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Child nutrition in rural Nicaragua

Population-based studies in a transitional society

MARIELA CONTRERAS



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Abstract

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Emerging favourable as well as unfavourable nutrition patterns are observed in societies undergoing rapid social and economic change. The aim of this thesis is to analyse the associations between household and maternal resources and infant and young child feeding habits and nutritional status in rural Nicaragua, a low-income transitional society.

All households ($n=1,500$) in *Los Cuatro Santos* with at least one child (0-3 y) were visited to collect information on feeding of the youngest child. Children's anthropometry was also measured using standardised World Health Organisation (WHO) techniques. Validated instruments were used to assess household and maternal resources. All instruments had been adapted to the local context and piloted in a nearby community.

The education of the mother showed more independent variation in the studied outcomes. The odds for exclusive breastfeeding were highest in infants aged 0 to 5 months of mothers with the lowest education. Further, children aged 6 to 35 months with lowest educated mothers were less likely to consume highly processed snacks (HP snacks) and sugar-sweetened beverages (SSBs). They were also less likely to be exposed to a double burden of suboptimal feeding (concurrent unmet WHO recommended feeding practices and consumption of HP snacks or SSBs). However, children aged 6 to 35 months were more prone to infrequently meet dietary diversity and to more shortness. Children in the same age group with lower educated mothers were also shorter in households with the lowest housing quality.

Higher level of maternal education contributed both favourably and unfavourably to child feeding and nutrition. This was reflected in more and less frequent practice of the WHO feeding indicators, but also in more frequent children's consumption of HP snacks and SSBs. Higher maternal education was associated with taller children, even in households with the lowest housing quality.

Keywords: autonomy, education, feeding practices, food security, nutritional status, social support

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To mom and dad

Research collaboration

This doctoral thesis was developed in collaboration with members of the non-governmental organisation Asociación para el Desarrollo Económico y Social de El Espino (APRODESE) in Chinandega, Nicaragua and the Department of Women's and Children's Health, International Maternal and Child Health (IMCH) at Uppsala University in Uppsala, Sweden. The doctoral thesis was funded by the Swedish International Development Cooperation Agency (Sida) Department for Research (SWE-2008-079) and by Uppsala University.



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List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I **Contreras M.**, Zelaya Blandón E., Persson L.Å. & Ekström E.C. Consumption of highly processed snacks, sugar-sweetened beverages and child feeding practices in a rural area of Nicaragua. *Maternal & Child Nutrition*. 2014. doi:10.1111/mcn.12144. [Epub ahead of print].
- II **Contreras M.**, Zelaya Blandón E., Persson L.Å., Hjern, A. & Ekström E.C. Socio-economic resources, young child feeding practices, consumption of highly processed snacks and sugar-sweetened beverages: a population-based survey in rural northwestern Nicaragua. *BMC Public Health*. 2015 Jan 21; 15:25. doi:10.1186/s12889-015-1374-5.
- III **Contreras M.**, Zelaya Blandón E., Persson L.Å., Hjern, A. & Ekström E.C. Socio-economic resources and child under- and over-nutrition. A population-based survey in rural Nicaragua. *Manuscript*.
- IV Ziaei S., **Contreras M.**, Zelaya Blandón E., Persson L.Å., Hjern, A. & Ekström E.C. Women's autonomy and social support and their associations with infant and young child feeding and nutritional status: community-based survey in rural Nicaragua. *Public Health Nutrition*. 2014 Nov 20: 1-12. doi:10.1017/S1368980014002468. [Epub ahead of print].

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Abbreviations

APRODESE	Asociación para el Desarrollo Económico y Social de El Espino
BAZ	BMI-for-age Z-scores
BMI	Body mass index
EBF	Exclusive breastfeeding
FFQ	Food frequency questionnaire
HAZ	Height-for-age Z-scores
HDSS	Health and Demographic Surveillance System
HP snacks	Highly processed snacks
IMCH	International Maternal and Child Health
LMICs	Low- and middle-income countries
NCDs	Non-communicable diseases
SDs	Standard deviations
SSBs	Sugar-sweetened beverages
UNICEF	United Nations Children's Fund
USD	United States dollar
WAZ	Weight-for-age Z-scores
WHZ	Weight-for-height Z-scores
WHO	World Health Organisation

Introduction

The double burden of malnutrition

The double burden of malnutrition displays itself by the coexistence of under- and overnutrition in the same country, household or individual. In many low- and middle-income countries (LMICs), the proportion of overweight women is higher than the proportion of underweight women (1). Underweight women still remain the most common nutritional burden in the poorest countries, but increasing prevalence of overweight in women is being reported, both in urban and rural areas (2) suggesting that under- and overweight women coexist in the same populations.

The global prevalence of stunting in children before the age of 5 years has decreased over the last decades (3). During the same period a steady rise in preschool overweight has been reported (4), which may indicate that stunting and overweight is found at the same time in LMICs. In some urban low-income areas more overweight than stunted children are found (5).

The double burden of malnutrition with overweight mothers and stunted children is sometimes found in the same household. This is especially found in middle-class households (6).

Sometimes the double burden of malnutrition is found in the same individual. Preschool children, who were both stunted and obese, were observed in disadvantaged indigenous populations in Mexico (7). In another Latin American study using 97 nationally representative surveys stunting and overweight were documented in the same child especially in countries that had a prevalence of childhood stunting of more than 20% (8). The presence of stunting and overweight in the same child has been observed both in Africa and Asia (9).

Overnutrition in children

Globally, the prevalence of overweight and obesity is on the rise (10) with the exception of some high-income countries that show a levelling-off in their overweight trends in recent years (11). However, an increase in the

prevalence of overweight has been observed particularly in women of lower socio-economic strata in LMICs (12). The magnitude of overweight in women has been reported to be almost similar in urban and rural areas in such parts of the world (10). Evidence may suggest that the burden of overweight is shifting towards the poorer rural segments of society in low- and middle-income settings. A large study in 36 LMICs reported that more wealth, higher educational levels and living in urban areas were some of the potential determinants of women being overweight (13). It was also concluded that those with a higher educational level are less prone to suffer from overnutrition and that the risk of overweight in wealthy urban women has decreased over time (13).

During the last few decades an increase in the proportion of overweight children has been observed globally (4). In South Africa substantial economic improvement was associated with an increase in the prevalence of overweight in 8- to 11-year-old boys (from 1% in 1994 to 10% in 2001-4, and in girls from 1% in 1994 to 17% in 2001-4) (14). Even in LMICs with modest urbanization a rise in the proportion of overweight children has been reported, particularly among those living in urban areas (15). A considerable proportion of overweight children younger than 5 years of age has been documented in isolated mountainous regions (16), as well as in remote rural areas with slow economic development (17). In general, the observed associations between potential determinants such as higher maternal education or urban residence and child overnutrition have been weak and inconsistent in LMICs (18).

Risk factors in children for chronic diseases in adulthood

Non-communicable diseases (NCDs) such as cardiovascular disease, type 2 diabetes, chronic respiratory diseases and cancer are the leading causes of global deaths, with 80% of the deaths attributed to these NCDs occurring in LMICs (19). Risk factors for NCDs are observed in children and adolescents worldwide. In 7- to 18-year-old urban Mexican children, the prevalence of insulin resistance was 23% in girls and 17% in boys. Children, who had a dietary intake that was high in highly processed foods, were more likely to become insulin resistant (20). In a sample of children in Uttar Pradesh, India, 9% of children aged 12 to 16 years had hypertension, a risk factor for cardiovascular disease (21). High blood pressure in children has been associated with high sodium intake in the United States (22). While in rural north-eastern South Africa girls, as opposed to boys (16% vs. 1%), had a high waist circumference and thus were at an increased risk of the metabolic

syndrome (23). NCDs are an added burden to the national economy and health care system. In Mexico, projections have shown that 13 NCDs cost the country in 2010 a total of \$USD 806 million, with expected cost increases of \$USD 1.2 and \$USD 1.7 billion by 2030 and 2050, respectively (24).

The nutrition transition

The nutrition transition is characterised by shifts in dietary patterns from low-energy-dense foods, such as complex carbohydrates (i.e. maize, rice, bulgur) and legumes to highly processed foods (25). The nutrition transition occurred in Europe over a span of several centuries. In LMICs this process is rapid, which may be attributable to globalization (26). Other factors that may fuel the nutrition transition at the global level are technical changes, such as cheap oil and economic growth (27). Urbanization is also a driver in the dietary transition, as an increased consumption of highly processed foods has primarily been observed in urban areas (28). Such dietary changes, mostly an increase of highly processed foods, have also been reported for rural women, revealing that the nutrition transition takes place also in rural settings (29). Many LMICs show an increase in the availability of highly processed foods, suggesting an emerging transition in many parts of the world to foods high in energy with added fat, sugar and salt (30).

Infant and young child feeding

Recommended feeding practices

The World Health Organisation (WHO) has issued guidelines to promote optimal infant and young child feeding practices, to ensure optimal growth and also in order to measure the global situation of child feeding (31, 32). The commonly assessed infant and young child feeding indicators are initiation of breastfeeding within the first hour after birth, exclusive breastfeeding (EBF) for the first six months of life and the continuation of breastfeeding at one year of age. In addition to these indicators the timely introduction of appropriate solids, semisolids or soft foods at around six months, dietary diversity, meal frequency and an acceptable diet are used to evaluate complementary feeding in 6- to 23-month-old children.

Recent estimates report that feeding practices according to WHO recommendations are suboptimal worldwide. For instance, only about one-third of infants reportedly are exclusively breastfed before the age of 6 months (33), even though breastfeeding promotion has a large potential to

reduce child morbidity and mortality (34). Beyond infancy, breast milk alone is not sufficient to ensure adequate child growth and development. The timely introduction of appropriate solids, semisolids or soft foods at around six months begins the complementary feeding phase. The quality and quantity of the diet, represented by dietary diversity and meal frequency, respectively, not only contribute energy, but in particular essential micronutrients and fatty acids to meet the growing demands of the infant. In some contexts solids, semisolids, or soft foods are introduced early (35), while complementary foods may be introduced late elsewhere (36). Dietary diversity in childhood in low-income settings is often at a low level suggesting that micronutrient-rich foods are infrequently consumed (37). The proportion of young children who meet minimum meal frequency tend to be higher than the proportion of children who meet minimum dietary diversity (33). However, a high proportion of young children with a low meal frequency is often found in poor settings (38). Given the constraints of fulfilling both a minimum dietary diversity and a minimum meal frequency, the proportion of children with minimum acceptable diet is usually low, reflecting the poor complementary feeding practices from six months to two years of age (39). These suboptimal feeding practices are found in spite of the generally satisfactory rates of children continuing to be breastfed at one year of age (40).

