Social and Behavioral Determinants of Child Undernutrition in Camasca, Honduras

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Abstract

Introduction

Child undernutrition remains a significant health challenge around the world despite its high-priority status on the global health agenda. While the global burden of child undernutrition has reached historically low levels, it remains a pressing issue in rural communities of Central America. Through a partnership with a grassroots intervention targeting child undernutrition, this study sought to explore predictors of child nutrition knowledge and child growth outcomes in the community of Camasca in Honduras.

Methods

The study recruited 80 participants in Camasca, Honduras who identified as primary caregivers of children enrolled in the nutrition intervention. Participants responded to a questionnaire examining their child nutrition practices, health attitudes towards child nutrition practices, and demographic characteristics potentially associated with child growth outcomes. The height and weight data of 55 children enrolled in the intervention were used to calculate children's Z-scores for three growth outcomes: height for age, weight for height, and BMI for age. Four outcome variables were computed from questionnaire responses to score participants' child nutrition practices and knowledge: dietary diversity score, dietary diversity number, child nutrition practices score, and health attitudes score. Three of the four outcome variables were individually tested for association with children's growth outcomes: dietary diversity number, child nutrition practices score, and health attitudes score. Multiple linear regression was used to evaluate association of other questionnaire responses, described as predictor variables, with each of these three outcome variables.

Results

Most children for whom data were available fell within the healthy range for all three growth outcomes. Equal or greater numbers of children were overweight than underweight for two of the three growth outcomes. Neither dietary diversity number, child nutrition practices score, nor health attitudes score was associated with children's growth outcomes. All but two respondents achieved minimum dietary diversity for their child. Most respondents reported feeding their child from five or more dietary diversity food groups. Many factors were associated with the outcome variables evaluated via multiple linear regression.

Discussion

The near-absence of child undernutrition in the sample may indicate the success of the nutrition intervention. It may also reflect the global trend towards obesity as a main cause of malnutrition. The low variability of Z-score ranges may explain why no outcome variable was associated with child growth outcomes. The study's low sample size limited the generalizability of findings but its methods may serve as a useful template for future studies.

Introduction

In 2015, all United Nations (UN) member states pledged to end child hunger and improve child nutrition outcomes by signing the UN 2030 Agenda for Sustainable Development (*Goal 2 .:. Sustainable Development Knowledge Platform*, 2019). Despite global progress in reducing hunger since the turn of the century, undernourishment continues to affect more than one in every nine people in the world as of October 2019 (*2019—Hunger Map | World Food Programme*, 2019). Food insecurity disproportionately impacts the Global South, largely comprised of low-income and rural communities where poor nutrition outcomes in children remain a pressing concern (*2018 Global Nutrition Report*, 2018).

The 2011-2012 national survey of Honduras estimated that 48% of children below the age of 5 in Intibucá suffered from chronic undernutrition (*INE-HONDURAS::Redatam—Diseminación de Información Estadística*, 2013). Intibucá is among the most rural of the 18 departments of Honduras, itself the second most impoverished country in Central America as of 2017 (*Central America: Honduras—The World Factbook—Central Intelligence Agency*, 2020). Intibucá borders El Salvador to the south-west and forms part of the region which reported the highest rates of stunting, wasting, and low weight for age among its children in the country in 1996 (*Encuesta Nacional de Epidemiologia y Salud Familiar, 1996.pdf*, 1997).

Since 2008, the nonprofit organization Shoulder to Shoulder has implemented the nutritional supplement distribution program *Mejorando la Alimentación de Niños en Intibucá* (MANI), which aims to eliminate undernutrition among Intibucá children between six months and six years old ("Research Projects," 2013).

The decade-long data collection process and grassroots involvement of MANI in Intibucá offer a unique opportunity to explore social and behavioral predictors of child undernutrition in the Intibucá municipality of Camasca. This investigation establishes the burden of child nutrition in the Camasca, quantifies parents' child nutrition practices and health attitudes towards child nutrition, and explores the relationship between parents' practices, attitudes, and children's tangible growth outcomes.

Background

What is child malnutrition?

Malnutrition describes deficiencies, excesses, or imbalances in a person's nutrient intake (*WHO | What is malnutrition?*, 2016). It encompasses "undernutrition" and "overnutrition" (Ge & Chang, 2001). Undernutrition may manifest as stunting, or low height for age; wasting, or low weight for height; underweight, or low weight for age; and micronutrient deficiencies (*Levels and trends in child malnutrition*, 2017.)(Ge & Chang, 2001). Overnutrition describes overweight, obesity, and diet-related noncommunicable diseases such as cardiovascular disease and diabetes. The focus of this study is undernutrition, although the latter is increasingly crucial to address with the global rise of obesity (*Obesity and overweight*, 2020). Measures for assessing child malnutrition include Z-scores, growth charts, weight-for-length index, body mass index (BMI), and skin fold thickness (Ge & Chang, 2001).

Stunting describes low height for age in children (*Malnutrition*, 2018). It is a condition with severe consequences for a child's health and future livelihood. Stunting occurs as a result of chronic or recurrent malnutrition. Statistically, a child is stunted if their height for age is more than two standard deviations below the median in a reference population (*UNICEF - Definitions*, 2020). Children who are too short for their age may never achieve full physical nor cognitive development. They often endure learning difficulties in school and consequently earn less as adults, face barriers to community participation, and find themselves trapped in a cycle of poverty and poor health (*Levels and trends in child malnutrition*, 2017).

Wasting describes children who are too thin for their height and is a manifestation of acute malnutrition (*Malnutrition*, 2018). Wasting may lead from rapid weight loss or failure to gain weight during crucial development periods (*Levels and trends in child malnutrition*, 2017). Children who are mildly to severely wasted have weakened immunity and often suffer from significant development delays (*WHO | Diagnostic performance of visible severe wasting for identifying severe acute malnutrition in children admitted to hospital in Kenya*, 2011).

Children who are underweight may be wasted, stunted, or both (*Levels and trends in child malnutrition*, 2017). Underweight children have a BMI for age more than two standard deviations below that of a reference population (*Malnutrition*, 2018). Being underweight increases children's risk of death from pneumonia, diarrhea, and all-cause mortality by 45 to 60% (Caulfield et al., 2004).

Vitamin and mineral inadequacies hinder children's ability to produce enzymes, hormones, and other substances essential for proper growth (Ge & Chang, 2001). The most important in global health terms are iodine, vitamin A, and iron, deficiencies of which represent major threats to children's health worldwide (*Malnutrition*, 2018).

The global burden of child malnutrition

In 2016, 155 million children under 5 were stunted worldwide. Nearly 69 million were wasted (*Levels and trends in child malnutrition*, 2017). Almost half of all child deaths worldwide are directly or indirectly attributable to global undernutrition or low weight for age (*Malnutrition in Children*, 2020).

Global improvement in rates of child malnutrition have followed global efforts to meet ambitious targets for progress. The first of eight Millennium Development Goals set forth by all 191 United Nations Member States in September 2000 was "to eradicate extreme poverty and hunger" (*WHO | Millennium Development Goals (MDGs)*, 2020). The 2030 UN Agenda for Sustainable Development, set forth in 2015, similarly aspires to "end hunger, achieve food security and improve nutrition" as part of its second goal (*Transforming our world: The 2030 Agenda for Sustainable Development .:. Sustainable Development Knowledge Platform*, 2015). April 2016 saw the UN General Assembly adopt the Decade of Action on Nutrition, which aims to promote policy to reduce malnutrition worldwide by 2025 (*The Decade of Action on Nutrition 2016-2025*, 2016). World Health Organization (WHO) member states, including Honduras, endorsed the "Global Targets 2025" in 2012, which specify exact goals for member states to achieve by the stated year (*WHO | Global Targets 2025*, 2014).

Table 1: The "Global Targets 2025" set forth by the WHO in 2012 to reduce the global burden of child undernutrition.

Goal	
1	To achieve a 40% reduction in the number of children under 5 who are stunted.
2	To achieve a 50% reduction of anaemia in women of reproductive age.
3	To achieve a 30% reduction in low birth weight.
4	To ensure that there is no increase in childhood overweight.
5	To increase the rate of exclusive breastfeeding in the first 6 months to at least 50%.
6	To reduce and maintain childhood wasting to less than 5%.

The WHO maintains several tools for countries to monitor their progress towards these goals, including the Global Nutrition Monitoring Framework (GNMF), the Nutrition Landscape Information System (NLiS), and the Global database on the Implementation of Nutrition Action (GINA) (*Home | Global database on the Implementation of Nutrition Action (GINA)*, 2020)(*WHO | Global nutrition monitoring framework*, 2017)(*WHO | Nutrition Landscape Information System (NLiS)*, 2020). The Honduras country profiles for each of these tools indicate that it generally meets or exceeds WHO targets.

The burden of child malnutrition in Central America

Central America includes Belize, Costa Rica, Nicaragua, Guatemala, El Salvador, Panama, and Honduras (*Central America Nutrition Profile*, 2018). The region has made significant gains in child nutrition over the past decade, although room for further progress remains. The percentage of stunted children under 5 declined from 23.9 to 14.1% between 2000 and 2016, paralleling a global trend (*Historic Global Nutrition Reports*, 2020). In 2017, less than 1% of children under 5 were wasted as compared with 7.5% globally. Overall, 76.8% of children under 5 in the region are neither stunted, wasted, nor overweight (*Central America Nutrition Profile*, 2018).

The most up-to-date nutrition data on Honduras suggest the country has contributed to the region's progress. The percentage of stunted children under 5 declined from 34.1% in 2001 to 22.6% in 2016 (*Honduras Nutrition Profile*, 2019). About 1.8% of children under 5 were wasted in 2012, more than the region's average but significantly less than the global figure. In 2018, almost 72% of children under 5 showed no form of malnutrition (*Honduras Nutrition Profile*, 2019).

Table 2: The burden of child malnutrition in Honduras, Central America, and globally.

	Global	**Central America**	**Honduras**
Percent change in stunted children under 5 from 2000 to 2016	-9.7%	-9.8%	-11.5%
Children under 5 who are wasted	7.3% (2017)	0.9% (2017)	1.8% (2012)
Children under 5 without malnutrition	64.9% (2018)	76.8% (2018)	72% (2018)

These figures represent averages and do not reflect differences between rural and urban settings. With the exception of obesity and overweight, outcomes are generally worse for rural children in Honduras: in 2012, almost twice as many rural as urban children under 5 were stunted, although rates of stunting have declined more quickly for rural than urban children (*Honduras Nutrition Profile*, 2019). These differences are important to keep in mind given that 4.1 million, or 45% of Honduras' 9.2 million inhabitants were projected to have lived in rural areas in 2019 (*INE – Instituto Nacional de Estadística Honduras*, 2020).

This progress is in no small part thanks to government initiatives aimed at improving child nutrition outcomes in the country. A search for "Honduras" in GINA gives 21 results for policy initiatives the country has undertaken to directly address nutrition, most set in motion in the mid-2000s. These include national strategic plans, special commissions, and a regional agreement with Costa Rica, El Salvador, and other neighbors regarding grains fortification (*Policy—Política de Estado: Plan Estratégico para el Sector Agroalimentación y el Medio Rural de Honduras | Global database on the Implementation of Nutrition Action (GINA)*, 2010)(*Mechanisms—Comisión de Seguridad Alimentaria y Nutricional de la Región del*

Occidente de Honduras, SAN-ROH | Global database on the Implementation of Nutrition Action (GINA), 2017)(*Policy—Reglamento Técnico Centroamericano RTCA 67.01.15.07 Harinas. Harina de Trigo Fortificada. Especificaciones. | Global database on the Implementation of Nutrition Action (GINA)*, 2007). These policies generally have 10-15-year timelines and outline exact targets for the country to strive for as well as specific strategies for achieving them, for instance reducing infant stunting by promoting exclusive breastfeeding in the first six months of life.

