Risk factors for malnutrition in Brazilian children: the role of social and environmental variables.* Bulletin of the World Health Organization, 1986. **64**(2): p. 299-309.
16. Barros, A.J.D., et al., *Infant malnutrition and obesity in three population-based birth cohort studies in Southern Brazil: trends and differences.* Cad. Saúde Pública, 2008. **24**(Sup 3): p. S417-S426.
17. Must, A., et al., *The Disease Burden Associated With Overweight and Obesity.* JAMA, 1999. **282**: p. 1523-1529.
18. Chen, A.Y. and J.J. Escarce, *Family structure and childhood obesity, Early Childhood Longitudinal Study - Kindergarten Cohort.* Prev Chronic Dis, 2010. **7**(3): p. A50.
19. Tome, F.S., et al., *Are birth weight and maternal smoking during pregnancy associated with malnutrition and excess weight among school age children?* Brazilian Journal of Medical and Biological Research, 2007. **40**: p. 1221-1230.
20. Berglund, S., B. Westrup, and M. Domellof, *Iron Supplements Reduce the Risk of Iron Deficiency Anemia in Marginally Low Birth Weight Infants.* Pediatrics, 2010. **126**(4): p. e874-e883.
21. Butte, N.F., M.G. Lopez-Alarcon, and C. Garza, *Nutrient Adequacy of Exclusive Breastfeeding for the Term Infant During the First Six Months of Life*, D.o.N.f.H.a. Development, Editor, World Health Organization: Geneva, Switzerland.

22. Jones, G., et al., *How many child deaths can we prevent this year?* The Lancet, 2003. **362**(9377): p. 65-71.
23. *The Optimal Duration of Exclusive Breastfeeding Report of an Expert Consultation*, D.o.N.f.H.a. Development, Editor 2002, World Health Organization: Geneva, Switzerland.
24. Simon, V.G.N., d.S.J.M. P., and d.S.S. B., *Breastfeeding, complementary feeding, overweight and obesity in pre-school children.* Rev Saúde Pública, 2008. **43**(1): p. 1-9.
25. Frye, C. and J. Heinrich, *Trends and predictors of overweight and obesity in East German children.* Int J Obes Relat Metab Disord, 2003. **27**(8): p. 963-9.
26. Kramer, M.S., *Do breast-feeding and delayed introduction of solid foods protect against subsequent obesity?* Journal of Pediatrics, 1981. **98**(6): p. 883-887.
27. Reilly, J.J., et al., *Early life risk factors for obesity in childhood: cohort study.* BMJ, 2005. **330**(7504): p. 1357.
28. Elliott, K.G., et al., *Duration of breastfeeding associated with obesity during adolescence.* Obes Res, 1997. **5**(6): p. 538-41.
29. Silveira, D., et al., *Risk factors for overweight among Brazilian adolescents of low-income families: a case–control study.* Public Health Nutrition, 2007. **9**(04).
30. Whitaker, R.C., et al., *Predicting Obesity in Young Adulthood from Childhood and Parental Obesity.* The New England Journal of Medicine, 1997. **337**(13): p. 869-873.
31. Monte, C.M.G. and E.R.J. Guigliani, *Recommendations for the complementary feeding of the breastfed child.* Jornal de Pediatria, 2004. **5**(Suppl/S131).
32. Nielsen, G.A., B.L. Thomsen, and K.F. Michealsen, *Influence of breastfeeding and complementary food on growth between 5 and 10 months.* Acta Pædiatr, 1998. **87**: p. 911-917.
33. Schack-Nielsen, L., et al., *Late introduction of complementary feeding, rather than duration of breastfeeding, may protect against adult overweight.* Am J Clin Nutr, 2010. **91**(3): p. 619-27.
34. Arimond, M. and M.T. Ruel, *Dietary Diversity Is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys.* The Journal of Nutrition, 2004. **134**(10): p. 2579-2585.