Not recommended feeding practices

Although the WHO feeding indicators are available, there is no global consensus on validated indicators to measure consumption of foods and beverages that may be related to overnutrition in young children. Concurrently, there have been reports of high intakes of sugar-sweetened beverages (SSBs) and foods items high in energy, saturated fat, sugar and salt by preschool children in several diverse settings in LMICs (41). In Indonesia, for instance, crispy salty snacks in combination with traditional sweets, fatty foods and sweetened beverages contributed to 40% of the total energy intake in the diet of a sample of young children (42). Likewise, in Thailand, crispy salty snacks contributed to 40% of sodium intake in a sample of 1- to 3-year-old children (43). Children's consumption of these highly processed foods and SSBs was reportedly linked to the presence of overweight and obesity in a sample of young children in Mexico (44). It can be argue that young children in LMICs may be at risk of a "double burden of suboptimal feeding", i.e. suboptimal feeding in relation to WHO recommended feeding practices and also consumption of unhealthy foods and beverages.

Household resources

Housing quality

Housing quality is often used as a proxy for economic resources of the household in addition to those expressed by household food security and maternal education. Housing quality may also express healthy or unhealthy environment that could influence child nutritional status. Children from poorer households typically are found to have low dietary diversity and unacceptable diets, when compared to children from richer households (38, 45). Household per capita expenditure is often associated with dietary diversity scores, suggesting that household per capita expenditures may predict children's dietary diversity (46). The economic resources of the household are important for child nutrition. Stunted children are more likely to live in households with fewer resources (47, 48). On the other hand, more household resources may also be a risk factor for overweight in children (49).

Food security

Household food insecurity is a multidimensional concept and an indicator that measures access to food resources. The food insecurity scales capture various dimensions of what the household members may encounter in order to manage food constraints. Children from households with more food insecurity are less likely to meet the requirements for diet diversity (50). Food expenses and accessibility to protein-rich foods are usually good predictors of dietary adequacy (51). Children, who live in food insecure households, are also more prone to be stunted and underweight (52), and thus at increased risk of long-term poor growth and development (53). Food insecurity may also be associated with level of maternal education (54). Dietary diversity is an inherent mediator of the association between household food insecurity and children's nutritional status, although this could be context-specific and vary in accordance with study design and methods used (55).

Maternal resources

Education

The independent association between level of maternal education and infant and young child feeding and nutrition has been extensively studied, showing both favourable and unfavourable associations (45, 56-58). Higher maternal education is typically related to lower occurrence of childhood stunting and underweight (59), but also to a higher likelihood of overweight (60).

Children of mothers with higher educational levels tend to more often meet criteria of dietary diversity (58) and are introduced to solid, semisolid or soft complementary foods at an appropriate time (45). However, a higher level of maternal education is often, especially in low-income countries, linked to less exclusive breastfeeding (61) and lower frequency of continued breastfeeding at around one year of age.

In some settings, it has been reported that socio-economic status explained most of the association between education and infant feeding and nutrition. A higher educational level is often linked to more use of modern health care and also more relevant knowledge (57). Maternal education is frequently associated with other household and maternal resources and may express itself through different pathways when associated with the occurrence of child undernutrition (56).

Autonomy

Maternal autonomy refers to the ability of mothers to decide how to use resources, to have control over their own body and to be able to make decisions on their own (62). Mothers with more autonomy may also have more ability to move outside of their households and be able to use more money for their own health and that of their children (63). The association between maternal autonomy and child nutrition may be age-specific and depend on context. More maternal autonomy, for instance, has been associated with chubbier children only among the older age groups in a rural, desert area in northern Kenya (62). This may suggest that breastfeeding could protect the younger children from the household resource constraints the mothers may face. Additionally, mothers' mobility can allow more opportunities for them to exchange information and acquire knowledge in favour of child health and growth (64). Financial autonomy may imply that mothers may seek antenatal care and gain knowledge about optimal feeding practices (65). Maternal autonomy may also be related with other maternal resources such as education. It has been found that among children of mothers with decision-making power, maternal reading skills was linked to lower risk of child mortality, while this was not the case for children of mothers with less decision-making power (66).

Social support

Maternal social support includes material, practical, cognitive and emotional dimensions (67). Children of mothers with more material and emotional support were found to be chubbier and bigger in a poor, urban area of north-eastern Brazil (68). Even practical support, such as preparation of meals and fetching water, has been shown to be associated with taller children (69).

This may suggest the importance for children of the type of support mothers may receive from family and community members.

Rationale for this thesis

In societies undergoing rapid economic development, improved household and maternal resources may be beneficial for growth and development of children. Such economic and social improvements may also be associated with increased prevalence of child overweight or obesity (49, 60, 70). Thus, household and maternal resources may display favourable and unfavourable associations with child nutrition in transitional societies. Child undernutrition is still present and its drivers have been well defined. The associations between maternal resources and child overnutrition have been studied to a lesser degree in LMICs. There is also a lack of global consensus on not recommended foods and feeding practices and how these food habits may increase the risk of overweight and obesity.

Conceptual framework of the thesis

The conceptual framework of the thesis is based on the United Nations Children's Fund (UNICEF) conceptual framework of the causes of malnutrition (71). Figure 1 illustrates how insufficient household economic resources and inadequate maternal resources with their direct or indirect pathways may lead to suboptimal feeding and child undernutrition. It also presents how sufficient household economic resources and adequate maternal resources directly or indirectly result in both optimal and suboptimal feeding practices and child overnutrition. The conceptual framework of this thesis also demonstrates the interrelatedness between the household and maternal resources and the immediate associations between child feeding and child under- and overnutrition. Child undernutrition may also be a risk factor for later overnutrition, as depicted in Figure 1.

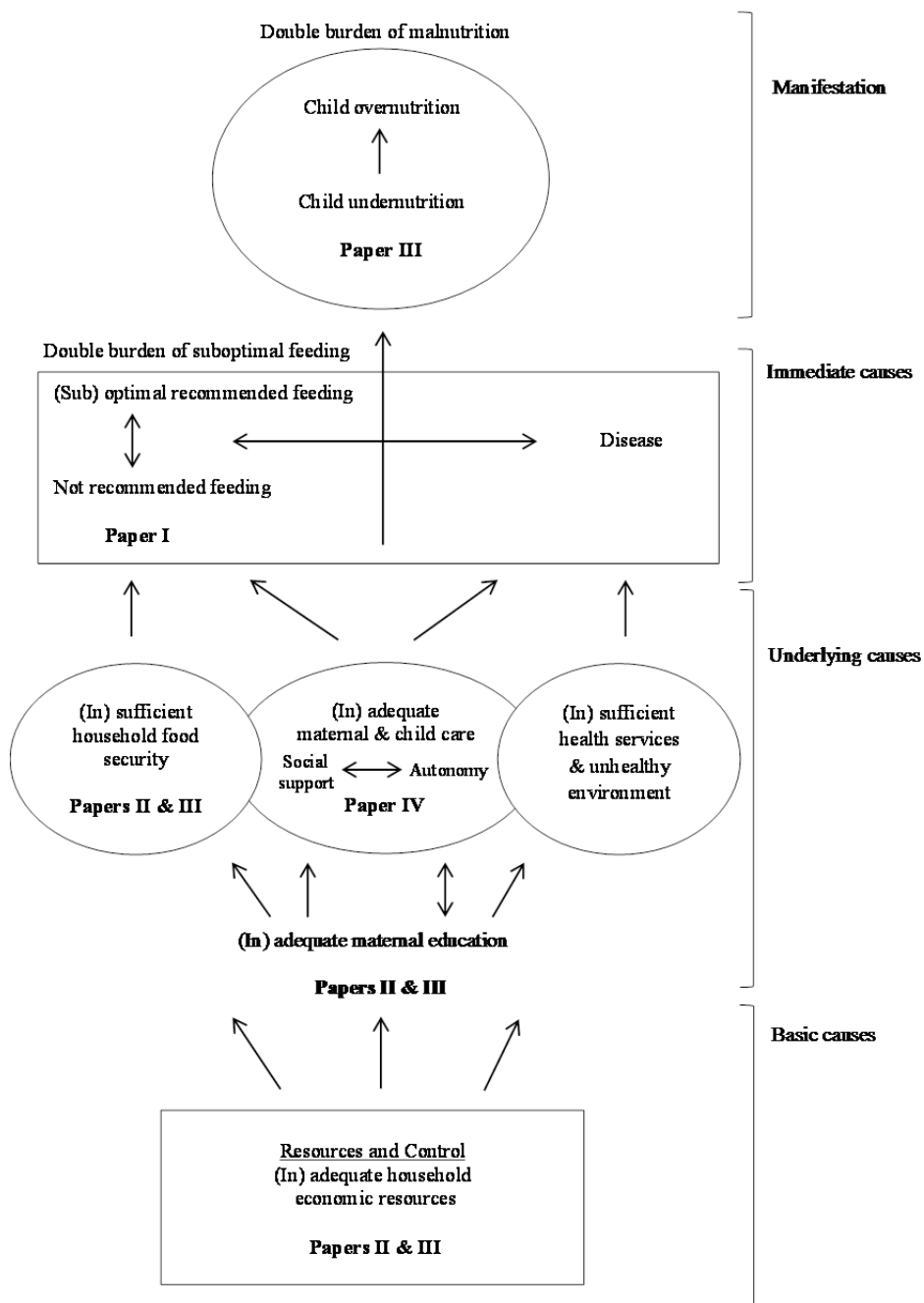


Figure 1. Thesis conceptual framework of causes of child under- and overnutrition

Aim of the thesis

The aim of this thesis is to investigate the associations between household and maternal resources and feeding patterns and nutritional status of infants and young children in rural Nicaragua, a low-income transitional society.