The state of healthcare and nutrition in Honduras

Honduras' strong policy emphasis on health and nutrition reflects an ambitious national vision that sadly falls short in reality. The Ministry of Health, the country's primary public sector health institution, theoretically offers health services to all Hondurans; however, estimates show that only 50-60% use its services regularly (*Honduras*, 2017). About 18% of Hondurans have health coverage through the Honduran Social Security Institute and 10-15% pay for private sector healthcare through either private insurance or out of pocket. Estimates show that 17% of Hondurans lack regular access to health services (*Honduras*, 2017). The current national health model, approved in 2013, strives to close this gap by strengthening primary health care in rural areas (Rápalo et al., 2005).

The Honduran government directly addresses nutrition in an official document of specific food-based dietary guidelines for its constituents. The most recent edition was published in 2013 (Salud, 2013). The document was revised from a first edition, published in 2001, to address undernutrition more directly as well as the "alarming increase" of nutritionally-originated chronic diseases such as hypertension, diabetes, obesity, and cardiovascular disease (Salud, 2013). The guidelines are comprehensive, detailing specific food groups, the amounts they should be consumed in, and why doing so is important for good health. Like the country's national health vision, they are also somewhat idealistic. The guidelines recommend daily consumption of fruits and leafy greens, for instance, although leafy greens are at best difficult to come by in rural parts of the country. It also recommends 6-8 glasses of water per day although 638,000 or 1 in 10 Hondurans lack access to clean, safe water (*What is the Water Quality in Honduras Like?*, 2017). The guidelines acknowledge corn-, protein-, and bean-heavy Honduran cuisine but favor a more balanced diet that does not account for the surplus of certain foods that form the foundation of the country's culinary and agricultural traditions.

The guidelines specifically address child nutrition in two places: in describing micronutrients' importance and deficiencies' consequences on children's development, and in a specific recommendation for increasing underweight children's caloric intake by cooking with unsaturated fats.

What influences a child's nutritional status?

There is little debate that the choices parents make when it comes to feeding their children play a large role in the children's growth. In high-income and low-income contexts alike, the attitudes that drive parents' choices at the dining table hold implications for the long-term health and development of the young ones they feed (Zarnowiecki et al., 2012). What in turn drives these attitudes is subject to factors as material as what food is available and as immaterial as culturally ingrained beliefs around foods and eating habits (Tasnim, 2018).

Children adhere to the eating standards set by their parents and adopt the habits they witness parents practice (SanGiovanni et al., 2018). As the children age, they gain more autonomy in what they eat and may make choices their parents disapprove of but practice themselves—"bad behavior," such as eating junk foods or drinking sugar-sweetened beverages (Alderman & Headey, 2017). Parents in turn will be increasingly unaware of what or how their children eat as the children realize they can make these choices without their parents' endorsement (Berhane et al., 2018). Whatever habits they have developed leading up to this point of greater autonomy will dictate what and how much they choose to eat from what is presented to them at school and elsewhere.

The choices parents can make are not the only ones that influence what their children eat; the choices they cannot make play a role as well. Parents' socioeconomic status, level of education, income, and occupation are well-established predictors of child nutritional outcomes (Urke et al., 2011)(Tasnim, 2018). Limited education may translate to limited knowledge of nutrition, limited job opportunities, and resultingly limited ability to purchase healthy, varied food or practice healthy habits. These variables may also reflect a family's rurality, a factor which limits its members' access to fresh, varied, and healthy food options (Johri et al., 2016)(Chavez & Martinez, 1975).

Shoulder to Shoulder and research context

In 2015, 82 municipalities in 15 departments accepted care from decentralized government health services (*Honduras*, 2017). Camasca was among them. The community by no means relies solely on government resources for health care, however: the nonprofit organization Shoulder to Shoulder/Hombro a Hombro has grown its presence in Intibucá over 30 years to operate 19 clinics in the department, including two in Camasca ("About Shoulder to Shoulder," 2012). Through partnership with the Ministry of Health and Ministry of Education, Shoulder to Shoulder is responsible for most government health and education services in the department, employing over 150 local staff and offering basic health care, advanced medicine, dental care, education, and community health programs across Intibucá.

Since 2008, Shoulder to Shoulder has led the nutritional program *Mejorando la Alimentación de Niños en Intibucá* (MANI), which aims to eliminate child undernutrition in the department. Now in its fifth iteration, MANI delivers the soy-based micronutrient supplement Chispuditos to families of more than 2,800 children in Intibucá every three months ("Research Projects," 2013). MANI tracks its success by conducting height and weight measurement campaigns—*peso y talla*—that families must attend to receive Chispuditos. MANI then uses these anthropometric data to monitor the children's growth outcomes.

The decade-long data collection process and grassroots involvement of MANI in Intibucá offer a unique opportunity to explore factors underlying child undernutrition in the region. The specific goals of this study are the following:

1. To describe parents' child nutrition practices and attitudes towards child nutrition practices in Camasca.
2. To examine factors (e.g., age, community, perceived income, and news exposure) that may be associated with child nutrition practices and parents' attitudes towards child nutrition practices.
3. To examine the relationship between parents' child nutrition practices and child growth outcomes, and the relationship between attitudes towards child nutrition practices and child growth outcomes.

This study will add to an existing body of literature on parents' practices and health attitudes' role in child nutritional outcomes by contributing knowledge on a rural community in Honduras. It also hopes to strengthen the approach of Shoulder to Shoulder's intervention model by suggesting potential areas for greater emphasis in nutrition education.

Methods

Overview

This is a cross-sectional study conducted in the municipality of Camasca, Honduras from July to August 2018. I administered a questionnaire to 80 respondents who identified as caregivers of children enrolled in MANI in Camasca. I approached potential respondents during the MANI supplement distribution campaigns and individually interviewed them in Spanish. The respondent pool was limited to primary caregivers whose children met specific eligibility criteria. The questionnaire tool, developed with input from the Duke University Social Science Research Institute, drew from a survey MANI had given the prior year as well as guidelines from the US Centers for Disease Control and Prevention, the WHO, the US Department of Agriculture, and past research studies on child nutrition practices and growth outcomes in rural communities.

Setting

Camasca counts itself among Honduras' many rural communities. It is a municipality in the department of Intibucá in the west of the country, bordering El Salvador to the south-west. Intibucá's population in 2015 was 241,568, of which 194,686 inhabitants or about 81% lived in rural areas. Intibucá is divided into 17 municipalities and 126 villages or *aldeas* (*INE-HONDURAS::Redatam—Diseminación de Información Estadística*, 2013).

*Figure 1: Honduras is divided into 18 departments. Intibucá is in the west of the country.(*Honduras Departments Named • Mapsof.net*, 2020)*

Camasca is a 90-minute drive through the mountains from Intibucá's capital, La Esperanza, which is itself about four hours away by car from the nearest major city, Tegucigalpa. Camasca's 2013 population totaled 6,780, of whom 95% identified as ethnically indigenous, 50% could not meet one or more basic needs, and 17% could not read or write (*INE-HONDURAS::Redatam—Diseminación de Información Estadística*, 2013). It is the second poorest municipality in Intibucá and 53rd poorest of Honduras' 298 municipalities. Agriculture and raising livestock far outstrip other economic activities in the area as a primary means of income.

The Camasca municipality includes 12 *aldeas*. The *casco urbano* or urban center of the municipality shares its name, Camasca. The other registered *aldeas* are El Rosario, El Carmen, Santa Lucía, San Lucas, San Isidro, San Ignacio, San Antonio del Monte, Agua Zarca, Santa Catarina, Santa Crúz, and San Juan de Dios (Malo, 2019).

Figure 2: A hand-drawn map of the Camasca municipality. Each colored region represents a different aldea, *with the excpetion of La Laguna to the east. It is registered as belonging to the surrounding* aldeas *but regarded as distinct by inhabitants of Camasca.(Malo, 2019).*

Camasca's *casco urbano*, formally referred to as Camasca Centro, is visibly the most economically developed of the municipality's *aldeas*. Its roads are well-paved and clean, it offers many small shops, restaurants, and other small businesses, and is directly connected to a highway system which leads to La Esperanza, a route Camascans frequent when they need to replenish food and supplies not readily available in the main town. There is even a bus that leaves twice a day from Camasca to La Esperanza. The other *aldeas*, in contrast, are only reachable through precarious unpaved paths cutting through the mountains. To reach Camasca Centro and La Esperanza thereafter, most Camascans either travel on foot, hire a *mototaxi* (motor rickshaw), or hitch a ride with one of the 8.1% of Camascans who possess a motor vehicle.

Figure 3: Camasca Centro is directly connected to La Esperanza via a well-paved highway that leads directly into the town. The highway sign reads "Welcome to Camasca, Intibucá."

Figure 4: The well-maintained roads within Camasca Centro (left) contrast sharply with those radiating from the town that connect it with the surrounding aldeas*, such as the route to San Isidro (right).*

Participants

Individuals were eligible to participate in the study if they identified as a caregiver of a child enrolled in MANI who met specific eligibility criteria. The questionnaire screened for respondents whose children were currently receiving the Chispuditos supplement from the MANI project, had been reciving Chispuditos for at least one year by the time of the questionnaire, ate solid food, and did not have an illness, deformity, or other handicap that impeded their ability to eat. The respondent pool included mostly mothers but also included fathers, grandmothers, aunts, and siblings of children enrolled in MANI.

I recruited most of the 80 respondents by accompanying Shoulder to Shoulder staff to MANI supplement distribution campaigns around the Camasca municipality. We traveled to El Carmen, El Rosario, La Laguna, San Antonio, San Ignacio, San Isidro, San Juan de Dios, San Lucas, Santa Catarina, and the three zones of Camasca Centro (Centro, La Ceiba, and El Campo). Primary caregivers brought their children to a community meeting place, usually someone's home or a local church, to collect the next three months' supply of Chispuditos for their children. Before parents received the next quarter's allotment of the supplement, Shoulder to Shoulder staff measured their children's height and weight. At the beginning of a campaign at one of the distribution sites, a Shoulder to Shoulder staff member introduced me to the caregivers as a student researcher and asked their consent to participate in the study. I also collected some responses (<10) by traveling door-to-door in Camasca Centro, first ensuring the caregivers had not already answered the questionnaire before screening for eligibility and asking for consent. The sampling framework was thus a convenience sample.

Caregivers of children who did not meet the eligibility criteria were excluded from the study. If the caregiver had more than one child receiving Chispuditos, I requested that they answer the questionnaire in reference to the oldest child. I assumed the oldest child was within the age range targeted by the program—i.e. before six years old, when school attendance becomes mandatory and children receive meals at school. I informed caregivers of the nature of the questionnaire and presented the option to decline participation in compliance with the Duke University Institutional Review Board consent guidelines.

Procedures

I collected 80 questionnaires over the course of six weeks in the Camasca municipality. At the beginning of a measurement campaign, the Shoulder to Shoulder staff emphasized to all potential respondents that participation was voluntary and they could withdraw at any time, for any reason. I confirmed voluntary participation and understanding of the research goals with each respondent before giving the questionnaire. I read the questions and, when applicable, response choices aloud in Spanish as I recorded their responses on paper. A Shoulder to Shoulder staff member would occasionally aid me to ensure respondents understood the questions. After some practice, I learned to phrase questions and response choices to minimize misunderstanding, for instance by repeating the initial question phrasing for each item in a question. Each questionnaire took 10 to 15 minutes to complete.