35. Boutelle, K.N., et al., *Fast food for family meals: relationships with parent and adolescent food intake, home food availability and weight status.* Public Health Nutr, 2007. **10**(1): p. 16-23.
36. Church, M., *Dietary factors in malnutrition: quality and quantity of diet in relation to child development.* Proc Nutr Soc, 1979. **38**(41): p. 41-49.
37. Hameed, A. and P.I. Paracha, *Nutritional Status and Feeding Practices of Children from Birth to 15 Months in Rural Area of North West Frontier Province Pakistan.* JPMI, 1991. **13**(1): p. 35-45.
38. Jiang, J., et al., *Risk factors for overweight in 2- to 6-year-old children in Beijing, China.* International Journal of Pediatric Obesity, 2006. **1**(2): p. 103-108.
39. Florêncio, T.M.d.M.T., et al., *Obesity and undernutrition in a very-low-income population in the city of Maceió, northeastern Brazil.* British Journal of Nutrition, 2007. **86**(02): p. 277.
40. Duncan, S., et al., *Modifiable risk factors for overweight and obesity in children and adolescents from Sao Paulo, Brazil.* BMC Public Health, 2011. **11**: p. 585.
41. Muniz, T.P., et al., *Child health and nutrition in the Western Brazilian Amazon: population-based surveys in two counties in Acre State.* Cad. Saúde Pública, 2007. **23**(6): p. 1283-1293.
42. Mushtaq, M.U., et al., *Prevalence and socio-demographic correlates of stunting and thinness among Pakistani primary school children.* BMC Public Health, 2011. **11**: p. 790.
43. Schaible, U.E. and S.H.E. Kaufmann, *Malnutrition and Infection: Complex Mechanisms and Global Impacts.* PLOS Medicine, 2007. **4**(5): p. 806-812.
44. Sawaya, A.L., et al., *The Link Between Childhood Undernutrition and Risk of Chronic Diseases in Adulthood: A Case Study of Brazil.* Nutrition Reviews, 2003. **61**(5): p. 168-175.
45. Thompson, D., et al., *Lifetime Health and Economic Consequences of Obesity.* Archives of Internal Medicine, 1999. **159**: p. 2177-2183.

46. Hoffman, D.J., et al., *Why are nutritionally stunted children at increased risk of obesity? Studies of metabolic rate and fat oxidation in shantytown children from São Paulo, Brazil.* Am J Clin Nutr, 2001. **72**: p. 702-707.
47. *The CIA World Factbook*. [https://www.cia.gov/library/publications/the-world-factbook/geos/br.html] 2011.
48. *Brazil Data*. The World Bank [http://data.worldbank.org/country/brazil] 2012.
49. Monteiro, C.A., W.L. Conde, and B.M. Popkin, *Income-specific trends in obesity in Brazil: 1975-2003.* Am J Public Health, 2007. **97**(10): p. 1808-12.
50. Haq, C., G. Gusso, and M.I.P. Anderson, *Strengthening Primary Health Care with Family and Community Medicine in Brazil.* Rev Bras Med Fam e Com, 2006. **2**(7): p. 196-202.
51. *Ministerio da Saude*, D.d.A.o.B.s. S.d.P.t.d.S.d., Editor 2011: http://dab.saude.gov.br/abnumeros.php#numeros.
52. *DATASUS*, 2011: http://tabnet.datasus.gov.br/cgi/tabnet.exe?pact2010/pactmg.def.
53. Saude, M.d., *Guia Pratico do Programa Saude da Familia*, P.S.d. Familia, Editor.
54. Macinko, J., et al., *Going to scale with community-based primary care: an analysis of the family health program and infant mortality in Brazil, 1999-2004.* Soc Sci Med, 2007. **65**(10): p. 2070-80.
55. Dourado, I., et al., *Trends in Primary Health Care-sensitive Conditions in Brazil The Role of the Family Health Program (Project ICSAP-Brazil).* Medical Care, 2011. **49**(6): p. 577-584.