Specific objectives

1. To assess infant and young child feeding practices of 0 to 35 months old children (Paper I)
2. To evaluate the independent associations between household and maternal resources and feeding practices of infants and children aged 0 to 35 months (Papers II & IV)
3. To evaluate child nutritional status and the independent associations between household and maternal resources and nutritional status of infants and children aged 0 to 35 months (Papers III & IV)

Methods

Study setting

Nicaragua is a lower-middle-income country (72) in Central America with a population of around six million inhabitants. Historically its economy has been based on agricultural production and exports, with the recent addition of the light manufacturing industry and tourism (73). In spite of Nicaragua's economic progress in the last decades, 43% of its population is poor with poverty being more pronounced in the rural areas (72). However, the country has shown improvements in the occurrence of child undernutrition in recent years. The prevalence of child stunting has decreased from 22% in 2006-7 to 17% in 2011-12, while the proportion of children younger than 5 years who were wasted and underweight remained low in 2011-12 (74). No country-level data were reported on the prevalence of child overweight in 2011-12, but estimations in 2008-12 documented that 6% of children younger than 5 years were overweight or obese (75). Though reductions in child undernutrition were observed, the prevalence of exclusive breastfeeding has been stagnant with only 32% of infants aged 0 to 5 months being exclusively breastfed in 2011-12, compared to 31% in 2006-7 (74). In general, the fulfilment of the WHO recommended feeding practices is suboptimal during the second half of infancy up to two years, despite an acceptable proportion of children still being breastfed at one year of age (75).

The municipalities of Santo Tomás del Nance, San Juan de Cinco Pinos, San Pedro del Norte and San Francisco del Norte are located in the Department of Chinandega in rural, north-western Nicaragua. The area is collectively called *Los Cuatro Santos* (The Four Saints) and has a population of approximately 25,000 people living in about 5,000 households. Most of the inhabitants work in subsistence agriculture, agro-industrial activities and to a limited extent in livestock production and government services. Unemployment is high and there is migration within the municipalities, as well as to bigger cities in the country and internationally.



Figure 2. *Los Cuatro Santos* in north-western Nicaragua

During the last 20 years, community efforts driven by local stakeholders have improved the livelihood in *Los Cuatro Santos*. Although most of the households still are poor, there has been a reduction in extreme poverty from 19% in 2004 to 14% in 2007, reflecting improvements in water and sanitation, housing quality and an increase in years of schooling in the population (76). In 2007, 45% of the population aged 12 years or more had completed primary school as opposed to 40% in 2004 (76). In addition to improvements in household and educational resources, the under-5 mortality rate has dropped from 24 per 1000 live births in 2004 to 16 per 1000 live births in 2009 (77). In addition to the overall reduction in mortality there has been an improved social equity in child survival when comparing children of mothers with and without formal education (76, 78).

A key stakeholder in the development of *Los Cuatro Santos* has been the Asociación para el Desarrollo Económico y Social de El Espino (APRODESE). This is a local non-governmental organisation constituted in 1998 with the objective of improving the socio-economic situation and human development of the area. Developmental projects, such as technical education, microcredit, potable water through piped or well systems, school breakfast programs, organic agriculture and educational scholarships, have been carried out successfully by APRODESE. The projects have brought economic and development progress to the area. Improvements in water and sanitation, home gardening and technical education, for instance, have been associated with poverty reduction in the households (77). All households in the area have also received a pamphlet containing general health messages, as well as recommendations on infant feeding. APRODESE, in coordination with partners, established a Health and Demographic Surveillance System (HDSS) in 2003. The HDSS covers the totality (25,000 people and about 5,000 households) of the *Los Cuatro Santos* society. Four rounds of HDSS data collection have been performed in 2003, 2007, 2009 and 2014. The 2009 HDSS round included a component of child feeding and nutrition. The data that are analysed in this thesis was embedded into the child feeding and nutrition module that was collected from May to November 2009.

Sampling frame

For the purpose of this thesis, a sampling frame of households with children younger than 3 years was selected. If there were two children aged less than three years in the same household the youngest child was selected. In households with twins, the last-born child was selected. Further, when two families lived in the same household and had two children younger than 3 years of age who were born on the same date, the child who was listed first in the HDSS instrument was included in these studies.

Data collection

The collection of data was carried out by two groups of trained local interviewers. The first group visited all households (about 5,000) and asked the head of the household about socio-demographic characteristics and household food insecurity. This group of interviewers also identified all households where children younger than 3 years lived. Thereafter, a second group of local interviewers visited the 1,500 households where at least one child younger than 3 years lived and interviewed the mothers or primary caretakers on aspects of the youngest child aged less than 3 years. The nutritional status of all children younger than 3 years was also assessed. Only the anthropometric measurements of the youngest child less than 3 years of age were included in this thesis. Data on maternal social support and autonomy of the mother of the selected child were also collected.

Assessment of exposures and outcomes

Exposures

Housing quality: Housing quality was used as a proxy for the economic resources of the household. It was based on meeting the following household needs: type of drinking water source, household walls and floors, electricity supply and having a latrine or toilet. All housing quality options were judged to have the same importance and were therefore given the same value. The options were coded from 1 to 3, where a value of 1 meant the lowest housing quality level and 3 the highest. For electricity supply, there were only two options (yes/no). Therefore, 1 point was given to households who had no electricity, and 3 points were given to households with electricity. The housing quality options were summed up to give a continuous score (ranging from 5 to 15) that was divided into lowest (5-10), middle (11-12) and highest (13-15) tertiles of housing quality.

Household food insecurity: The Household Food Insecurity Access Scale was used to assess household food insecurity (79). This scientific tool consists of nine questions that evaluate uncertainty to obtain food, limited access to foods of high quality and reduction of food quantity in the past four weeks. The options were *never* (0 points), *rarely* (once or twice in the past four weeks; 1 point), *sometimes* (3 to 10 times in the past four weeks; 2 points) and *often* (more than 10 times in the past four weeks; 3 points). The Household Food Insecurity Access Scale definitions (food secure, mildly food insecure, moderately food insecure and severely food insecure) were used to evaluate the phenomenon in the study area. For the analytical analyses, the food insecurity options were summed up and a continuous score was created with a range from 0 to 27, where a higher value signified more household food insecurity. The score was further divided into tertiles of lowest (0-7), middle (8-11) and highest (12-27) food insecurity.

Maternal education: The education of the mother was assessed by asking for the highest level of schooling completed by the mothers at the time of the survey. The question had 28 coded options that were defined by APRODESE and were part of the HDSS data collection instrument. Maternal education was further categorised into three levels: less than 5 years, 5 to 9 years and 10 years or more. The lowest level of education reflects United Nations Millennium Development Goal 2, which targets universal primary education for all children.

Maternal autonomy: Maternal autonomy was assessed by a 17-item questionnaire. Twelve questions were elaborated for the study context, while five questions were adapted from the Demographic and Health Surveys Women's Questionnaire (80). The 17 questions measured maternal decision-making in relation to child nutrition and health, freedom of movement, reproductive health and household and financial independence. The options to the questions were: *cannot decide at all* (1 point), *can decide to a little extent* (2 points), *can decide to some extent* (3 points), *can decide to a large extent* (4 points) and *can decide on your own* (5 points). The options were summed up to give a continuous score (34-85), where a higher value signified more maternal autonomy. The score was then divided into tertiles of lowest (34-65), middle (66-74) and highest (75-85) maternal autonomy.

Maternal social support: The Duke-UNC Functional Social Support Questionnaire was used to measure maternal social support (81). This instrument assesses dimensions of social support such as: confident, instrumental and affective support. The options to the first question "How many friends and relatives do you have?" were the following: *none* (1 point), *one* (2 points), *two* (3 points), *three* (4 points) and *four or more friends and relatives* (5 points). Question 2 measured "How often do you meet your

close friends?” and the pre-coded options were: *less than once per month* (1 point), *once per month* (2 points), *once per week* (3 points), *several times per week* (4 points) and *every day* (5 points). For the rest of the questions, the options were: *much less than you would like* (1 point); *less than you would like* (2 points); *not much, not less* (3 points); *almost as you would like* (4 points) and *as much as you would like* (5 points) to questions such as “Do you get visits from friends and relatives?”. The options were summed up to give a continuous score (19-72), where a higher value signified more maternal social support. The continuous score was further divided into lowest (19-36), middle (37-41) and highest (42-72) tertiles of maternal social support.

Outcomes

Weight-for-age Z-scores (WAZ): A composite child undernutrition indicator, which considers both weight-for-length/height and length/height-for-age that represents smallness. A higher negative Z-score indicates more smallness.

Weight-for-length/height Z-scores (WHZ): A child undernutrition indicator that represents thinness. A higher negative Z-score indicates more thinness. The right side of the WHZ distribution may also represent chubbiness. Thus, a higher positive Z-score indicates more chubbiness.

Height-for-age Z-scores (HAZ): A child undernutrition indicator that represents shortness. A higher negative Z-score indicates more shortness.

Body mass index (BMI)-for-age Z-scores (BAZ): A child overnutrition indicator that represents relative adiposity. Therefore, a higher positive Z-score indicates more chubbiness.

Underweight: Children who were below -2 standard deviations (SDs) from median weight-for-age of reference population.

Wasted: Children who were below -2 SDs from median weight-for-length/height of reference population.

Stunted: Children who were below -2 SDs from median length/height-for-age of reference population.

Overweight: Children who were above +2 SDs from median BMI-for-age of reference population.

Early initiation of breastfeeding: Proportion of children born in the last 24 months who were put to the breast within the first hour after birth.

Exclusive breastfeeding: Proportion of infants aged 0 to 5 months who only received breast milk during the previous day.

Continued breastfeeding: Proportion of children aged 6 to 35 months who received breast milk during the previous day. The WHO continued breastfeeding indicator at one year considers children aged 12 to 15 months.

Minimum dietary diversity: Criteria based on consumption of at least one food item of four of the seven food groups during the previous day. The seven food groups included in the dietary diversity indicator are the following: (1) grains, roots, tubers; (2) legumes and nuts; (3) vitamin A-rich fruits and vegetables; (4) others fruits and vegetables; (5) flesh foods (i.e. meat, poultry); (6) eggs and (7) dairy products.

Minimum meal frequency: Based on breastfed children who received solid, semisolid or soft foods the minimum number of times (2 times if aged 6 to 8 months and 3 times if aged 9 to 35 months) or more and non-breastfed children who received solid, semisolid or soft foods or milk feeds the minimum number of times (4 times if aged 6 to 35 months) or more the previous day.