There was no research incentive, although participants may have interpreted their participation as required for receiving the next quarter's supply of Chispuditos. All study procedures were approved by the Duke University Campus Institutional Review Board.

Questionnaire instrument

I developed a questionnaire which drew from a survey Shoulder to Shoulder had developed and administered to 250 families in Camasca from late 2016 to early 2017. The MANI survey's primary focus was families' demographic characteristics, infant feeding practices surrounding breastfeeding and liquids consumption, and Chispuditos consumption. My questionnaire elaborated on parents' child nutrition practices and further explored caregivers' perception of foods' healthfulness, with less emphasis on demographics.

The questionnaire was divided into four parts: screening criteria (see ***Participants***), nutrition habits, nutrition knowledge, and demographics.

The nutrition habits section evaluated dietary diversity; meal frequency; perceived portion size; food preparation; consumption of sweet beverages, sweets, and junk food; Chispuditos consumption; and whether the child was breastfed in infancy. With the exception of breastfeeding and frequency of Chispuditos consumption, caregivers were asked to respond in reference to how they had fed their child in the 24 hours preceding the questionnaire.

The WHO emphasizes sufficient diversity in a child's diet as key to healthy growth. The questionnaire evaluated children's dietary diversity by asking parents to report how their children ate per the WHO dietary diversity categories in the day before the questionnaire. A child's diet is sufficiently diverse if it includes at least four of the seven categories in Table 3.

Table 3: Food groups used to evaluate minimum dietary diversity.

Dietary diversity food group	**Spanish translation**	**Terms used in questionnaire**	**Spanish translation**
Grains, roots, and tubers	*Granos y raíces*	Corn flatbread, corn, porridge, corn flour drink, bread, rice, pasta or potatoes, cassava, yam, onion, garlic	*Tortilla, maíz, papilla, atole, pan, arroz, fideos o papas, yucas, ñame, cebolla, ajo*
Legumes and nuts	*Frutos secos y semillas*	Tree nuts, beans, lentils, lima beans, chickpeas, string beans	*Nueces, frijoles, lentejas, habas, garbanzos, habichuelas*
Dairy products (milk, yogurt, cheese)	*Productos lácteos*	Milk, cheese, cream, yogurt	*Leche, queso, crema, yogur*
Flesh foods (meat, fish, poultry, and liver/organ meats)	*Carne de cualquier animal*	Meat from beef, pork, lamb, goat, chicken, duck, or other bird; fresh or dried fish, shellfish	*Carne de vaca, cerdo, cordero, chivo, pollo, pato u otra ave; pescado fresco o seco, conchas, mariscos*
Eggs	*Huevos*	Eggs	*Huevos*
Vitamin-A rich fruits and vegetables	*Vegetales o frutas amarillas por dentro o vegetales de hoja verde oscura*	Pumpkin, carrot, zucchini, squash, sweet potato, mango, orange, papaya, tomato, spinach, chard, black nightshade, longbeak rattlebox	*Calabaza, zanahoria, güicoy, ayote, camote, mango, naranja, papaya, tomate, espinaca, acelga, macuy, chipilín*
Other fruits and vegetables	*Otras frutas o vegetales*	Other fruits and vegetables	*Otras frutas o vegetales*

Participants responded yes or no to whether their child had consumed from the above food categories the day preceding the questionnaire.

Respondents described portion sizes in terms of *cucharadas* or spoonfuls. The original questionnaire asked respondents to describe portion sizes for each meal but the question was adapted after the first few questionnaires so respondents would give an average portion size across meals. Similarly, when I presented five ways of preparing food, respondents described the method they had used most often the prior day instead of describing how they prepared food for each meal, as the questionnaire originally intended to document.

The nutrition knowledge section used a four-dimension scale to evaluate parents' perception of different food categories' healthfulness. Respondents also used the healthfulness scale to report their perceived healthfulness of five food preparation methods and of their child eating within two hours of bedtime. The dimensions were *muy saludable*, *más o menos saludable*, *más o menos no saludable*, and *no saludable*, which translate to very healthy, somewhat healthy, somewhat unhealthy, and unhealthy, respectively (Table 4). The food groups evaluated followed the designations in the Honduras national dietary guidelines.

Table 4: Four-dimension scale used to rate the healthfulness of food categories and food preparation methods.

Healthfulness dimensions	English translation
Muy saludable	Very healthy
Más o menos saludable	Somewhat healthy
Más o menos no saludable	Somewhat unhealthy
No saludable	Unhealthy

A similar four-dimension scale asked them to rank the importance of variety in their child's diet and of daily Chispuditos consumption.

Table 5: Four-dimension scale used to rate the importance of a diverse diet and of consuming Chispuditos daily.

Importance dimensions	English translation
Muy importante	Very important
Más o menos importante	Somewhat important
Más o menos no importante	Somewhat unimportant
No importante	Not important

Table 6: Food categories, food preparation methods, and habits (eating right before bedtime, eating a diverse diet, and consuming Chispuditos daily) evaluated for perceived healthfulness or importance. The food categories follow the designations in the Honduras national dietary guidelines.

Category evaluated for healthfulness or importance	English translation
Food category	
Granos (tortilla, maíz, papilla, atole, pan, arroz, fideos)	Grains (corn pancake, corn, cornflour drink, bread, rice, noodles)
Raíces (papas, yucas, ñame, cebolla, ajo)	Roots and tubers (potato, cassava, yam, onion, garlic)
Frutos secos o semillas (nueces, frijol, lenteja, habas, garbanzos, habichuelas)	Nuts or seeds (tree nuts, beans, lentils, fava beans, chickpeas, string beans)
Productos lácteos (leche, queso, crema, yogur)	Dairy products (milk, cheese, cream, yogurt)
Carne roja (vaca/res, cerdo, cordero, chivo; hígado, riñón, corazón, o víscera)	Red meat (beef, pork, lamb, goat, liver, kidney, heart, guts)
Carne de ave (pollo, pato)	Poultry (chicken, duck)
Pescado fresco o seco, conchas o mariscos	Fresh or dried fish, shellfish, or seafood
Insectos y hormigas	Insects and ants
Huevos	Eggs
Frutas	Fruit
Vegetales	Vegetables
Pasteles, galletas, chocolates, dulces, caramelos o similar	Pastries, cookies, chocolates, sweets, candies or similar
Churros (Tortrix, Takis, Doritos, papas fritas o similar)	Junk food (brand names, potato chips or similar)
Jugo o zumo de fruta	Fruit juice
Frescos o sodas	Bottled soda

Food preparation method	
Hervida	Boiled
Horneada, sobre fuego o en la parilla	Baked, over flame, or grilled
Frita	Fried
En microondas	In the microwave
Fría	Cold
Other categories	**Scale used**
Eating within two hours of bedtime	Healthfulness
Diversity in child's diet	Importance
Daily Chispuditos consumption	Importance

The next segment of the nutrition knowledge section asked respondents to report how many times per week they believed their child should eat from the food categories described above. I recorded their responses as days per week instead of occasions or meals per week. Many respondents misunderstood this question as asking how often their child actually ate from each food category, not how often they should.

The demographic section of the questionnaire included identifiers for the child to later match the questionnaire data to the anthropometric data from the measurement campaigns. Respondents described the child's household size and perceived monthly income as well as the primary caregivers' relationship to the child, age at the child's birth, occupation, marital status, education level, and exposure to news.

Analysis

Variable categorization

Several variables in the questionnaire were recoded to facilitate analysis and characterization of the study sample. The new variables and their recoded response options are described in Table 7.

Table 7: Original variables with corresponding collapsed variables.

Original question (Spanish)	Original question translation	Recoded variable	Recoded variable options
4a - ¿A qué horas su niño comió ayer? (Mañana)	At what time did your child eat yesterday? (Morning)	Morning meal time	Early: Before 8 AM Late: At or after 8 AM
4b - ¿A qué horas su niño comió ayer? (Tarde)	At what time did your child eat yesterday? (Afternoon)	Afternoon meal time	Early: At or before 12 PM Late: After 12 PM
4b - ¿A qué horas su niño comió ayer? (Noche)	At what time did your child eat yesterday? (Evening)	Evening meal time	Early: At or before 6 PM Late: After 6 PM
5 - ¿Qué tal de grande era la porción de comida?	How large was the portion of food?	Perceived portion size	Small: 3 spoonfuls or less Medium: 3 – 6 spoonfuls Large: > 6 spoonfuls
12 - ¿Cómo su hijo comió Chispuditos ayer?	How did your child eat Chispuditos yesterday?	Chispuditos consumption	Water: Any method excluding milk Milk: Any method including milk
13 - ¿Con qué frecuencia su niño come Chispuditos?	How often does your child eat Chispuditos?	Chispuditos frequency	Less than 5x/week At least 5x/week
28 - ¿Cuántos años tenía cuidador(a) principal cuando nació?	How old was the primary caregiver when the child was born?	Age range at child's birth	Young: 25 years old or less Middle age: 25-35 years old Upper age: >35 years old

29 - ¿Cuál es su ocupación?	What is your occupation?	Job status	Not employed Housewife Not employed All else
30 - Estado civil	Marriage status	Married or not	Married Not married
31 - Último año de escuela	Last year of school	Education level	Primary school or less Middle school High school University
33 - Exposición a media	Exposure to media	Media exposure	Daily Less than daily

Calculating Z-scores to quantify child growth outcomes

Shoulder to Shoulder provided the height and weight data of children whose families received Chispuditos in July 2018. The child's name, date of birth, and community as given by the respondent were used to find the child's height and weight measurements in the MANI data.

The WHO Z-score calculator tool was used to calculate BMI, weight for age Z-score, height for age Z-score, weight for age Z-score, BMI Z-score, and percentage above or below the median for each of these. The tool uses the National Center for Health Statistics (NCHS) /WHO international reference population to calculate Z-scores.

To facilitate data analysis, Z-scores were used to categorize children into three groups per growth outcome: above normal Z-score range, below normal Z-score range, and at normal Z-score range.

Table 8: Z-score categories by growth outcome. SD represents standard deviation.

Growth metric	Z-score range	Z-score category	Growth outcome
Height for age	<-2 SD	Below normal range	Stunted
	-2 to 2 SD	At normal range	Normal
	>2 SD	Above normal range	Tall
Weight for height	<-2 SD	Below normal range	Wasted
	-2 to 2 SD	At normal range	Normal
	>2 SD	Above normal range	Overweight
BMI for age	<-2 SD	Below normal range	Underweight
	-2 to 2 SD	At normal range	Normal
	>2 SD	Above normal range	Overweight

Outcome variable: Dietary diversity score

The WHO standard for minimum dietary diversity for children ages 6-23 months is consumption from any four out of the seven following food groups:

1. Grains, roots, and tubers
2. Legumes and nuts
3. Dairy products (milk, yogurt, cheese)
4. Flesh foods (meat, fish, poultry, and liver/organ meats)
5. Eggs
6. Vitamin-A rich fruits and vegetables
7. Other fruits and vegetables

The questionnaire was modified upon noting that respondents typically did not recognize the direct Spanish translations of nutrition terms designating food categories. The questionnaire instead referred directly to specific food items belonging to each category, as shown in Table 3.

Caregivers received a "dietary diversity score" of 1 if they described having fed their child from four or more of the above food groups during the day prior to the questionnaire. They received a score of 0 if they described having fed their child from three food groups or less.

Outcome variable: Dietary diversity number

Respondents received a "dietary diversity number" ranging from 1 to 7 according to how many dietary diversity food groups they reported feeding their child from in the day before the questionnaire.

Outcome variable: Child nutrition practices score

The Honduras national dietary guidelines recommend frequencies with which Hondurans should eat certain foods.

Table 9: Recommended frequency of consumption of certain foods according to the Honduras national dietary guidelines.