56. Uauy, R., C. Albana, and J. Kain, *Obesity Trends in Latin America: Transiting from Under- to Overweight.* Journal of Nutrition, 2001. **131**: p. 893S - 899S.
57. Aquino, R., N.F. de Oliveira, and M.L. Barreto, *Impact of the family health program on infant mortality in Brazilian municipalities.* Am J Public Health, 2009. **99**(1): p. 87-93.
58. Bezerra, R.C.R., *Evaluation of the Epidemiologic Impact of a National Primary Health Care Policy on Infant Health Outcomes in Brazil, From 1999-2002*, 2006, The University of Arizona.
59. Dorofeev, S. and P. Grant, eds. *Statistics for Real Life Sample Surveys*. 2006, Cambridge University Press: New York.
60. Barros, A.J.D. and C.G. Victora, *A nationwide wealth score based on the 2000 Brazilian demographic census.* Rev Saúde Pública, 2005. **39**(4): p. 1-6.
61. de Onis, M. and J.P. Habicht, *Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee.* Am J Clin Nutr, 1996. **64**(4): p. 650-8.
62. Monteiro, C.A., et al., *Causes for the decline in child under-nutrition in Brazil, 1996-2007.* Rev Saúde Pública, 2009. **43**(1).
63. Sullivan, K. *Open Epi*. Sample Size Calculation for Cross-Sectional, Cohort, and Clinical Trials Version 3.04.04; Available from: http://www.sph.emory.edu/~cdckms/sample%20size%202%20grps%20cohort.htm.
64. Akinyele, I.O., *Gender Informed Nutrition Agriculture: Summary of Achievements Report*, USAID, Editor 2007.
65. *Methods used for assessments in the Rachna program*, in *Women and child health at scale: Paper* 22006, CARE.
66. King, G. and L. Zeng, *Logistic Regression in Rare Events Data*, in *The Global Burden of Disease 2000 in Aging Populations* 2000, Harvard Burden of Disease Unit - National Institute on Aging.
67. Golden, M.H., *Proposed Recommended Nutrient Densities for Moderately Malnourished Children*, 2008, WHO, UNICEF, WFP and UNHCR Consultation on the Dietary Management of Moderate Malnutrition in Under-5 Children by the Health Sector: Aberdeen, Scotland.
68. Ndiku, M., et al., *Gender inequality in food intake and nutritional status of children under 5 years old in rural Eastern Kenya.* Eur J Clin Nutr, 2011. **65**(1): p. 26-31.
69. Diaz, M.E., et al., *Fat Distribution in Cuban Infants.* American Journal of Human Biology, 1994. **6**: p. 687-692.

70. Cooke, L.J. and J. Wardle, *Age and gender differences in children's food preferences.* British Journal of Nutrition, 2007. **93**(05): p. 741.
71. Kravdal, Ø. and I. Kodzi, *Children's stunting in sub-Saharan Africa: Is there an externality effect of high fertility?* Demographic Research, 2011. **25**: p. 565-594.
72. Ricci, J.A. and S. Becker, *Risk factors for wasting and stunting among children in Metro Cebu, Philippines.* Am J Clin Nutr, 1996. **63**: p. 966-975.
73. Vitolo, M.R., et al., *Some risk factors associated with overweight, stunting and wasting among children under 5 years old.* Jornal de Pediatria, 2008. **84**(3): p. 251-257.
74. Ashworth, A., S.S. Morris, and P.I.C. Lira, *Postnatal Growth Patterns of Full-Term Low Birth Weight Infants in Northeast Brazil Are Related to Socioeconomic Status.* The Journal of Nutrition, 1997. **127**(1950-1956).
75. Berglund, S., B. Westrup, and M. Domellof, *Iron supplements reduce the risk of iron deficiency anemia in marginally low birth weight infants.* Pediatrics, 2010. **126**(4): p. e874-83.