Minimum acceptable diet: Based on breastfed children aged 6 to 35 months who had at least the minimum dietary diversity and the minimum meal frequency and non-breastfed children aged 6 to 35 months who received at least two milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency the previous day.

Highly processed snacks (HP snacks): Based on children aged 6 to 35 months who consumed at least once any of the following items: cookies, crackers, chocolates, candies or salty crisps.

Sugar-sweetened beverages (SSBs): Criteria based on children aged 6 to 35 months who consumed at least once any carbonated soft drinks, powdered fruit drinks or coffee. In Paper I the SSB variable included coffee, but in Papers II, III and IV coffee was not included in the SSB outcome. The reasoning behind the non-inclusion of coffee in such papers is that coffee is a deeply rooted cultural drink and thus may have different determinants, when compared to the other SSBs.

Double burden of suboptimal feeding: Based on infants aged 0 to 5 months, who were not exclusively breastfed and who also consumed at least one HP snack or SSB. For children aged 6 to 35 months, it was based on children,

who had at least one unmet WHO complementary feeding practice and who concurrently consumed at least one HP snack or SSB.

Statistical analyses

The statistical analyses considered the cross-sectional design of the study. In Paper I, children who followed the WHO recommended feeding practices were analysed in the age groups: 0-5, 6-11, 12-23, and 24-35 months. The proportion of children who consumed not recommended feeding such as HP snacks and SSBs and were exposed to a double burden of suboptimal feeding was also analysed in the age groups 0-5, 6-11, 12-23 and 24-35 months. In Paper III, the proportion of children who were underweight, wasted, stunted and overweight was assessed in the age groups 0-5, 6-11, 12-23 and 24-35 months. Cross-tabulations were used for the abovementioned analyses. Additionally, one-way analysis of variance was utilised to examine mean Z-scores with SD of WAZ, WHZ, HAZ and BAZ in the same child age groups noted beforehand.

In Paper II, adherence to WHO classifications of feeding practices, children's consumption of HP snacks and SSBs and exposure to a double burden of suboptimal feeding were coded as binary outcomes (yes/no). Multivariate logistic regression was employed for these analyses. While an odds ratio below one was "protective" of the WHO recommended feeding outcomes, it also signified a lower likelihood of children's consumption of HP snacks and SSBs and of children's exposure to a double burden of suboptimal feeding.

Children's nutritional status was represented as a continuous outcome in Paper III and general linear models were developed. Tertiles of the three household and maternal resources, i.e. housing quality, household food insecurity and maternal education were generated. The highest tertile and highest category of housing quality and maternal education, respectively, were used as references, while the lowest tertile was the reference for household food insecurity. In terms of confounders, maternal age, child age and municipality (expressing geographical differences) were selected on the basis of their associations with the study exposures and outcomes and change of the effect estimate by 10% or more.

The conceptual framework of Paper II was developed to represent the independent associations between the three household and maternal resources and child feeding. Paper III evaluated the independent associations between each of the three household and maternal resources with the indicators of child under- and overnutrition. To meet these purposes, three

models were created; the first being unadjusted, the second only including confounders and the third including all three household and maternal resources and the confounders. Stratified analyses were also undertaken to study whether maternal education modified the associations between housing quality and household food insecurity on the one hand and the indicators of child under- and overnutrition on the other hand.

In Paper IV children's nutritional status was represented as a continuous outcome while WHO feeding practices, children's consumption of HP snacks and SSBs and children's exposure to a double burden of suboptimal feeding were coded as binary outcomes (yes/no). The odds ratios for child feeding followed the same interpretation mode as in Paper II. Multivariate logistic regression and the general linear model were employed for these analyses. Tertiles of maternal autonomy and social support were created, with the highest levels used as reference. Three models were created to analyse the independent associations between maternal autonomy and social support with child feeding and the under- and overnutrition indicators; the first being the unadjusted, the second including either maternal autonomy or social support and the confounders and the third model including both maternal exposures and the confounders. The confounders that were selected *a priori* were housing quality, household food insecurity, maternal education and age, child age and municipality.

Ethics

The thesis study followed the principles of the Universal Helsinki Declaration. Mothers or the primary caretakers were informed about the study objectives and procedures before the start of the interview. Verbal informed consent was obtained from the mothers or the primary caretakers prior to the interview. Mothers or the primary caretakers were informed about their right to withdraw from the interview at any point in time. The local interviewers were knowledgeable in the culture and were sensitised about the food insecurity experiences the families may have faced. They were trained to maintain confidentiality of the collected data and thus the families' privacy. The Biomedical Research Ethics Committee at the National Autonomous University of Nicaragua in León approved the study.

Results

General characteristics

Although improvements in housing quality had taken place in *Los Cuatro Santos*, a low percentage of the households had a piped water system (22%). There were few home gardens in use (8%). Food insecurity was common, with 36% and 51% of households reporting to be severely food insecure and moderately food insecure, respectively. Thirty-six percent of mothers had completed less than 5 years of education. Further, 43% of the mothers had between 5 to 9 years of schooling and 21% of them had completed 10 years or more of formal education. Most of the mothers were housewives (90%) and the majority of them were either married or lived with a partner (87%). Less than one percent worked in agricultural activities. Mean Z-scores with SD of HAZ [-0.80 (1.55)] were negative, while WHZ [0.22 (0.27)] and BAZ [0.31 (1.27)] were on average positive. Childhood stunting (20%) was high, but wasting (4%) was low. Nine percent of the children were overweight or obese in the study area.

Infant and young child feeding (Paper I)

Infants aged 0 to 5 months

Only 34% of the infants were exclusively breastfed, even though most of the mothers had initiated breastfeeding right after birth (91%) (Table 1). Consumption of any HP snack or SSB (10%) started already in infancy (Table 1). The most prevalent items were cookies and crackers (6%) and powdered fruit drinks (4%) (Table 2). Further, 8% of infants were exposed to a double burden of suboptimal feeding (Table 1).

Children aged 6 to 35 months

Breastfeeding was also common (80%) in children aged 6 to 11 months (Table 1). However, there were limitations in achieving WHO complementary feeding recommendations. In terms of minimum dietary diversity and minimum meal frequency, 50% and 70% of children aged 6 to 11 months met these feeding practices, respectively. Yet, only 41% of the

children in the same age group achieved both of them and thus had an acceptable diet.

Table 1. Infant and young child feeding in *Los Cuatro Santos*, Nicaragua, 2009

	Age group (m)			
	0-5 <i>n</i> =231	6-11 <i>n</i> =250	12-23 <i>n</i> =441	24-35 <i>n</i> =449
Infant and young child feeding¹				
WHO feeding recommendations				
Breastfeeding				
Early initiation of breastfeeding	91 (208)	89 (216)	94 (404)	92 (406)
Exclusive breastfeeding	34 (72)	--	--	--
Continued breastfeeding	--	88 (213)	60 (262)	15 (66)
Complementary feeding				
Minimum dietary diversity	--	50 (124)	69 (304)	74 (332)
Any animal-source food	--	64 (159)	78 (343)	81 (362)
Any vit. A-rich fruit or vegetable	--	17 (42)	23 (102)	25 (112)
Minimum meal frequency	--	70 (170)	69 (303)	47 (210)
Minimum acceptable diet	--	41 (101)	46 (201)	34 (152)
Not recommended feeding				
Any HP snack or SSB	10 (22)	62 (155)	81 (357)	92 (412)
Double burden of suboptimal feeding	8 (19)	27 (67)	34 (148)	48 (215)

¹Values are percentages % (n). Total *n* may be smaller in some analyses.

A substantial proportion of the children practised unfavourable feeding behaviours. Children aged 6 to 11 months consumed frequently any HP snack or SSB (62%) (Table 1). The most common HP snacks consumed were cookies and crackers (41%) (Table 2). The consumption of SSBs was also common among children aged 6 to 11 months; powdered fruit drinks were most prevalent (20%). Moreover, 27% of children in the same age group were exposed to a double burden of suboptimal feeding (Table 1).

Table 2. Percentage of children who consumed selected foods and beverages during the previous day in *Los Cuatro Santos*, Nicaragua, 2009

	Age group (m)			
	0-5 <i>n</i> =231	6-11 <i>n</i> =250	12-23 <i>n</i> =441	24-35 <i>n</i> =449
Infant and young child feeding¹				
Micronutrient-rich foods				
Eggs	10 (22)	73 (182)	90 (395)	91 (407)
Poultry	4 (9)	31 (78)	46 (203)	47 (210)
Local cheese (<i>cuajada</i>)	2 (4)	20 (50)	23 (100)	25 (112)
Mango	5 (11)	40 (100)	51 (226)	56 (250)
Highly processed snacks				
Cookies and crackers	2 (4)	14 (36)	22 (95)	23 (103)
Highly processed snacks	6 (13)	50 (125)	58 (257)	64 (287)
Cookies and crackers	6 (13)	41 (103)	44 (195)	45 (203)
Chocolates and candies	1 (3)	19 (48)	28 (124)	39 (173)
Salty crispy snacks	1 (3)	13 (32)	23 (101)	26 (118)
Sugar-sweetened beverages				
Sugar-sweetened beverages	6 (13)	50 (125)	58 (257)	64 (287)
Coffee	2 (4)	13 (33)	44 (193)	69 (308)
Powdered fruit drinks	4 (8)	20 (50)	32 (140)	33 (148)
Carbonated soft drinks	0 (1)	6 (14)	11 (47)	17 (75)

¹Values are percentages % (n). Total *n* may be smaller in some analyses.

Household and maternal resources for infant and young child feeding (Papers II & IV)

Infants aged 0 to 5 months

Maternal education and the autonomy of the mother were independently associated with EBF (Table 3). Infants of mothers with the lowest level of education were more likely to be exclusively breastfed ($OR_{adj.}$ for not meeting EBF: 0.19; 95% CI: 0.07, 0.51), as compared to infants of mothers with highest education. EBF was also more common among children of mothers with lowest and middle autonomy ($OR_{adj.}$ for not meeting EBF: 0.24; 95% CI: 0.08, 0.71 and $OR_{adj.}$ for not meeting EBF: 0.35; 95% CI: 0.13, 0.19).

Children aged 6 to 35 months

Children with the highest food insecurity were less likely to meet dietary diversity (Table 3). Housing quality was neither associated with the WHO feeding recommendations nor with children's consumption of HP snacks and SSBs or children's exposure to a double burden of suboptimal feeding (Tables 3 and 4).