Recommended frequency	Honduras dietary guidelines food category
Every meal	Grains (corn pancake, corn, cornflour drink, bread, rice, pasta)
	Roots and tubers (potato, cassava, yam, onion, garlic)
	Nuts or seeds (tree nuts, beans, lentils, fava beans, chickpeas, string beans)
Daily	Fruit
	Vegetables
At least 3x per week	Dairy products (milk, cheese, cream, yogurt)
	Eggs
At least 2x per week	Red meat (beef, pork, lamb, goat, liver, kidney, heart, guts)
	Poultry (chicken, duck)
	Fresh or dried fish, shellfish, or seafood
Limited consumption	Pastries, cookies, chocolates, sweets, candies or similar
	Oils, fats, peanuts, cashews, sesame seeds

Respondents were scored according to how closely their aspirational child feeding practices tracked the national dietary guidelines. Respondents' scores were aggregated across 15 food categories into a "child nutrition practices" score.

Outcome variable: Health attitudes score

The Honduras national dietary guidelines food categories in Table 9 as well as five categories of food preparation methods in Table 6 were used to score respondents' health attitudes towards child nutrition practices. A respondent received a score of 1 in a category if their opinion of its healthfulness tracked the Honduras national dietary guidelines and a score of 0 if it did not. These were aggregated across 20 categories into a "health attitudes" score.

ANOVA and multiple linear regression

The statistical software R was used to conduct one-way analysis of variance (ANOVA) on the outcome variables dietary diversity number, child nutrition practices score, and health attitudes score. Three ANOVA tests were conducted for each outcome variable:

1. Comparison of mean outcome variable value between BMI for age Z-score categories
2. Comparison of mean outcome variable value between weight for age Z-score categories
3. Comparison of mean outcome variable value between height for age Z-score categories

Multiple linear regression analysis was used to evaluate association of predictor variables from the questionnaire with each of three outcome variables. Regression analysis was conducted on the outcome variables dietary diversity number, child nutrition practices score, and health attitudes score.

Results

Description of the sample

Parents

Respondents were residents of the Camasca municipality who identified as primary caregivers of children who met the eligibility criteria for the study.

Table 10: Relationships between respondents and children concerned in study (N=80).

Caregiver relationship to child	*n*	%
Mother	72	90
Father	3	3.75
Sister	1	1.25
Grandmother	4	5
Aunt	1	1.25

The respondents' age at birth of the child ranged from 13 to 60 years old, with a mean of 26.96 years old and standard deviation of 8.5 years. Forty-two out of 80 or 52.5% of respondents were in the 19-29 age range at the birth of the child.

The respondents' relationship status fell into one of four categories: single, married, separated, or *unión libre*, which roughly translates to "consensual union" and designates an unmarried couple that lives together.

Table 11: Questionnaire respondents by marriage status (N=80).

Caregiver marriage status	*n*	%
Single	14	17.5
Married	34	42.5
Separated	1	1.25
Consensual union	31	38.8

Caregiver education level ranged from no formal education to university schooling. Most respondents had formal education through grade six, which is the last year of compulsory primary education in Honduras.

Table 12: Questionnaire respondents by education level (N=80).

Caregiver education level	*n*	%
No formal schooling	1	1.25
Primary school	62	77.5
Middle school	5	6.25
High school	6	7.5
University	6	7.5

Children

Slightly less than half the children in the study were female and slightly more than half were male. The children ranged in age at the time of the study from 14 months to 5.5 years old.

Table 13: Assigned sex at birth of children described in study (N=80).

Child sex at birth	***n***	**%**
Female	37	46.3
Male	43	53.8

Table 14: Age range of children described in study (months) (N=80).

Age of children	***n***	**%**
<20 months old	3	3.75
20-39 months old	22	27.5
40-49 months old	17	21.3
>50 months old	38	47.5

Household size ranged from 3 to 13 family members. Questionnaires were collected in communities across the Camasca municipality as described below.

Table 15: Questionnaire count by community (N=80).

Community	***n***	**%**
Santa Catarina	5	6.25
San Lucas	10	12.5
San Juan de Dios	13	16.3
San Isidro	7	8.75
San Ignacio	8	10
San Antonio	7	8.75
La Laguna	6	7.5
El Rosario	7	8.75
El Carmen	6	7.5
Camasca (town)	11	13.8

Parents' child nutrition practices and health attitudes towards child nutrition

Dietary diversity

The WHO standard for minimum dietary diversity for children ages 6-23 months is consumption from any four out of the seven following food groups:

1. Grains, roots, and tubers
2. Legumes and nuts
3. Dairy products (milk, yogurt, cheese)
4. Flesh foods (meat, fish, poultry, and liver/organ meats)
5. Eggs
6. Vitamin A-rich fruits and vegetables
7. Other fruits and vegetables

The questionnaire was modified upon noting that respondents typically did not recognize the direct Spanish translations of nutrition terms designating food categories. The questionnaire instead referred directly to specific food items belonging to each category, as described in Table 3. Table 16 shows the distribution of dietary diversity scores across the sample.

Table 16: Dietary diversity scores of respondents (N=80). A score of 1 represents achievement of minimum dietary diversity per WHO standards for infant and young child nutrition.

Dietary diversity score	*n*	%
0	2	2.5
1	78	97.5

Respondents who received a score of 1 may have fed their child from four to seven of the dietary diversity food categories. The breakdown of food categories met for minimum dietary diversity is as follows:

Table 17: Number of food categories met for minimum dietary diversity (N=80).

Dietary diversity score	Dietary diversity food groups met	*n*	%
0	0	0	0
	1	0	0
	2	0	0
	3	2	2.5
1	4	9	11.3
	5	20	25
	6	38	47.5
	7	11	13.8

Table 18: Dietary diversity food groups respondents reported feeding their children from, broken down by achievement or not of minimum dietary diversity (N=80).

Dietary diversity food group	**Fed from food group**		**Did not feed from food group**	
Dietary diversity score	**Diverse diet**	**Not diverse diet**	**Diverse diet**	**Not diverse diet**
Grains, roots, and tubers	78	2	0	0
Legumes and nuts	77	2	2	0
Dairy products (milk, yogurt, cheese)	71	1	6	0
Flesh foods (meat, fish, poultry, and liver/organ meats)	27	1	51	2
Eggs	56	2	21	0
Vitamin A-rich fruits and vegetables	64	1	15	0
Other fruits and vegetables	68	1	10	2

Dietary diversity: Factors associated with dietary diversity number

The most inclusive and parsimonious multiple linear regression model predicting dietary diversity number from all possible predictor variables included the terms in Table 19. The model excluded predictor variables associated with dietary diversity score, namely the dietary diversity food groups. The significant predictor variables were Number of snacks ($p<0.05$), Preparation - Fried ($p<0.1$), Chispuditos frequency - Less than 5x/week ($p<0.05$), Red meat healthy? ($p<0.1$), Eggs healthy? ($p<0.1$), Grilled healthy? ($p<0.1$), Roots frequency? ($p<0.1$), Relationship - Mother ($p<0.1$), Relationship - Aunt ($p<0.1$), Age of respondent at child's birth ($p<0.1$), and Marriage status - Single ($p<0.05$). The adjusted R-squared value of this model is 0.904, meaning about 90.4% of the variation in dietary diversity scores can be explained by the model. The model did not account for interaction effects between any two or more variables.

*Table 19: Regression coefficients for the largest multiple linear regression model predicting dietary diversity number from predictor variables. Numbers rounded to three significant figures. Adjusted R-squared = 0.904. P-value significance levels: 0-0.001 '***', 0.001 - 0.01'**', 0.01 - 0.05'*', 0.05 - 0.1 '+'.*

Term	Regression coefficient	Standard error	P
(Intercept)	3.422	0.719	0.005**
Number of meals	0.050	0.038	0.246
Number of snacks	-0.106	0.047	0.074+
Portion size	-0.006	0.003	0.171
Preparation			
Fried	0.546	0.247	0.078+
Boiled	-0.024	0.068	0.741
Boiled and fried	0.021	0.131	0.879
Number of juices	-0.081	0.035	0.071+
Number of sodas	0.143	0.105	0.230
Number of sweets	-0.028	0.064	0.674
Chispuditos portion size	0.028	0.018	0.189
Chispuditos consumption			
Milk	-0.026	0.143	0.861
Water	0.146	0.170	0.432

Chispuditos frequency (vs At least 5x/week)			
Less than 5x/week	-0.345	0.101	0.019*
Honduras dietary guidelines food category healthfulness			
Grains healthy?	-0.300	0.394	0.481
Dairy healthy?	0.246	0.245	0.361
Red meat healthy?	0.279	0.116	0.061+
Poultry healthy?	0.368	0.210	0.140
Fish healthy?	-0.135	0.313	0.685
Eggs healthy?	0.374	0.179	0.092+
Sweets healthy?	0.266	0.222	0.284
Junk healthy?	0.164	0.180	0.404
Juice healthy?	0.316	0.348	0.405
Sodas healthy?	0.134	0.275	0.647
Food preparation methods healthfulness			
Boiling healthy?	-0.444	0.469	0.387
Grilled healthy?	0.412	0.167	0.057+
Fried healthy?	0.306	0.204	0.194
Microwave healthy?	0.359	0.277	0.251
Cold healthy?	0.434	0.257	0.152
Health attitudes score	-0.284	0.188	0.192
Honduras dietary guidelines food category aspirational feeding frequency			
Grains frequency?	-0.132	0.127	0.346
Roots frequency?	-0.227	0.106	0.085+
Seeds frequency?	0.051	0.104	0.644

Dairy frequency?	-0.075	0.069	0.325
Red meat frequency?	-0.136	0.090	0.193
Poultry frequency?	-0.038	0.064	0.573
Fish frequency?	0.108	0.124	0.421
Eggs frequency?	0.115	0.079	0.208
Fruit frequency?	0.073	0.091	0.461
Vegetables frequency?	0.156	0.094	0.159
Sweets frequency?	-0.022	0.060	0.731
Junk frequency?	0.170	0.091	0.121
Sodas frequency?	-0.052	0.141	0.727
Variety in diet important?	-0.276	0.171	0.166
Sex (vs F)			
M	-0.067	0.064	0.340
Community (vs Camasca – Centro)			
Camasca - El Campo	-0.086	0.214	0.704
Camasca - La Ceiba	0.553	0.324	0.149
El Carmen	0.165	0.306	0.613
El Rosario	0.251	0.420	0.577
La Laguna	0.278	0.255	0.326
San Antonio	0.323	0.369	0.422
San Ignacio	0.516	0.264	0.108
San Isidro	0.615	0.308	0.102
San Juan de Dios	0.492	0.297	0.159
San Lucas	0.507	0.464	0.324

Santa Catarina	0.639	0.368	0.144
Household size	0.005	0.012	0.682
Relationship of primary caregiver to child (vs Grandmother)			
Sister	-0.369	0.399	0.398
Mother	-0.405	0.169	0.062+
Father	-0.235	0.198	0.289
Mother and father	0.356	0.458	0.472
Aunt	0.879	0.344	0.051+
Age of respondent at child's birth	0.017	0.007	0.054+
Age range of respondent at child's birth (vs Older age)			
Upper age	-0.199	0.123	0.167
Young	0.137	0.104	0.242
Job status (vs Employed)			
Not employed	-0.244	0.229	0.335
Marriage status (vs Married)			
Separated	-0.095	0.240	0.708
Single	0.300	0.108	0.039*
Consensual union	0.161	0.110	0.202
Education level (vs High school)			
Middle school	0.154	0.133	0.298
Primary school or less	0.145	0.159	0.406
University	0.158	0.149	0.338
Monthly income	0.000	0.000	0.313
Media exposure (vs Daily)			
Less than daily	0.112	0.104	0.327

Dietary diversity: Relationship with child growth outcomes

Three growth metrics were calculated from the height, age, and weight of respondents' children: height for age Z-score, weight for height Z-score, and BMI for age Z-score. Height for age Z-scores indicate stunting, weight for height Z-scores indicate wasting, and BMI for age Z-scores indicate underweight or overweight. Of the 80 respondents, 55 had children with available height and weight data from which to calculate Z scores.