Table 3. Selected associations between household and maternal resources and WHO feeding recommendations in *Los Cuatro Santos*, Nicaragua, 2009

Resources	WHO feeding outcomes ¹		
	Not met exclusive breastfeeding	Not met dietary diversity	Not met meal frequency
	0-5 m n=209	6-35 m n=1,135	6-35 m n=1,125
Household			
Housing quality ²			
Lowest	1.08 (0.40,2.90)	1.20 (0.82,1.74)	1.11 (0.78,1.58)
Middle	0.75 (0.30,1.90)	1.03 (0.72,1.49)	0.99 (0.70,1.38)
Highest	Ref.	Ref.	Ref.
Food insecurity ²			
Highest	0.58 (0.25,1.35)	1.47 (1.05,2.05)	0.88 (0.65,1.21)
Middle	0.71 (0.29,1.69)	1.21 (0.87,1.69)	0.75 (0.58,1.06)
Lowest	Ref.	Ref.	Ref.
Maternal			
Education ²			
<5 years	0.19 (0.07,0.51)	2.04 (1.36,3.08)	0.60 (0.41,0.85)
5-9 years	0.50 (0.20,1.26)	1.70 (1.15,2.50)	0.76 (0.54,1.06)
≥10 years	Ref.	Ref.	Ref.
Autonomy ³			
Lowest	0.24 (0.08,0.71)	1.06 (0.74,1.52)	0.88 (0.63,1.22)
Middle	0.35 (0.13,0.91)	0.69 (0.48,0.98)	0.68 (0.50,0.94)
Highest	Ref.	Ref.	Ref.
Social support ³			
Lowest	1.30 (0.48,3.49)	0.73 (0.51,1.03)	0.92 (0.66,1.27)
Middle	0.52 (0.21,1.30)	0.92 (0.66,1.27)	1.04 (0.77,1.40)
Highest	Ref.	Ref.	Ref.

¹Values are adjusted odds ratio and confidence intervals; ²Adjusted for housing quality, maternal education, household food insecurity, child age, maternal age, municipality; ³Adjusted as in previous models, but including maternal autonomy or social support; Significance level at <0.05 and in bold.

Children of mothers with the lowest level of education were less likely to meet the dietary diversity criteria (Table 3). However, they more frequently had a satisfactory meal frequency. Children with mothers of the lowest education level were less likely to consume HP snacks and SSBs (Table 4).

No associations were observed between maternal social support and the WHO feeding indicators (Table 3). However, children of mothers with the lowest level of social support were more likely to consume HP snacks, but were less likely to drink SSBs (Table 4).

Table 4. Associations between household and maternal resources and not recommended feeding in *Los Cuatro Santos*, Nicaragua, 2009

Resources	Feeding outcomes ¹		
	Highly processed snacks 6-35 m n=1,135	Sugar-sweetened beverages 6-35 m n=1,135	Double burden of suboptimal feeding 6-35 m n=1,135
Household			
Housing quality ²			
Lowest	0.88 (0.62,1.25)	0.76 (0.53,1.09)	1.15 (0.81,1.63)
Middle	1.04 (0.74,1.46)	0.78 (0.56,1.10)	1.08 (0.77,1.51)
Highest	Ref.	Ref.	Ref.
Food insecurity ²			
Highest	0.78 (0.57,1.08)	0.76 (0.55,1.05)	0.98 (0.72,1.33)
Middle	0.78 (0.57,1.07)	0.92 (0.68,1.25)	0.93 (0.69,1.26)
Lowest	Ref.	Ref.	Ref.
Maternal			
Education ²			
<5 years	0.47 (0.32,0.68)	0.68 (0.46,0.98)	0.64 (0.44,0.92)
5-9 years	0.55 (0.39,0.79)	0.71 (0.50,1.00)	0.73 (0.52,1.03)
≥10 years	Ref.	Ref.	Ref.
Autonomy ³			
Lowest	1.00 (0.71,1.41)	1.12 (0.79,1.59)	0.91 (0.65,1.27)
Middle	1.76 (1.27,2.46)	1.00 (0.71,1.39)	0.81 (0.60,1.11)
Highest	Ref.	Ref.	Ref.
Social support ³			
Lowest	1.92 (1.37,2.68)	0.65 (0.46,0.91)	1.26 (0.92,1.74)
Middle	1.07 (0.79,1.44)	0.85 (0.62,1.16)	1.06 (0.79,1.44)
Highest	Ref.	Ref.	Ref.

¹Values are adjusted odds ratio and confidence intervals; ²Adjusted for housing quality, maternal education, household food insecurity, child age, maternal age, municipality; ³Adjusted as in previous models, but including maternal autonomy or social support; Significance level at <0.05 and in bold.

Infant and young child nutrition (Paper III)

Infants aged 0 to 5 months

All three infant undernutrition indicators had on average positive Z-scores, except for BMI-for-age (Table 5). When considering the anthropometric categorical outcomes, the proportion of infants who were stunted, wasted and overweight was relatively high in *Los Cuatro Santos*.

Children aged 6 to 35 months

HAZ were on average negative, with mean Z-scores reaching almost minus 1 SD of 12 to 23 months old children (Table 5). On the other hand, mean WHZ and BAZ were positive in children of the same age group. Stunting in children aged 12-23 months was prevalent, while few wasted children were observed in the study area. A high proportion of overweight children was noted across the age groups.

Table 5. Mean Z-score with SD and prevalence of child under- and overnutrition in *Los Cuatro Santos*, Nicaragua, 2009

Child nutrition	Age group (m)			
	0-5 n=231	6-11 n=250	12-23 n=441	24-35 n=449
Mean (SD)				
WAZ	0.11 (1.29)	0.09 (1.24)	-0.43 (1.15)	-0.52 (1.00)
WHZ	0.04 (1.68)	0.36 (1.38)	0.05 (1.22)	0.39 (0.94)
HAZ	0.02 (1.56)	-0.15 (1.85)	-0.90 (1.34)	-1.45 (1.19)
BAZ	-0.03 (1.52)	0.26 (1.42)	0.22 (1.27)	0.59 (0.97)
Prevalence % (n)				
Underweight	5 (11)	4 (9)	7 (30)	6 (25)
Wasted	11 (24)	4 (9)	4 (19)	1 (4)
Stunted	10 (21)	14 (34)	17 (74)	32 (142)
Overweight	11 (23)	11 (27)	8 (35)	7 (30)

Total *n* may be smaller in some analyses.

Household and maternal resources for infant and young child nutrition (Papers III & IV)

Infants aged 0 to 5 months

Household food insecurity and maternal education were associated with indicators of infant undernutrition. Infants living in households with highest and middle food insecurity had lower height-for-age ($\beta_{\text{adj.}}$: -0.70; 95% CI: -1.22, -0.17 and $\beta_{\text{adj.}}$: -0.83; 95% CI: -1.35, -0.30), when compared to infants living in households with the lowest food insecurity. Infants of mothers with the lowest education had the lowest weight-for-age ($\beta_{\text{adj.}}$: -0.61; 95% CI: -1.08, -0.14), when compared to their counterparts.

Children aged 6 to 35 months

Children from households with the highest reported food insecurity were more likely to be wasted ($\text{OR}_{\text{adj.}}$ for wasting: 2.84; 95% CI: 1.06, 7.60). Children in households with the lowest housing quality had the lowest weight-for-height, when compared to their counterparts (Table 6). The

household resources were not associated with the BMI-for-age overnutrition indicator (data not shown).

Children of mothers with the lowest level of education had the lowest height-for-age (Table 6). Children of mothers with lowest social support had the highest height-for-age. The maternal resources were not associated with the overnutrition indicator BMI-for-age (data not shown).

Table 6. Selected associations between household and maternal resources and child nutrition in *Los Cuatro Santos*, Nicaragua, 2009

Resources	Anthropometric outcomes ¹		
	WAZ 6-35 m n=1,134	WHZ 6-35 m n=1,115	HAZ 6-35 m n=1,126
Household			
Housing quality ²			
Lowest	-0.12 (-0.30,0.06)	-0.22 (-0.42,0.03)	-0.19 (-0.42,0.05)
Middle	0.02 (-0.15,0.20)	-0.14 (-0.32,0.05)	-0.01 (-0.24,0.21)
Highest	Ref.	Ref.	Ref.
Food insecurity ²			
Highest	-0.20 (-0.37,-0.04)	-0.15 (-0.32,0.02)	-0.10 (-0.31,0.11)
Middle	-0.06 (-0.21,0.10)	0.05 (-0.12,0.22)	-0.11 (-0.31,0.10)
Lowest	Ref.	Ref.	Ref.
Maternal			
Education ²			
<5 years	-0.46 (-0.65,-0.27)	0.18 (-0.38,0.03)	-0.34 (-0.59,-0.09)
5-9 years	-0.28 (-0.46,-0.10)	-0.07 (-0.26,0.13)	-0.27 (-0.51,-0.04)
≥10 years	Ref.	Ref.	Ref.
Autonomy ³			
Lowest	-0.11 (-0.29,0.07)	-0.07 (0.26,0.12)	-0.07 (-0.30,0.16)
Middle	-0.15 (-0.32,0.01)	-0.04 (0.21,0.57)	-0.17 (-0.38,0.04)
Highest	Ref.	Ref.	Ref.
Social support ³			
Lowest	0.05 (-0.12,0.22)	-0.08 (-0.26,0.10)	0.26 (0.05,0.48)
Middle	-0.05 (-0.20,0.11)	-0.02 (-0.19,0.14)	0.02 (-0.18,0.22)
Highest	Ref.	Ref.	Ref.

¹Values are adjusted β -value and confidence intervals; ¹Adjusted for housing quality, maternal education, household food insecurity, child age, maternal age, municipality; ²Adjusted as in previous models, but including maternal autonomy or social support; Significance level at <0.05 and in bold.

Maternal education levels combined with housing quality were associated with the presence of child undernutrition in a relatively complex pattern (Table 7). In households with the lowest housing quality, children of lower educated mothers had lower height-for-age when compared to children of mothers with the highest education. Also in households with the highest housing quality, children of the lowest educated mothers had the lowest height-for-age, when compared to their counterparts. Maternal education also modified the association between housing quality and child

overnutrition. In households with middle housing quality, lowest maternal education was associated with the lowest BMI-for-age (Table 7).

Table 7. Maternal education on selected associations between housing quality and child nutrition (6-35 m) in *Los Cuatro Santos*, Nicaragua, 2009

<i>n</i> =1,126			
	Housing quality and HAZ ¹		
	Lowest	Middle	Highest
Maternal education²			
<5 years	-1.24	-0.85	-1.20
5-9 years	-1.26	-0.92	-0.73
≥10 years	-0.54	-0.72	-0.64
<i>n</i> =1,113			
	Housing quality and BAZ ¹		
	Lowest	Middle	Highest
Maternal education²			
<5 years	0.32	0.13	0.17
5-9 years	0.44	0.50	0.44
≥10 years	0.31	0.57	0.47

¹Values are adjusted mean Z-scores; ²Adjusted for household food insecurity, child age, maternal age, municipality; The analyses compare only within strata; i.e. lowest education category (<5 years of schooling) to the highest educational level of 10 years or more, as well as the middle educational level of 5 to 9 years of education to the highest educational category of 10 years or more. Bold mean Z-score indicates significantly different Z-score from highest educational level based on estimated adjusted β -values and confidence intervals of general linear models, $p<0.05$.

Discussion

In this thesis, results are presented on social determinants of infant and young child feeding and nutritional status based on a representative sample of mother-and-child pairs from a health and demographic surveillance area in north-western Nicaragua; an area undergoing rapid social and economic changes. There were limitations in following WHO recommended feeding guidelines across the child age groups. This was combined with consumption of unhealthy high-energy-dense items, suggesting a double burden of suboptimal feeding. Lower levels of maternal resources were associated with optimal breastfeeding practices in infancy. The opposite was true for the older children, where higher levels of the household and maternal resources were linked to a greater likelihood of appropriate complementary feeding practices.

Children on average had a tendency towards shortness and chubbiness. A high prevalence of child stunting and overweight was also observed in *Los Cuatro Santos*. Better off levels of household and maternal resources were associated with less child undernutrition. The level of maternal education modified some of the other resources and child undernutrition associations; in households with the poorest housing quality, children of higher educated mothers were taller, when compared to children of mothers with the lowest educational level.

Methodological considerations

Internal validity

The thesis study was embedded into the data collection in 2009 of the HDSS in *Los Cuatro Santos*, north-western Nicaragua. The quality control mechanisms of the fieldwork had been carefully installed in previous rounds of the surveillance and were adhered to in the thesis study. Local interviewers were selected with at least a high school diploma. They were trained according to global nutrition guidelines created by WHO and other organisations (i.e. International Fund for Agricultural Development) (32, 82). Most of the local interviewers had participated in the data collection of the author's master thesis in 2007. Thus, they were already acquainted with similar data collection instruments. The data collection instruments followed

the principles of the WHO nutrition global guidelines (31), in addition to other validated scientific tools that have been used previously in multiple settings (79, 81).

The instruments were pilot tested in a nearby community similar to the study setting. A manual was developed that described the data collection process, which was helpful when questions arose in the fieldwork. During the first weeks of data collection, about 10% of the collected questionnaires were randomly selected and underwent a second household visit by the author to identify any discrepancies between the interviewers' and the author's interviews. One local interviewer was assigned to be responsible for quality control and worked closely with the HDSS field supervisor to check for missing values and/or inconsistencies in the collected questionnaires.

Exposure assessments

Household food insecurity and housing quality were exposure assessments used in Papers II and III. Household food insecurity was measured with a validated questionnaire that has been used previously in multiple settings (79). This may have reduced potential biases that may occur with carrying out the interviews in the field. The validated questionnaire showed good internal consistency (Cronbach's $\alpha=0.86$) in the study setting.

The physical quality of housing was used as an indicator for the economic resources of the household. However, housing quality may not indicate present household assets. Instead, it may be a better measurement of past investments in the household. To complement indicators of household resources, studies have suggested an asset index of ownership of durable goods (e.g. bicycle, refrigerator, television) as a way to improve the proxy for a household's purchasing capacity in LMICs (83, 84).

Maternal autonomy and social support were part of the analyses in Paper IV. The maternal autonomy instrument showed good internal consistency (Cronbach's $\alpha=0.91$) in the study setting. Most of the autonomy questions were aimed to capture mothers' decision-making ability in relation to child feeding and nutrition. However, a potential limitation is whether the decision-making dimensions actually captured "true" maternal autonomy. A recent review noted that mothers who decide on household and child care aspects may do it as part of their responsibility and not necessarily because they have more autonomy, thus potentially reducing the measurement's validity (85). However, the inclusion of a maternal social support measurement to the maternal autonomy and child nutrition models is a strength, and makes it possible to differentiate the two concepts from each other. Other strengths of the inferential analyses are the opportunity to

investigate the associations between maternal autonomy and child nutritional status across different age groups and the use of several anthropometric indicators (85). This may allow for a better interpretation of the impact of maternal autonomy on indicators of child under- and overnutrition (85).

The 15-item validated Duke-UNC Functional Social Support Questionnaire was adapted for use in the rural study setting (81). This modification may have allowed for a better interpretation of the mothers on the social support received from family and community members. The instrument showed acceptable internal consistency (Cronbach's $\alpha=0.70$), although it was initially tested in a population with high socio-economic conditions in a high-income country. Two studies that tested the Duke-UNC Functional Social Support Questionnaire in Latin American settings showed good reliability and validity (86, 87). One of the former studies validated the instrument in poor, rural communities of Colombia and found an association between social support of the mothers and children's growth, contrary to the findings in this thesis (86).

Outcome assessments

Height and weight are usually considered to be precisely measured in anthropometry (88) but like other anthropometric measurements they are subject to measurement error. Two conceptual terms often discussed are validity and reliability regarding measurement error. Validity is how close one comes to measure what it is intended to measure, or in other words, how accurate or "true" is the measured value (89). Reliability is whether repeated measures give the same value and thus refers to reproducibility (89). In order to correct for invalid and unreliable measurements, the local interviewers underwent training and standardisation sessions. However, the two standardisation sessions occurred before the study started and not throughout the data collection process. It may be possible that some of the interviewers might have not maintained the same level of expertise throughout the data collection process. However, for measuring length/height at least three independent measurements were carried out by two interviewers until there was agreement (or a maximum allowed difference of 7 mm) between the two interviewers' measurements (90). This may have reduced the inter-observer measurement error. Furthermore, we cannot rule out that measuring length especially of the youngest infants is always difficult (e.g. crying and being uncooperative) and may be more subject to measurement error. Therefore, some of the infants' length measurements could have been underestimated, since it may be more difficult to stretch to a full position an infant's body for the measurement (90). Consequently, this limitation may have overestimated the infant nutrition prevalence, particularly of stunting, wasting and overweight. It is noteworthy however that the *Los Cuatro Santos* overall

child stunting prevalence of 20% fell within the Department of Chinandega's child stunting prevalence reported in the Demographic and Health Surveys of 2006-7 (22%) (91) and 2011-12 (17%) (74).

The WHO feeding indicators and children's consumption of HP snacks and SSBs were captured by a food frequency questionnaire (FFQ) that recalled foods and beverages, which were consumed during the previous day (including night time). The WHO recommended feeding guidelines suggest the use of a 24 hour recall or a FFQ to collect dietary information that is used to construct the feeding indicators (32). Although a FFQ is considered to be the preferred choice to document dietary consumption in large epidemiological surveys, it may be subject to biases. In *Los Cuatro Santos*, due to social desirability bias some mothers may have underestimated or overestimated their children's intake of some foods and beverages, but only to a degree of randomness. Further, given the long list of foods and beverages (70 items) in the FFQ, this may have created a response fatigue on the mothers that could have influenced the validity of the results. Even though the FFQ used gave the possibility for mothers to minimise recall bias, the short-term recall period may increase random within-person error and may have overestimated the proportion of children who did not meet dietary diversity (92). The WHO feeding indicators also lack specificity and therefore may limit the possibility to detect diet and health relationships (i.e. association between dietary diversity and child growth) (93).

Confounding

The thesis included analyses of household and maternal resources that are well-known determinants of child undernutrition but that may also be associated with child overnutrition. The inclusion of these factors, together with other confounding factors, in the analytical models permitted the opportunity to manage confounding in an acceptable way.

Other important confounders such as child age, maternal age and geographical locality were also included in the analyses. The possibility of residual confounding still exists, however. For instance, maternal height is usually a good proxy of a mother's own growth and development and may subsequently impact child growth (94, 95).

External validity and generalizability of findings

Nicaragua is small in geographical size, but has important socio-economic and agro-ecological variability. Most of the inhabitants live in the western part of the country, where the major cities are situated. The eastern part is mostly inhabited by a small concentration of indigenous people. It is mainly

covered by rain forest with a rudimentary transportation system and in general is less accessible. Thus, the results of *Los Cuatro Santos* may only be generalizable to populations in the western part of the country. However, it is likely that some of the thesis findings may be of relevance to other low-income populations particularly in the Central American region (most of whom live in similar agro-ecological conditions), as well as to poor populations in other parts of Latin America. This may be especially true for populations in countries undergoing a similar stage of nutrition transition and economic and social development.

Infant and young child feeding

The prevalence of EBF in *Los Cuatro Santos* was relatively low, which is in line with other reports from some low- and middle-income countries, e.g. Nigeria and Mexico (35, 96). Non-exclusively breastfed infants may miss the protective effects that breastfeeding could offer not only against infectious diseases, but also against child overweight (97). Non-exclusive breastfed infants are more at risk of infectious diseases (98) that may hamper optimal growth (99). One well-known barrier to EBF is that mothers perceive that they have insufficient breast milk quality or quantity to meet their baby's needs (100). Subsequently, they may introduce other foods and liquids apart from breast milk to their infants already before six months of age. A recent study in rural Zimbabwe reported that the inappropriate introduction of non-breast milk foods and liquids to very young infants (aged 0 to 2 months) was due to mothers valuing them as traditional oral remedies and thus believing that these foods might cure diseases (101). Apart from such barriers that originate from cultural beliefs, poor knowledge and attitudes mothers who are employed and return to work early are less likely to exclusively breastfeed for the first six months of a baby's life (102).