Table 20: Z-scores of 55 children in the study for whom height and weight data in July 2018 were available (N=55). Percentages approximated to three significant figures.

Growth metric	Z-score range	Growth outcome	*n*	%
Height for age	<-2 SD	Stunted	12	21.8
	-2 to 2 SD	Normal	42	76.4
	>2 SD	Tall	1	1.82
Weight for height	<-2 SD	Wasted	2	3.64
	-2 to 2 SD	Normal	51	92.7
	>2 SD	Overweight	2	3.64
BMI for age	<-2 SD	Underweight	0	0
	-2 to 2 SD	Normal	52	94.5
	>2 SD	Overweight	3	5.45

There was no significant difference in mean dietary diversity number between respondents whose children were in different BMI for age Z-score categories.

Table 21: One-way analysis of variance (ANOVA) for BMI for age Z-score categories and dietary diversity number. Degrees of freedom = 1 because all children fell into "Above normal range" or "At normal range" BMI for age Z-score categories. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
BMI for age Z-score category	1	0	0.0005	0.001	0.981
Residuals	53	44.4	0.838		

There was no significant difference in mean dietary diversity number between respondents whose children were in different weight for height Z-score categories.

Table 22: ANOVA output for weight for height Z-score categories and dietary diversity number. Degrees of freedom = 2 because one or more children fell into each weight for height Z-score category. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
Weight for height Z-score category	2	0.29	0.144	0.17	0.844
Residuals	52	44.2	0.849		

There was no significant difference in mean dietary diversity number between respondents whose children were in different height for age Z-score categories.

Table 23: ANOVA output for height for age Z-score categories and dietary diversity number. Degrees of freedom = 2 because one or more children fell into each height for age Z-score category. Numbers rounded to three significant figures.

	Degrees of freedom	**Sum of squares**	**Mean square**	**F value**	**P**
Height for age Z-score category	2	2.07	1.04	1.27	0.29
Residuals	52	42.4	0.815		

Parents' aspirational child nutrition practices

Tables 24and 25 describe the spread and distribution of child nutrition practices scores across the sample.

Table 24: Distribution of aggregate scores for child nutrition practices (N=80).

Child nutrition practices score	*n*	%
<5	10	12.5
5-10	62	77.5
>10	8	10

Table 25: Spread and characteristics of aggregate scores for child nutrition practices.

Child nutrition practices statistic	Value
Minimum score	2
Maximum score	12
Mean score	7.2
Median score	7
Standard deviation	2.4

Aspirational child nutrition practices: Factors associated with parents' scores

The most inclusive and parsimonious multiple linear regression model predicting child nutrition includes the terms in Table 26. The model excluded aspirational feeding frequencies of food categories from the Honduras national dietary guidelines. The significant predictor variables were Dietary diversity food groups - Meat ($p<0.05$), Dietary diversity food groups - Vegetables ($p<0.05$), Number of meals ($p<0.05$), Morning meal time - Late ($p<0.05$), Preparation - Fried ($p<0.1$), Preparation - Boiled ($p<0.1$), Number of sodas ($p<0.05$), Number of sweets ($p<0.05$), Number of junk foods ($p<0.05$), Chispuditos portion size ($p<0.05$), Chispuditos consumption - Milk ($p<0.1$), Roots healthy? ($p<0.1$), Red meat healthy? ($p<0.1$), Fish healthy? ($p<0.05$), Eggs healthy? ($p<0.05$), Junk healthy? ($p<0.1$), Sodas healthy? ($p<0.05$), Boiling healthy? ($p<0.05$), Grilled healthy? ($p<0.1$), Microwave healthy? ($p<0.05$), Community - El Rosario ($p<0.05$), Community - La Laguna ($p<0.05$), Community - San Ignacio ($p<0.05$), Community - San Isidro ($p<0.05$), Community - San Juan de Dios ($p<0.05$), Community - San Lucas ($p<0.05$), Relationship - Mother ($p<0.1$), Age of respondent at child's birth ($p<0.05$), Age range - Upper age ($p<0.1$), Marriage status - Separated ($p<0.1$), Marriage status - Single ($p<0.1$), Marriage status - Consensual union ($p<0.05$), Education level - Primary school or less ($p<0.1$), and Education level - University ($p<0.05$). The R-squared value of the model was 0.904, meaning about 90.4% of the variability in the outcome variable "child nutrition practices score" can be explained by the model. The model did not account for interaction effects between any two or more variables.

*Table 26: Regression coefficients for the largest parsimonious multiple linear regression model predicting child nutrition practices score from predictor variables. Numbers rounded to three significant figures. Adjusted R-squared = 0.904. P-value significance levels: 0-0.001 '***', 0.001 - 0.01'**', 0.01 - 0.05'*', 0.05 - 0.1 '+'.*

Term	Regression coefficient	Standard error	P
(Intercept)	-7.699	6.689	0.333
Dietary diversity food groups fed from in prior day			
Seeds	7.977	3.655	0.117
Dairy	3.017	1.738	0.181
Meat	-2.120	0.656	0.048*
Eggs	0.360	0.653	0.620
Vegetables	2.493	0.547	0.020*
Other	2.332	1.941	0.316
Dietary diversity score	-3.948	3.725	0.367
Number of meals	0.907	0.283	0.049*
Number of snacks	-0.894	0.511	0.179
Morning meal time (vs Early)			
Late	-4.509	0.941	0.017*
Afternoon meal time (vs Early)			
Late	2.270	1.139	0.140
Evening meal time (vs Early)			
Late	-5.417	2.624	0.131
Portion size	0.013	0.042	0.787
Perceived portion size (vs Large)			
Medium	1.073	0.829	0.286
Small	-1.209	0.973	0.302
Preparation			
Fried	5.977	1.954	0.055+

Boiled	-2.243	0.819	0.071+
Boiled and fried	-1.096	0.923	0.321
Number of juices	-0.172	0.310	0.617
Number of sodas	2.775	0.602	0.019*
Number of sweets	1.070	0.334	0.049*
Number of junk foods	-3.093	0.658	0.018*
Chispuditos portion size	-0.831	0.191	0.022*
Chispuditos consumption			
Milk	4.033	1.379	0.061+
Water	2.514	1.295	0.148
Chispuditos frequency (vs At least 5x/week)			
Less than 5x/week	0.705	1.055	0.552
Was child breastfed?	-3.651	2.227	0.200
Honduras dietary guidelines food category healthfulness			
Grains healthy?	3.643	3.434	0.367
Roots healthy?	-3.045	1.238	0.091+
Dairy healthy?	-2.959	1.608	0.163
Red meat healthy?	2.377	0.875	0.073+
Poultry healthy?	1.026	0.623	0.198
Fish healthy?	-9.930	2.773	0.037*
Eggs healthy?	-10.646	2.099	0.015*
Sweets healthy?	-1.080	0.489	0.114
Junk healthy?	-5.123	1.682	0.056+
Juice healthy?	5.986	4.639	0.287

Sodas healthy?	3.830	1.002	0.032*
Food preparation methods healthfulness			
Boiling healthy?	12.031	3.079	0.030*
Grilled healthy?	-4.913	1.743	0.067+
Fried healthy?	-1.487	0.694	0.121
Microwave healthy?	4.661	0.805	0.010*
Cold healthy?	2.155	1.895	0.338
Sex (vs F)			
M	-0.753	0.794	0.413
Community (vs Camasca – Centro)			
Camasca - El Campo	3.036	6.904	0.690
Camasca - La Ceiba	0.517	2.344	0.840
El Carmen	0.886	1.957	0.681
El Rosario	8.929	2.281	0.030*
La Laguna	8.632	2.557	0.043*
San Antonio	4.580	2.154	0.123
San Ignacio	9.812	2.190	0.021*
San Isidro	8.890	2.212	0.028*
San Juan de Dios	7.521	2.073	0.036*
San Lucas	8.129	2.325	0.040*
Santa Catarina	4.537	2.522	0.170
Relationship of primary caregiver to child (vs Grandmother)			
Sister	-2.553	5.201	0.657
Mother	3.578	1.286	0.069+
Father	4.840	3.898	0.303

Mother and father	0.733	1.987	0.737
Aunt	-4.632	7.527	0.582
Age of respondent at child's birth	0.444	0.108	0.026*
Age range of respondent at child's birth (vs Older age)			
Upper age	-5.024	1.936	0.081+
Young	0.832	0.857	0.403
Marriage status (vs Married)			
Separated	-5.115	2.031	0.086+
Single	2.977	1.031	0.063+
Consensual union	4.245	1.146	0.034*
Education level (vs High school)			
Middle school	1.852	1.391	0.275
Primary school or less	-3.641	1.313	0.069+
University	5.804	1.587	0.035*
Monthly income	0.000	0.000	0.234
Media exposure (vs Daily)			
Less than daily	-0.329	0.529	0.578

Aspirational child nutrition practices: Relationship with child growth outcomes

There was no significant difference in mean child nutrition practices score between respondents whose children were in different BMI for age Z-score categories.

Table 27: ANOVA output for BMI for age Z-score categories and child nutrition practices score. Degrees of freedom = 1 because all children fell into "Above normal range" or "At normal range" BMI for age Z-score categories. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
BMI for age Z-score category	1	9.5	9.53	1.51	0.224
Residuals	53	334	6.30		

There was no significant difference in mean child nutrition practices score between respondents whose children were in different weight for height Z-score categories.

Table 28: ANOVA output for weight for height Z-score categories and child nutrition practices score. Degrees of freedom = 2 because one or more children fell into each weight for height Z-score category. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
Weight for height Z-score category	2	14.1	7.06	1.12	0.336
Residuals	52	329	6.32		

There was no significant difference in mean child nutrition practices score between respondents whose children were in different height for age Z-score categories.

Table 29: ANOVA output for height for age Z-score categories and child nutrition practices score. Degrees of freedom = 2 because one or more children fell into each height for age Z-score category. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
Height for age Z-score category	2	0.2	0.082	0.012	0.988
Residuals	52	343.0	6.60		

Parents' health attitudes towards child nutrition practices

Health attitudes scores ranged from 11 to 18 out of a possible 20. No respondent received a perfect score and most scores were in the 15-16 range.

Table 30: Distribution of parental health attitudes scores (N=80).

Health attitudes score	*n*	%
<10	0	0
11-14	21	26.3
15-16	46	57.5
>16	13	16.3

Table 31: Spread and characteristics of respondent health attitudes scores.