There were fewer limitations in meeting children's dietary diversity in the study setting, similar to what has been found in other Latin American countries (33). In the study area the consumption was low of vitamin-A rich fruits and vegetables and flesh food groups. These food groups contribute to important micronutrient intake (i.e. vitamin A and zinc) that has been recognised as critical for optimal child linear growth and survival (103, 104). While micronutrient-rich foods are to be encouraged in the young children's diet (105), several barriers may hinder mothers from providing diverse diets to their children. In *Los Cuatro Santos*, a potential driver that could be fuelling constraints in the diversity of the diet is the low number of home gardens in use that were observed in the rural study setting. The higher economic costs and perishability of fruits and vegetables and flesh food products, in addition to seasonality effects, long distances to markets and

water shortage, may also be driving the children's low consumption of micronutrient-rich foods.

A considerable proportion of children in *Los Cuatro Santos* consumed HP snacks. This finding is similar to a recent report from Africa and Asia that found a higher proportion of young children who consumed sugary snack foods, than the proportion of children who consumed micronutrient-rich foods such as eggs, fruits or infant fortified cereals (41). Apart from displacing micronutrient-rich foods, children's consumption of HP snacks may contribute to excess intake of high-energy-dense foods, ultimately leading to child overweight (106). A potential mechanism in the association between consumption of HP snacks and overweight children is that these foods have been found to have lower satiety values, unlike micronutrient-rich foods (107). Given the innate preference of humans for sweet or salty tastes (108) and the familiarization of HP snack foods at a very young age, children may foster habits that could lead to a frequent intake of these highly palatable foods later in childhood and as adults (109).

The high prevalence of SSB consumption by the young children in *Los Cuatro Santos* mirrors the high consumption of SSBs observed globally (110). Beverage intake including sugar-sweetened ones contributed to 28% of the total energy intake among preschool Mexican children, with an increasing trend in beverage consumption observed from 1999 to 2006 (111). Likewise in Brazil, among 3-year-olds 8% of the total energy intake came from SSBs (112). Consumption of SSBs may result also in child and adult overweight (113) and NCDs later in life (114). A potential driver in the association between consumption of SSBs and overweight is that when consuming liquids there is no compensation of lower caloric intake later during the day (115). This may ultimately add more calories to daily caloric intake and therefore may lead to a higher likelihood of overweight. Additionally, there are usually low satiety levels when consuming beverages and it may also increase the chance for more food and beverage consumption and subsequently overnutrition (116). Fructose found in carbonated soft drinks produces uric acid (117) and may increase the risk of visceral adiposity, which is a known predictor for NCDs (118).

In the study area, a considerable proportion of children were exposed to a double burden of suboptimal feeding. There are no other current studies evaluating this double burden of suboptimal feeding in young children. This novel-feeding concept is a contribution of the thesis to the existing infant and young child feeding literature. A double burden of suboptimal feeding may likely put the young child at risk of both stunting and overweight and subsequently increase the likelihood of a double burden of malnutrition not only in the same populations, but also in the same individuals.

Household and maternal resources for infant and young child feeding

Both infants of lowest educated mothers and of mothers with lower maternal autonomy were more prone to be exclusively breastfed in *Los Cuatro Santos*. These findings are in line with results from other low- and middle-income settings (119-121). Mothers with lower levels of education may practise more EBF because they more frequently stay at home. Lower educated mothers were also more likely to be unemployed. Subsequently, these mothers may have more time to be at home and exclusively breastfeed their infants. Mothers with lower autonomy in the study area may also practise more EBF not because they thought it was optimal, but possibly because they were not so mobile and thus spent more time at home. Lower maternal autonomy may also imply low decision-making power to buy formula and other commercial baby food products that may be given to infants along with the provision of breast milk.

The interrelatedness between maternal autonomy and the educational level of the mother could have further increased the odds for more frequent EBF among mothers in such groups. It also may be that the reason for no independent associations between the household resources and EBF is that the provision of breast milk is less dependent on household economic and food resources in settings similar to *Los Cuatro Santos* (122).

Improved household food security was associated with meeting children's dietary diversity. Such associations have been reported from other low-income settings, such as Bangladesh (50) and Burkina Faso (51). Since the household food insecurity scales reflect access to high-quality foods and diverse diets, it is intrinsic to consider its association with the quality aspect of the children's diet.

The thesis findings also showed that higher maternal education was associated with both favourable and unfavourable child feeding practices. The association between higher level of maternal education and meeting children's dietary diversity has been documented in multiple settings (45, 123). A potential mechanism in such an association is that knowledge and skills gained throughout the schooling years may transfer into more general health knowledge (124). Consequently, higher maternal health knowledge may lead to an understanding of the importance of diverse diets for their children. Another possible explanation is that mothers with higher education may be more prone to use the information that is acquired on a daily basis, which subsequently may lead to improved diversity in children's diets (125).

There are few reports on the association between maternal education and unfavourable child feeding in LMICs, but recently calls have been made to analyse social determinants of young children's sugary and savoury snack consumption in such parts of the world (41). It has been reported that higher maternal education may not equate into overall appropriate nutritional knowledge especially in LMICs (126). The lack of knowledge on the inappropriateness of consumption of HP snacks and SSBs for young children could be a reason why children of higher educated mothers consumed more of them. Likewise, lack of knowledge of appropriate child feeding practices of the higher educated mothers may be also an explanation for their children's more frequent exposure to a double burden of suboptimal feeding.

Children of mothers with middle autonomy were more likely to have more appropriate complementary feeding practices in *Los Cuatro Santos*. A study in India reported that autonomy of the mother implied more freedom to move (64) and more household decision-making ability (65). One may speculate that mothers with middle autonomy also made decisions jointly with their partners about important components of their children's diet. Mothers who decided jointly have been shown to discuss more health matters, prepare better for birth and use antenatal care more often in other low-income settings (127, 128). A potential mechanism is that when two people are involved in the decision-making process there are more options that are discussed and thus a higher likelihood for better outcomes (129).

When considering the interrelatedness between the household and maternal resources with whether or not children met dietary diversity in the study setting, housing quality expressed itself through maternal education and household food security. Notably, more of the expression of housing quality on the diversity of children's diet was mediated through maternal education, than through household food security. It can be argue that a favourable interrelatedness between housing quality, maternal education and household food security translated into a higher likelihood of children meeting dietary diversity in the study area.

For the associations between the household and maternal resources and children's consumption of HP snacks, the expression of household food security and housing quality on children's consumption of HP snacks was mediated through maternal education. This may also imply a degree of interrelatedness between the household and maternal resources when associated with children's consumption of HP snacks.

Infant and young child nutrition

The nutritional status of children in *Los Cuatro Santos* differed according to age and anthropometric outcome. Z-scores of length-for-age were on average negative, while WHZ were generally positive in the infants. These findings are similar to a Latin American growth faltering pattern of average length-for-age starting close to the standard population and thereafter rapidly declining with age, while average weight-for-length situating above the standard population throughout the first years of life (130). In the study area, stunted infants may be a result of intergenerational growth mishaps (131, 132), while the observed higher prevalence of wasted and overweight infants may be due to measurement error.

Childhood stunting was prevalent in *Los Cuatro Santos* and of public health concern in line with reports from most LMICs (133). Stunting may not only contribute to restrictive growth and cognitive development in childhood, but also to limitations in adult and community social capital (134). It has also been found that stunted children are more prone to be overweight (7).

A high prevalence of overweight children was observed in the study area. Overweight has been linked to child morbidity (135) and mortality especially in adulthood (136). Altogether, child stunting and overweight increases the risk of overnutrition and of a double burden of malnutrition in the study population and in the same child.

Household and maternal resources for infant and young child nutrition

The finding of an association between household food insecurity and shorter infants could be related to lack of food for child growth, but also potentially be related to an intergenerational component of household food security mediated through maternal nutrition. Consistent with this explanation, mothers in rural Kenya with higher household food insecurity were more likely to have a lower BMI (137). A lower maternal BMI was also associated with shorter infants and higher probability of child stunting in such low-income setting (137). Further, infants of mothers with the lowest education were smaller in the study setting. The association between higher levels of maternal education and higher infant weight-for-age has been also found in other low-income settings (138). Higher educated mothers may more often seek health care to cure gastrointestinal and respiratory infections or to get immunization or other preventive services to their infants (139, 140). Thus, their infants may have a lower incidence of infectious diseases and consequently have a higher weight-for-age (141).

Housing quality was not associated with any of the infant anthropometric indicators. However, levels of housing quality were interrelated with the educational levels of the mothers. This may indicate that better housing quality combined with higher levels of maternal education may be linked to more optimal infant weight. Higher maternal education may not only indicate better caretaking capacities of these mothers as discussed above, but also higher position in the household (142).

Worst household food security was associated with wasted children in *Los Cuatro Santos*. The association between higher household food insecurity and wasted children is in congruence with findings from Bangladesh, Ethiopia and Vietnam (55). Wasting is a reflection of acute child undernutrition, which may develop due to short periods of food constraints and infectious diseases. Therefore, it is likely that limitation in access to food and a low consumption of high-quality foods in food insecure households results in more wasted children. Lower household food insecurity was associated with less stunting among children aged 24 to 59 months across eight LMICs (143). However, no association was observed between household food insecurity and height-for-age among the older children in *Los Cuatro Santos* and in a study in neighbouring Honduras (54). The lack of association between household food insecurity and children's height-for-age in the study setting may be due to incongruence in the recall periods for food insecurity and this anthropometric outcome. In the thesis study, the food insecurity measurement included a short-term recall period of one month to measure the food insecurity experiences of the family members in the household. On the other hand, child height-for-age is an indicator of chronic undernutrition that may develop because of environmental and socio-economic deficits that occur throughout a longer period of time.

Children of higher educated mothers were taller in the study setting. The association between higher maternal education and taller children has been documented in multiple settings such as Kenya and Bangladesh (47, 139, 144). Consistent with the association between higher maternal education and favourable child feeding practices, higher maternal education may be indicating gained general health knowledge, that in turn, may result in more health-seeking behaviour and thus lower infections and taller children (124).

The highest level of maternal social support was associated with the shortest children in *Los Cuatro Santos*. Elsewhere, findings have shown that higher maternal social support has been associated with taller children (69). In the study setting, the observed association between maternal social support and child growth may be due to a spurious finding or reverse causality. Thus, mothers of children with poor growth may seek more social support to enable better growth of their children.