Health attitudes statistic	Value
Minimum score	11
Maximum score	18
Mean score	15.3
Median score	15
Standard deviation	1.3

Health attitudes towards child nutrition practices: Factors associated with parents' scores

The most inclusive and parsimonious multiple linear regression model predicting parent's health attitudes score includes the terms in Table 32. The model excluded all predictor variables associated with health attitudes score, namely any questionnaire response which involved rating the healthfulness of a food or habit or the importance of a diet-related habit. The significant predictor variables were Dietary diversity food groups - Dairy ($p<0.05$), Dietary diversity food groups - Meat ($p<0.05$), Morning meal time - Late ($p<0.1$), Afternoon meal time - Late ($p<0.05$), Evening meal time - Late ($p<0.05$), Preparation - Boiled ($p<0.05$), Preparation - Boiled and fried ($p<0.05$), Number of sodas ($p<0.1$), Chispuditos portion size ($p<0.1$), Roots frequency? ($p<0.1$), Poultry frequency ($p<0.1$), Fish frequency ($p<0.1$), Vegetables frequency ($p<0.05$), Junk frequency ($p<0.01$), Community - Camasca El Campo ($p<0.1$), Relationship of primary caregiver to child – Mother ($p<0.05$), Age of respondent at child's birth ($p<0.1$), Job status - Not employed ($p<0.05$), and Monthly income ($p<0.05$). The R-squared value of the model was 0.696, meaning about 69.6% of the variability in the outcome variable "health attitudes score" can be explained by the model. The model did not account for interaction effects between any two or more variables.

*Table 32: Regression coefficients for the largest parsimonious multiple linear regression model predicting health attitudes score score from predictor variables. Numbers rounded to three significant figures. Adjusted R-squared = 0.696. P-value significance levels: 0-0.001 '***', 0.001 - 0.01'**', 0.01 - 0.05'*', 0.05 - 0.1 '+'.*

Term	Regression coefficient	Standard error	P
(Intercept)	2.838	5.144	0.593
Dietary diversity food groups fed from in prior day			
Dairy	2.486	0.872	0.017*
Meat	1.194	0.492	0.036*
Eggs	0.717	0.556	0.226
Vegetables	0.738	0.548	0.208
Other	-0.605	0.825	0.480
Morning meal time (vs Early)			
Late	-1.110	0.546	0.070+
Afternoon meal time (vs Early)			
Late	-2.396	0.885	0.022*
Evening meal time (vs Early)			
Late	3.220	1.196	0.023*
Portion size	0.019	0.028	0.509
Perceived portion size (vs Large)			
Medium	-1.337	0.799	0.125
Small	-0.667	0.671	0.343
Preparation			
Fried	-1.086	2.025	0.603
Boiled	1.103	0.493	0.049*
Boiled and fried	1.719	0.715	0.037*
Number of sodas	0.742	0.403	0.095+
Number of sweets	0.380	0.349	0.302

Number of junk foods	0.707	0.528	0.211
Chispuditos portion size	0.324	0.176	0.096+
Chispuditos consumption			
Milk	0.569	0.710	0.442
Water	0.068	0.692	0.924
Chispuditos frequency (vs At least 5x/week)			
Less than 5x/week	0.929	0.636	0.175
Was child breastfed?	2.580	1.682	0.156
Honduras dietary guidelines food category aspirational feeding frequency			
Grains frequency?	-2.613	1.554	0.124
Roots frequency?	-2.823	1.509	0.091+
Seeds frequency?	-3.332	1.867	0.105
Dairy frequency?	-2.934	1.745	0.124
Red meat frequency?	-0.688	1.294	0.607
Poultry frequency?	-2.988	1.543	0.081+
Fish frequency?	-3.946	2.057	0.084+
Eggs frequency?	-2.042	1.554	0.218
Fruit frequency?	-2.033	1.536	0.215
Vegetables frequency?	-3.578	1.418	0.030*
Sweets frequency?	-1.703	1.640	0.324
Junk frequency?	-3.405	1.704	0.074+
Sodas frequency?	-2.402	1.514	0.144
Community (vs Camasca – Centro)			
Camasca - El Campo	6.305	3.018	0.063+
Camasca - La Ceiba	1.494	1.570	0.364

El Carmen	-0.115	1.738	0.949
El Rosario	-2.240	1.977	0.284
La Laguna	-0.654	1.810	0.725
San Antonio	-0.200	2.161	0.928
San Ignacio	-1.473	1.388	0.313
San Isidro	-1.836	1.915	0.360
San Juan de Dios	-1.010	1.583	0.538
San Lucas	-1.351	2.014	0.517
Santa Catarina	-2.221	2.029	0.299
Household size	-0.094	0.133	0.497
Relationship of primary caregiver to child (vs Grandmother)			
Sister	3.290	2.331	0.188
Mother	3.948	1.536	0.028*
Father	2.642	1.778	0.168
Mother and father	-2.773	2.090	0.214
Aunt	0.461	4.583	0.922
Age of respondent at child's birth	0.114	0.059	0.082+
Age range of respondent at child's birth (vs Older age)			
Upper age	-1.156	1.064	0.302
Young	0.809	0.618	0.219
Job status (vs Employed)			
Not employed	-5.095	1.771	0.016*
Marriage status (vs Married)			
Separated	-2.207	1.372	0.139

Single	-1.051	0.811	0.224
Consensual union	-0.958	0.693	0.197
Education level (vs High school)			
Middle school	1.545	0.982	0.147
Primary school or less	2.132	1.184	0.102
University	0.953	1.122	0.415
Monthly income	0.000	0.000	0.034*
Child nutrition practices score	2.531	1.444	0.110

Health attitudes towards child nutrition practices: Relationship with child growth outcomes

There was no significant difference in mean health attitudes score between respondents whose children were in different BMI for age Z-score categories.

Table 33: ANOVA output for BMI for age Z-score categories and health attitudes score. Degrees of freedom = 1 because all children fell into "Above normal range" or "At normal range" BMI for age Z-score categories. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
BMI for age Z-score category	1	0.46	0.463	0.283	0.597
Residuals	53	86.5	1.63		

There was no significant difference in mean health attitudes score between respondents whose children were in different weight for height Z-score categories.

Table 34: ANOVA output for weight for height Z-score categories and health attitudes score. Degrees of freedom = 2 because one or more children fell into each weight for height Z-score category. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
Weight for height Z-score category	2	1.06	0.53	0.321	0.727
Residuals	52	85.9	1.65		

There was no significant difference in mean health attitudes score between respondents whose children were in different height for age Z-score categories.

Table 35: ANOVA output for height for age Z-score categories and health attitudes score. Degrees of freedom = 2 because one or more children fell into each height for age Z-score category. Numbers rounded to three significant figures.

	Degrees of freedom	Sum of squares	Mean square	F value	P
Height for age Z-score category	2	1.59	0.795	0.484	0.619
Residuals	52	85.4	1.64		

Qualitative observations

Healthfulness of available foods

Respondents often assigned staple foods such as rice, beans, and corn tortillas the "very healthy" rank in the four-dimension healthfulness scale. Sufficient volume is one of the most important aspects of child nutrition for ensuring healthy growth. The consistent high availability of these foods, the foods' relative easiness to prepare, and the cultural norm of the foods' essentialness for any meal led many parents to prioritize them in their children's diets. A diet consisting of rice, beans, and corn alone is not a healthy one, but serving these foods regularly is one way parents could try to guarantee that their children ate enough to grow and develop healthily.

Wild-caught versus store bought meats

A common remark of respondents upon being asked to rank the healthfulness of red meat or chicken was a distinction between store-bought and wild-caught meats. Many respondents asserted that store-bought chicken, pork, or beef was very unhealthy while meats from locally raised livestock or wild animals were healthy. This specific remark arose in at least 10 out of 80 questionnaires without solicitation and was also a frequent comment among members of the Project HEAL 2018 research team's host families.

Chispuditos consumption

Parents had myriad ways of serving Chispuditos to their children. Responses were eventually collapsed to "milk" and "water," but original answers included:

1. *Agua y atol de maíz*.....Water and cornflour drink
2. *Agua y azúcar*.....Water and sugar
3. *Agua y dulce de panela*.....Water and unrefined whole sugar
4. *Agua y leche*.....Water and milk
5. *Agua y leche y canela*.....Water and milk and cinnamon
6. *Leche y azúcar*.....Milk and sugar
7. *Leche y azúcar y canela*.....Milk and sugar and cinnamon

When they could, parents often made creative efforts to ensure the supplement was palatable to their children by adding sweeteners or other ingredients that enhanced its flavor and caloric content. This not only raised the odds that children would consume the minimum serving but also the odds that they would enjoy it. Making Chispuditos a daily ritual that children looked forward to helped ensure children's daily consumption of it and thereby MANI's broader goal of healthy child nutrition in Camasca.

Parents' reported serving volume of Chispuditos could divulge a family's experience with food insecurity. The recommended serving volume is one spoonful per day per child. Parents who reported greater portion sizes or more than daily frequency had often finished the prior quarter's ration of Chispuditos long before the beginning of the next quarter, when they could obtain a refill. This behavior could have resulted from household food insecurity which led parents to

serve Chispuditos more often than they should. By parents' logic, Chispuditos could fill the void when not enough beans, rice, or other foods were available for each family member to have a sufficient meal.

Fruit and fruit juices

Fruit juices came in two varieties: pre-bottled and homemade. Homemade fruit juices were often sweetened with white sugar and diluted in water. Their flavors followed indigenous fruits' seasonality; in the summer months, a common fruit beverage is made from *jocote* or hog plum. Respondents did not distinguish between the fresh and prepared varieties when asked to rank the healthfulness of fruit juices. They generally reported fruit juices to be healthy and important for their children to consume frequently.

The healthfulness of fruit juices is complex as they can serve as a source of vitamins from fruit but contain more sugar and less fiber than an equivalent serving of fruit. The greater per serving sugar content of fruit juice make it more palatable to children, increasing their willingness to consume it and thereby of obtaining the important nutrients in fruit. Fruit in itself already contains high amounts of sugar, however; concentrating the sugar and then adding additional sweetener to create a palatable juice reduces the product's health value compared to fruit alone. Fresh juices also differ in healthfulness from prepared ones which contain preservatives, artificial flavors, and flavor enhancers not used at home.

Meal frequency and snacks

All respondents reported three specific times during which their child ate in the day before the questionnaire, indicating that all children received at least three full meals. All but two respondents additionally reported giving their child at least one snack that day. A large majority reported two or more snacks, with about 41% reporting two snacks and more than 60% reporting three or more. Respondents did not specify what snacks consisted of but understood them as a small, incomplete meal with still more substance than just a beverage. Snacks' commonness attested to the availability of food in the community as well as households' general food security.

Discussion

Summary of findings

Within the study sample, child undernutrition was nearly absent. Three-fourths or more of children for whom height and weight data were available were within the healthy range for all three growth outcomes: height for age, weight for height, and BMI for age, which indicate stunting, wasting, and underweight, respectively. For the latter two growth outcomes, equal or greater numbers of children were overweight than underweight. This may suggest that MANI has been successful in minimizing child undernutrition in Camasca. It may also reflect the global trend towards overnutrition as the new scourge to healthy child growth.

Almost all respondents achieved minimum dietary diversity for their child. Most exceeded it, feeding their child from five or more dietary diversity food groups in the day preceding the questionnaire. Although some food groups were more common than others, this finding suggests children in Camasca generally have adequate variety in their diets. The number of snacks the child ate the prior day, low weekly consumption of Chispuditos, and whether the parent was single were most significantly associated with the number of dietary diversity food groups a respondent reported feeding their child from. There was no relationship between the number of dietary diversity food groups a child ate from and whether the child was above, below, or within the normal range for any growth outcome.

Respondents' child nutrition practices scores suggest most parents in Camasca had strong basic knowledge of child nutrition but lacked full understanding of details. Twenty-two predictors were very significantly associated with respondents' child nutrition practices score. Some of these associations were logical and others not, suggesting that low sample size may have hindered the accuracy of results. There was no relationship between child nutrition practices score and whether the child was above, below, or within the normal range for any growth outcome.

Respondents' health attitudes scores suggest most parents know what is and is not healthy for their child as described in the Honduras national dietary guidelines. Nine predictors were very significantly associated with health attitudes score. Most but not all associations were logical, reinforcing the influence of sample size on results. There was no relationship between health attitudes score and whether the child was above, below, or within the normal range for any growth outcome.