No associations were reported between the household and maternal resources and the child overnutrition indicator BMI-for-age in *Los Cuatro Santos*. Similarly, no association was observed between household food insecurity and BMI-for-age among a sample of young children in Brazil (145). In the study area, this may indicate an increasing overweight problem in young children across the socio-economic groups. Also, other unmeasured household, maternal and child determinants may matter more for overweight children, given that it is a multifactorial nutritional problem (146). Further, the effects of the nutrition transition that could be mediated through more household economic resources and access to food might not yet be reflected in the young children (145). However, children in households with the lowest housing quality had the lowest weight-for-height in the study area. Average positive Z-scores of weight-for-height may also represent chubbiness in children and a higher risk of child overweight. A mechanism in such an association may be higher household incomes, which may translate to more purchasing power to access high-energy-dense foods that subsequently may lead to chubbier children. It was also observed that children in general had positive WHZ indicating that these young children may be more prone to overweight, than wasting in the years to come.

In the study setting higher maternal education predicted taller children, in spite of living in households with the lowest housing quality. A study in rural Mexico also found that in times of food or economic scarcity, higher educational levels of the mothers increased the likelihood of having tall children (147). Mothers who are more educated may more efficiently use the scarce resources that ultimately lead to taller children. They also may be more innovative and creative in solving problems due to food or economic constraints that consequently may favour child growth. Another finding of this thesis is that children of lowest educated mothers were shortest in households with the highest housing quality. It is difficult to explain this finding, but it may potentially suggest that social inequity in the households has a negative influence on children's nutritional status. A previous Nicaraguan study found that poor children living in non-poor environments had the highest risk for infant mortality (148). In the study area, lowest educated mothers in households with the highest housing quality may have a low social status, impeding them from using available household resources for their children's growth.

More independent associations were observed between the household and maternal resources and the nutritional status of the older children. This may reflect the relative importance of household and maternal resources on child nutrition, which is less dependent on breast milk. It may also point out at how favourable interrelated expressions between such resources may also result in optimal child linear growth. The expression of housing quality on

child height-for-age was mediated through maternal education. On the other hand, the expressions of maternal education and of household food security on child weight-for-height were mediated through housing quality.

It is likely that dietary diversity was a mediator of the association between maternal education and taller children in *Los Cuatro Santos*. This has been shown in a recent cohort study where dietary diversity at six months of age mediated some of the effects of maternal education on child growth (149). The associations between the household and maternal resources and infant nutritional status were not mediated through feeding practices. Instead, it is possible that the associations between household and maternal resources and infant nutritional status, if causal, were mediated over the occurrence of infectious diseases.

Some of the household and maternal resources and child feeding and nutrition pathways did not follow a congruent line in the study setting. As such, dietary diversity was not a mediator of the association between housing quality and child growth. Similarly in Zambia, dietary diversity did not mediate the association between household wealth and children's nutritional status (149).

There were also some inconsistencies in the observed associations between the household and maternal resources and child feeding and nutrition in *Los Cuatro Santos*. For instance, children of mothers in the middle autonomy tertile were more prone to meet the complementary feeding practices, but they did not have better growth. Similarly, children of mothers with the lowest level of social support were the tallest, but they were not so frequently adhering to the WHO feeding practices. These discrepancies may be due to spurious associations or reflect other unobserved determinants that may come into play and affect the growth of children.

Public health implications

The cross-sectional design of the study does not allow drawing causal inferences of the studied associations. Still, some of the findings are relevant for public health planning and suggest relationships that could be of public health significance. The size of the differences in height (0.34 standard deviation) between children of mothers with 10 years or more of education and children of mothers with less than 5 years of schooling may be considered public health significant. The difference was even bigger when education levels and housing quality levels were combined. This suggests medium to large differences of child growth between maternal schooling levels in *Los Cuatro Santos* (150). The observed differences in attained

linear growth falls within what could be a moderate effect size (0.10 to 0.50) of efficacy trials of complementary feeding and child growth (151). Overall, the thesis findings shed light on favourable and unfavourable patterns between levels of household and maternal resources and child feeding and nutrition in low-income societies undergoing a nutrition transition.

Conclusions

The thesis findings suggest the existence of a double burden of malnutrition in the studied infants and young children in a low-income, but rapidly changing rural area in Nicaragua. Too few were fed according to WHO recommendations but frequently received HP snacks and SSBs. This could be viewed as a double burden of suboptimal feeding - in society as well as in the same child.

A higher educational level of the mother was the resource that showed more independent variation in child feeding and nutrition. In some instances, higher maternal education was favourably associated with WHO complementary feeding practices and child growth, while in other cases it was unfavourably associated with WHO breastfeeding recommendations and children's consumption of HP snacks and SSBs. Higher maternal education also protected against shorter children in households with the lowest housing quality.

Higher maternal education was associated with taller children, even in households with the poorest housing quality. However, higher maternal education may not be able to guarantee optimal child feeding practices and thus less exposure to later overnutrition in a rural Nicaraguan low-income society undergoing a nutrition transition and rapid social and economic change.

Summary in Spanish/Resumen en Español

La desnutrición infantil sigue siendo un importante contribuyente a la mortalidad de los niños (as) menores de 5 años de edad en los países de ingreso bajo y mediano (PIBM) (3). Recursos del hogar y maternos como la falta de acceso a los alimentos, el poder económico bajo y la educación y autonomía materna deficiente son causas subyacentes que pueden conducir a reducir la ingesta de la dieta y/o enfermedades infecciosas y, posteriormente, la desnutrición infantil (71). La Organización Mundial de la Salud (OMS) ha publicado guías recomendadas para ayudar a promover prácticas adecuadas de alimentación en niños (as) menores de 2 años de edad (31). Prácticas óptimas de alimentación infantil no sólo pueden reducir la desnutrición infantil (93), sino que pueden prevenir el sobrepeso en niños (as) (97). Junto a la carga común de la desnutrición infantil, un aumento constante en el sobrepeso infantil se ha observado a nivel mundial (4), resultando en la doble carga de la malnutrición. La doble carga de la malnutrición puede coexistir en mismas poblaciones (5) e incluso en mismos individuos (7). Un aumento en el sobrepeso se ha relacionado con la morbilidad infantil (135) y con enfermedades crónicas en el adulto más tarde en la vida (136). Un aumento en el sobrepeso puede explicarse en parte por los cambios en la dieta a artículos densos de alta energía, como aperitivos altamente procesados (HP aperitivos) y las bebidas endulzadas con azúcar (SSBs), que es signo de la transición nutricional que está ocurriendo en muchos PIBM (152). Estos cambios en la dieta son concurrentes con los cambios en el acceso a la alimentación y el poder económico; por lo tanto los mismos recursos del hogar y maternos que reducen la desnutrición infantil pueden llegar a ser factores de riesgo para el exceso de nutrición infantil (70). Estos recursos del hogar y maternos a menudo se asocian entre sí (54). La educación materna también puede modificar las asociaciones entre los recursos del hogar y la desnutrición y sobrepeso infantil. El objetivo de esta tesis, que se encuentra en zonas rurales de Nicaragua, es investigar si los recursos del hogar y maternos se asocian de forma independiente con la alimentación y la nutrición de niños (as) pequeños en una sociedad en transición de bajos ingresos.

El estudio de tesis tiene un diseño de corte transversal. Entrevistadoras locales fueron entrenadas y participaron en la recogida de datos, de mayo a noviembre de 2009. Las madres fueron entrevistadas sobre aspectos de la alimentación de los niños (as) más pequeños (0-3 años) utilizando un cuestionario de frecuencia de alimentos que recordó el número de veces los alimentos y bebidas que fueron

consumidos el día anterior (incluyendo la noche). El estado nutricional del niño (a) también se midió utilizando técnicas estandarizadas de la OMS. Instrumentos científicos validados evaluaron los recursos del hogar y maternos. Todos los instrumentos fueron adaptados al contexto local y se pusieron a prueba en una comunidad cercana similar a las comunidades del estudio.

Los resultados mostraron que el 9% de los niños (as) tenían sobrepeso. El bajo peso (6%) y emaciación (4%; peso para la talla puntuación $Z < -2$ desviaciones estándar) fue bajo en los niños (as). El retraso del crecimiento (20%) fue más frecuente entre los niños (as) pequeños. La adhesión a los indicadores de alimentación de la OMS fue bajo, con sólo alrededor de un tercio de los bebés de 0 a 5 meses exclusivamente con leche materna y sólo casi la mitad de los niños (as) de 6 a 11 meses recibieron una dieta aceptable. Sin embargo, entre los niños (as) de 6 a 11 meses de edad, el consumo de HP aperitivos (50%) y las bebidas azucaradas (50%) fue predominante.

La educación materna fue el recurso que mostró más variación independiente en la alimentación y la nutrición infantil. Las probabilidades para la lactancia materna exclusiva fueron más altas en los infantes de 0 a 5 meses de madres con la educación más baja. Además, los niños (as) de 6 a 35 meses de madres con más bajo nivel educativo eran menos propensos a consumir HP aperitivos y las bebidas endulzadas con azúcar. Dichos niños (as) también tuvieron probabilidades más bajas de una doble carga de alimentación subóptima (prácticas complementarias insatisfechas concurrentes de alimentación y el consumo de HP aperitivos o bebidas endulzadas con azúcar. Sin embargo, también eran más propensos a la diversidad de la dieta poco frecuente y a ser más bajos de estatura. Los niños (as) de 6 a 35 meses de madres menos educadas eran también más bajos en los hogares con la más baja calidad de la vivienda.

Los resultados de tesis sugieren la existencia de una doble carga de la malnutrición en la misma población. Tanto limitaciones en las prácticas recomendadas de alimentación de la OMS y el gran consumo de HP aperitivos y bebidas azucaradas estuvieron también presentes; es decir una doble carga de alimentación subóptima. La educación materna superior protegió niños (as) de ser más bajos hasta en los hogares con mínima calidad de la vivienda. Sin embargo, la educación materna superior no protegió a los niños (as) de una mayor probabilidad de una doble carga de alimentación subóptima. Por lo tanto, en un entorno de transición rápida como la zona de estudio, se puede concluir que la educación materna más alta puede no ser suficiente para proteger a los niños (as) de prácticas de alimentación subóptima que pueden eventualmente desencadenar en sobrepeso u obesidad.

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