Significance of findings

Rural communities like Camasca disproportionately bear the weight of global child undernutrition. This study offers a glimpse into what may predict child undernutrition's unequal distribution at the household and individual levels within such communities. It suggests that how parents prepare food, understand and implement the importance of different food groups, and how they administer a nutritional supplement may predict measures of parents' child nutrition knowledge and best practice. It suggests that parents' own characteristics such as their age, marriage status, and relationship to the child may also predict these measures.

Within the limited scope of this study, the measures of child nutrition knowledge and best practice—dietary diversity score and number, child nutrition practices score, and health attitudes score—do not themselves predict children's growth outcomes in Camasca. They do, however, offer a structured approach to quantifying child nutrition beliefs and practices that may serve useful in a similar study of greater scale.

This study also offers reason to hope for further progress. It demonstrates that efforts thus far may indeed have reduced the disproportionate burden of child undernutrition that Camasca and its analog communities experience.

Child growth outcomes

Most children in Camasca had healthy results for all three growth outcomes. Table 20 shows that 76% of the 55 children were within two standard deviations of the median for height for age, an indicator of stunting in children. About 93% and 95% of children were within the healthy range for weight for height and BMI for age, respectively. In fact, equal numbers of children were overweight and wasted as indicated by weight for height. More children were overweight than underweight as indicated by BMI for age.

These largely optimistic results may attest to the success of the MANI intervention in Camasca since its introduction in 2008. They may also somewhat reflect the shift of the global burden of malnutrition from undernutrition to overnutrition—obesity, overweight, and diet-related noncommunicable diseases such as cardiovascular disease and diabetes. For two out of three child growth outcomes, equal numbers or more children were overweight than underweight. For all three child growth outcomes, however, more than 75% of children for whom data were available were within the normal range. The prevalence of overweight and obesity among Camasca should not be taken to mean undernutrition is no longer an issue nor that nutrition interventions should immediately shift to address overnutrition instead.

Obesity is a chronic, non-communicable disease. Its pattern of spread suggests that classic epidemiological models for infectious disease still apply, however: obesity spreads through social ties (Christakis & Fowler, 2007). A person may be at greater or lesser risk of obesity by nature of their social network. This reinforces the importance of ensuring a basic level of community-wide understanding of nutrition. Ischemic heart disease and diabetes ranked third and eighth, respectively, in causes of disability-adjusted life years (DALYs) in Honduras in 2017 (*Honduras*, 2015). Obesity is a direct risk factor for both. Malnutrition and dietary risks have been the top two drivers of DALYs since 2007, suggesting that human behavior is at the root of chronic diseases' frightening rise in the country (*Honduras*, 2015). Robust nutrition education may be the country's best weapon to beat them back.

Dietary diversity

Outcomes

The WHO identifies minimum dietary diversity for young children as consumption from any four of seven distinct food groups described in Table 3. All but two out of 80 respondents achieved minimum dietary diversity for their child. Most children in fact exceeded minimum dietary diversity by eating from more than four dietary diversity food groups: 25% ate from five food groups, almost 48% ate from six food groups, and 14% ate from all seven food groups. These are encouraging signs that children have sufficient variety in their diets even in more rural parts of Camasca.

Children who achieved minimum dietary diversity disproportionately ate from some food groups, however. Grains, roots, and tubers; Legumes and nuts; and Dairy products were favored by 92% or more of children who achieved minimum dietary diversity. All children who achieved minimum dietary diversity ate from the Grains, roots, and tubers category, unsurprising given the corn-heavy Honduran diet. Few children who achieved minimum dietary diversity are from the Flesh foods category. These distributions reflect the availability of some foods over others in Camasca. Many children ate from the Diary products; Eggs; and fruits and vegetables-inclusive categories, however, minimizing concern for nutrient deficiencies among children in Camasca.

Factors associated with dietary diversity number

Three predictors were associated at a significance level of $p<0.05$ with the number of dietary diversity food groups parents reported feeding their child from. These were the number of snacks parents reported feeding their child the prior day, low weekly frequency of Chispuditos consumption, and whether the parent was single.

A greater number of snacks was associated with a lower dietary diversity number. This suggests that more frequent snacking does not translate to a more varied diet. This may be because the most available foods end up comprising children's snacks. The most available foods will already feature in children's diets and so eating more from the same food group would not improve dietary diversity.

Chispuditos consumption less than five times per week was associated with a lower dietary diversity number. In one way, this finding is counterintuitive. Parents who overfeed Chispuditos to compensate for household food insecurity would be expected to offer less varied food options to their children. In another way, this result is sensible. Parents who can offer more varied food options to their children may be better-resourced and less dependent on Chispuditos to fulfill their children's nutritional needs.

Single parents were more likely to have a higher dietary diversity number, counter to the expectation that dual-parent households would be able to offer more varied foods to their

children. This may be because overall smaller household size translates to more varied food options per child.

Eight predictors were associated at a significance level of $p<0.1$ with the number of dietary diversity food groups parents reported feeding their children from. These were whether they fried their children's food the prior day, parents' healthfulness rating of red meat, eggs, and grilling food, the frequency with which they their child from the Roots food group of the Honduras national dietary guidelines, whether the respondent identified as the child's mother or aunt, and the parent's age at the child's birth.

Relationship between dietary diversity and child growth outcomes

Dietary diversity number was not on average significantly different between children in different Z-score categories for each growth outcome. All children fell into "Above normal range" and "At normal range" Z-score categories for BMI for age, which indicates general undernutrition. One-way analysis of variance (ANOVA) showed that the mean dietary diversity number of respondents whose children fell into these two groups was not significantly different. Weight for height, which indicates wasting, and height for age, which indicates stunting, had children in each Z-score category. ANOVA indicated no significant difference in mean dietary diversity number between children in "Above normal range", "At normal range", and "Below normal range" categories. This is unsurprising given the low variability of growth outcomes within the sample; for all three growth outcomes, 76% or more children were within the normal range.

Parents' aspirational child nutrition practices

Outcomes

Almost 78% of respondents received a child nutrition practices score between 5 and 10 out of a possible 15. The concentration of scores in this range suggests most parents in Camasca had a good base of child nutrition knowledge but few were knowledgeable on details. The standard deviation of 2.4 was high given the limited range of scores from 2 to 12.

Factors associated with aspirational child nutrition practices

Twenty-two predictors were associated with child nutrition practices score at a significance level of $p<0.05$. These were: reported feeding from the Meat and Vegetables dietary diversity food groups the prior day, reported number of meals, late reported breakfast time, reported number of sodas, sweets, and junk foods, Chispuditos portion size, parents' healthfulness rating of fish, eggs, soda, boiling food, and microwaving food, whether the family lived in one of five different Camasca villages, the parent's age at the birth of the child, whether the parent was in a consensual union relationship, and whether the parent reported a university education. Of these, late breakfast (-4.51), number of junk foods (-3.09), healthfulness rating of fish (-9.93), eggs (-10.65) and microwaving food (4.66), the communities (all >7.5), consensual union (4.24), and university education (5.8) had relatively large regression coefficients in absolute value. Many of these associations are logical. Parents who limit the number of junk foods their child consumes may generally exercise better child nutrition practices than parents who do not. Parents with a university education may generally implement better child nutrition practices than less educated parents. They may also be more aware that microwaving is a safe and healthy cooking option. Other associations are less easily explicable or outright counterintuitive. There is no obvious reason why living in particular communities should be associated with a higher child nutrition practices score other than limited sampling of respondents from those areas affecting statistical outcomes. There is no obvious reason why parents living in consensual union should be associated with a higher child nutrition practices score than parents who are married. These results demonstrate the complexity of quantifying and measuring habits related to health outcomes. They also attest to the value of a more simplified approach than this one for a small sample size.

Relationship between aspirational child nutrition practices and child growth outcomes

As with dietary diversity, child nutrition practices score was not on average significantly different between parents of children in different Z-score categories for each growth outcome. ANOVA showed that the mean child nutrition practices score was not significantly different between respondents whose children fell into "Above normal range" and "At normal range" Z-score categories for BMI for age. ANOVA indicated no significant difference in mean child nutrition practices score between children in "Above normal range", "At normal range", and "Below normal range" categories for weight for height nor for height for age Z-score categories. Again, low variability in all three growth outcomes likely shaped these results.

Parents' health attitudes towards child nutrition practices

Outcomes

Most respondents received a health attitudes score of 15-16 out of a possible 20. The range of scores was even more limited than for child nutrition practices, at 11-18. The standard deviation of scores was lower, at 1.3, but carried more weight because of the smaller range. No respondent scored less than half the possible maximum, a positive sign that Camasca parents know what they should about healthy and unhealthy child nutrition practices.

Factors associated with health attitudes towards child nutrition practices

Nine predictors were associated with parents' health attitudes score at a significance of $p<0.05$. These were: reported feeding from the Dairy and Meat dietary diversity food groups, late lunch and dinner times, whether parents boiled or boiled and fried food, how frequently parents aspired for their children to eat vegetables, whether the respondent was the child's mother, whether the parent was unemployed, and reported household monthly income.

Diary and meat consumption in the prior day were positively associated with health attitudes score. Parents who are more able to feed their children from these food groups may generally know more about healthy child nutrition because they may be more educated or better-resourced. Later lunch time was negatively associated with health attitudes score while later dinner time was positively associated with health attitudes score. Possible explanations for these associations are not immediately obvious. Both food preparation methods that included boiling food were positively associated with health attitudes score. This is logical as boiling is generally viewed as a healthier food preparation method than frying food in oil. Oddly, parents who aspired for their children to eat more vegetables tended to receive lower health attitudes scores. This is counter to the expectation that parents who want to feed their child more vegetables know more about what constitutes healthy child nutrition. Also counterintuitive is the finding that monthly income, with a regression coefficient of 0, is a significant predictor of health attitudes score. This may have resulted from most respondents not having a grasp for their household income, generally viewed as the purview of male heads of household and not of female caretakers. Respondents often asked for the question to be repeated before offering a number that seemed to be a guess at best. The remaining two highly significant associations are intuitive, however. Unemployment was negatively associated with health attitudes score. This makes sense given that parents with fewer job prospects may likely have less food options to offer their child, and thus more likely to think any food is a healthy food. Respondents identifying as the child's mother was positively associated with health attitudes score. This latter finding is logical given that mothers tend to invest more in their children's health and thus would seek more knowledge on what their children ought and ought not to eat.

Relationship between health attitudes towards child nutrition practices and child growth outcomes

As with the prior two outcome variables, health attitudes score was not on average significantly different between parents of children in different Z-score categories for each growth outcome. The mean health attitudes score was not significantly different between respondents whose children fell into “Above normal range” and “At normal range” Z-score categories for BMI for age. ANOVA indicated no significant difference in mean health attitudes score between children in “Above normal range”, “At normal range”, and “Below normal range” categories for weight for height nor for height for age Z-score categories. Low variability in all three growth outcomes likely shaped these results.

Limitations

Child growth outcomes

Less than half of respondents in the sample had children with corresponding height and weight data in the MANI database. Of an already limited sample size of 80, only 55 respondents had children whose Z-scores I could calculate and then measure for association with dietary diversity, child nutrition practices, and health attitudes scores. This may have resulted from my arbitrary choice to have participants respond to the questionnaire with respect to how they fed their oldest child. Many parents continued to feed their children Chispuditos after they had reached schooling age although the intervention intends for them to stop once they reach age 6, when children theoretically begin to receive free meals at school. I noticed when aligning the data that children whose height and weight measurements I could not find were often five years old or older. This could also reflect that MANI tends to focus its intervention on younger children within the target age range because nutrition in the earliest years of life is more crucial to long-term health.

The WHO Z-score calculator reference population is of limited relevance to children in Camasca. The reference for children ages 0 to 2 years is based on children in the Ohio Fels Research Institute Longitudinal Study conducted from 1929 to 1975. The reference from 2 to 18 years of age is based on data from three cross-sectional surveys conducted in before 1975. The reference data are thus both outdated and based on a population vastly different from that of Camasca.

Dietary diversity

One day's worth of eating does not reflect an entire childhood. How parents reported feeding their children the day before the questionnaire could have been affected by foods' differing seasonal availability. The corn and bean harvests begin in the summer, for example, so these foods may be more available during the time of the questionnaire than in the winter months. Dietary diversity as a metric does not account for food volume and so is limited in its ability to evaluate the adequacy of a child's diet. Dietary diversity also does not distinguish between different food items within each food group, glossing over significant differences in terms of health consequences of, for example, a fresh homemade tortilla and packaged sandwich bread made from bleached white flour. It was designed to evaluate diets of children aged 6-23 months only and so may be less relevant to the children in this study.

The multiple linear regression with dietary diversity number as the outcome variable from other variables as predictors included many terms for the study's sample size. The model is likely not generalizable for this reason, although its high R-squared value suggests it has high predictability for its outcome measure within the population it examines. The model also did not account for interaction effects between variables, further limiting its applicability.

Aspirational child nutrition practices

Many respondents misinterpreted the questions meant to evaluate their aspirational child nutrition practices. They instead responded with respect to how they actually fed their child, not how they would want to feed their child if they had the means. I learned to repeat the initial phrasing of the question for each question item to minimize this effect, although my efforts did not guarantee that respondents understood the question fully or responded to all question items with the correct interpretation.

Those who understood the intent of these questions may have modified their answers to what they thought was the "correct" answer, a kind of social desirability bias. A good example is sweets, which most parents knew their children should not consume often and so they would report that their children should never eat them, which did not reflect reality. There was also no bowl or other serving item used as a reference for portion size when respondents reported food servings.

The many variables in the questionnaire and small sample size produced a very large multiple linear regression model for predicting parents' child nutrition practices score. This made it challenging to draw confident conclusions from the data as well as generalize findings. The scoring method itself was also novel and untested. It likely included many unnecessary or arbitrary components that were not pertinent to what it intended to measure. As with the model predicting dietary diversity, the model predicting child nutrition practices score did not account for interaction effects between variables.

Health attitudes towards child nutrition practices

Social desirability bias likely affected respondents' health attitudes score more than dietary diversity score or child nutrition practices score. Most parents understood sweets, bottled sodas, and junk foods as unhealthy and reported them as such even though they often permitted or even facilitated their children's consumption of them.

Like the child nutrition practices score, the health attitudes score was an untested construct. Its applicability from small sample size to a large population is likely limited. The multiple linear regression model measuring its association with predictor variables was more concise than the model predicting child nutrition practices score, but still produced surprising results that throw its validity into question. The model did not account for interaction effects between variables, further affecting its applicability.

Conclusion

This study aimed to quantify measures representing child nutrition beliefs and practices of parents in a rural Honduran community. It hoped to capitalize on a bounty of child growth data to explain why child undernutrition affects some more than others where it is already a disproportionate problem. The study's ambition certainly exceeded its actual statistical power. Limited time in the community with limited means of reaching individuals for in-person questionnaires translated to less than ideal numbers from which to produce results. The study's greatest value is perhaps as a template for studies of greater reach and similar ambition to follow.

Information holds power over community health outcomes. Detailed national health guidelines are a credible resource Hondurans can access and trust should they seek to bolster or validate their child nutrition knowledge. Whether Camascan parents drew their knowledge from the Honduran national dietary guidelines was unclear and merits further study.

Education alone is not enough to encourage uptake of information, however. The intervention at the heart of this study may have strengthened community knowledge of child nutrition because it delivers information alongside a tangible, desirable product: the Chispuditos supplement. The apparent success of MANI was likely also tied to its grassroots involvement with its target community; the staff I worked with were almost all locals, not foreigners. These two lessons can inform child nutrition interventions in similar settings around the world.

The study was an incredibly enriching opportunity on a personal level. The people of Camasca are warm, kind, generous, and humble. Without observing people's circumstances, it would be difficult to even perceive a problem through the all-pervasive positivity and sense of gratitude in the community. Words cannot express how thankful I am for the six weeks I spent there.

If nothing else, this study demonstrates that progress on child undernutrition is possible, even in such remote communities as Camasca. Further progress is hopefully on the horizon, even with the major challenge of the COVID-19 pandemic casting its shadow.

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Appendix: Questionnaire instrument

Encuesta Cualitativa – MANI V, Julio 2018

Maya Iskandarani, Project HEAL, Duke University

I. Criterios de inclusión

	Sí	No
1. ¿Su niño tiene entre 4 y 6 años de edad?		
2. ¿Su niño toma Chispuditos actualmente?		
3. ¿Su niño ha tomado Chispuditos por al menos un año?		
4. ¿Su niño tiene alguna enfermedad, malformación u otra incapacidad que podría afectar su habilidad de comer?		

Exceptuando la pregunta 4, si respondió a cualquiera de las preguntas anteriores con "no", el cuidador/la cuidadora principal del niño/a NO participará en el estudio.

Si los padres no desean participar o no firman consentimiento informado, el niño o niña tampoco participará en el estudio.

II. Costumbres alimentares

1. Su niño ayer comió:	Sí	No
a. ¿**Granos** (tortilla, maíz, papilla, atole, pan, arroz, fideos) o **raíces** (papas, yucas, ñame, cebolla, ajo)?		
b. ¿**Frutos secos** o **semillas** (nueces, frijol, lenteja, habas, garbanzos, habichuelas)?		
c. ¿Productos **lácteos** (leche, queso, crema, yogur)?		
d. ¿**Carne** de cualquier animal (vaca, cerdo, cordero, chivo; pollo, pato u otra ave; pescado fresco o seco, conchas o mariscos)?		
e. ¿**Huevos**?		
f. ¿**Vegetales o frutas amarillas** por dentro (calabaza, zanahoria, güicoy, ayote, camote; mango, naranja, papaya, tomate) o **vegetales de hoja verde** oscura (espinaca, acelga, macuy, chipilín)?		
g. ¿Otras **frutas** o **vegetales**?		
2. ¿Cuántas veces su niño comió ayer?		
3. ¿Cuántas veces su niño comió meriendas entre comidas ayer?		
4. ¿A qué horas su niño comió ayer?		
5. Para cada vez que su niño comió ayer, ¿qué tal de grande era la porción de comida? Comida 1		

	Comida 2 Comida 3 Adicionales	
6.	Para cada vez que su niño comió ayer, ¿cómo fue preparada la comida? a. Hervida b. Horneada, sobre fuego o en la parilla c. Frita d. En microondas e. Fría Comida 1 Comida 2 Comida 3 Adicionales	
7.	¿Cuántos jugos o zumos de fruta su niño tomó ayer?	
8.	¿Cuántos frescos o sodas su niño tomó ayer?	
9.	¿Cuántos postres o dulces su niño comió ayer?	
10.	¿Cuántos churros (Tortrix, Takis, Doritos, papas fritas o similar) su niño comió ayer?	
11.	¿Qué tal de grande fue la porción de Chispuditos que su niño consumió ayer? a. Una cucharada (18.75 g) b. Más c. Menos d. Nada	
12.	¿Cómo su niño comió Chispuditos ayer? a. Con agua b. Con leche c. Secos d. Nada	
13.	¿Con qué frecuencia su hijo come Chispuditos? (diariamente, cada x días)	
14.	¿Su niño fue amamantado/le dio pecho la madre al niño?	

III. Conocimiento de la nutrición

15.	¿Qué tal de saludable son los siguientes alimentos? a. Muy saludable b. Más o menos saludable c. Más o menos no saludable d. No saludable

a. Granos (tortilla, maíz, papilla, atole, pan, arroz, fideos)	
b. Raíces (papas, yucas, ñame, cebolla, ajo)	
c. Frutos secos o semillas (nueces, frijol, lenteja, habas, garbanzos, habichuelas)	
d. Productos lácteos (leche, queso, crema, yogur)	
e. Carne roja (vaca/res, cerdo, cordero, chivo; hígado, riñón, corazón, o víscera)	
f. Carne de ave (pollo, pato)	
g. Pescado fresco o seco, conchas o mariscos	
h. Insectos y hormigas	
i. Huevos	
j. Frutas	
k. Vegetales	
l. Pasteles, galletas, chocolates, dulces, caramelos o similar	
m. Churros (Tortrix, Takis, Doritos, papas fritas o similar)	
n. Jugo o zumo de fruta	
o. Frescos o sodas	

16. ¿Qué tal de saludable son las siguientes maneras de preparar comida?
    a. Muy saludable
    b. Más o menos saludable
    c. Más o menos no saludable
    d. No saludable

a. Hervida	
b. Horneada, sobre fuego, en la parilla	
c. Frita	
d. En microondas	
e. Fría	

17. ¿Cuántas veces por semana su niño debe consumir los siguientes alimentos?

a. Granos	
b. Raíces (papas, yucas, ñame, cebolla, ajo)	
c. Frutos secos o semillas (frijol, lenteja, habas, garbanzos, habichuelas)	
d. Productos lácteos (leche, queso, crema, yogur)	
e. Carne roja (vaca/res, cerdo, cordero, chivo; hígado, riñón, corazón, o víscera)	
f. Carne de ave (pollo, pato)	
g. Pescado fresco o seco, conchas o mariscos	
h. Insectos y hormigas	

i. Huevos	
j. Frutas	
k. Vegetales	
l. Pasteles, galletas, chocolates, dulces, caramelos o similar	
m. Churros (Tortrix, Takis, Doritos, papas fritas o similar)	
n. Jugo o zumo de fruta	
o. Frescos o sodas	
18. ¿Qué tal de saludable es para su niño comer dos horas o menos antes de dormir? a. Muy saludable b. Más o menos saludable c. Más o menos no saludable d. No saludable	
19. ¿Qué tal de importante es para su niño comer una variedad de alimentos? a. Muy importante b. Más o menos importante c. Más o menos no importante d. No importante	
20. ¿Qué tal de importante es para su niño comer Chispuditos todos los días? a. Muy importante b. Más o menos importante c. Más o menos no importante d. No importante	

IV. Identificación e información demográfica

21.	¿Cuál es el nombre de su niño?	
22.	¿Cuál es la fecha de nacimiento de su niño? (D-M-Y)	
23.	¿Niño o niña?	
24.	¿En qué comunidad vive?	
25.	¿Cuántas personas viven en la misma casa que su niño?	
26.	Si usted es el cuidador/la cuidadora principal del niño, ¿cuál es su relación?	
27.	Si usted no es el cuidador principal del niño, ¿cuál es la relación entre ellos?	
28.	¿Cuántos años tenía el cuidador principal cuando nació el niño?	
29.	¿Cuál es la ocupación del cuidador principal del niño?	
30.	¿Cuál es el estado civil del cuidador principal del niño?	

	a. Soltero b. Casado c. En una relación, no casado d. Viudo e. Separado o divorciado f. Otro	
31.	¿Cuál fue el último año de escuela que completó el cuidador principal del niño? a. No recibió educación b. Primaria c. Básico d. Diversificado e. Técnico f. Universitario g. No sabe	
32.	¿Cuál fue el ingreso familiar total en lempiras en el mes de junio, antes de pagar impuestos?	
33.	¿Cuántas veces por semana el cuidador principal del niño lee el periódico, escucha la radio o ve las noticias en la televisión?	

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