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Garrett Fox Date

Infant and Young Child Feeding Practices and Undernutrition in Rural El Salvador

By

Garrett Paul Fox

Master of Public Health

Department of Epidemiology

_____

Dr. Aryeh Stein, MPH, PhD
Committee Chair

_____

Dr. Melissa F. Young, PhD
Committee Member

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By

Garrett Paul Fox

Bachelor of Science, Biomedical Sciences
Auburn University
2012

Thesis Committee Chair: Dr. Aryeh Stein, MPH, PhD

An abstract of a thesis submitted to the Faculty of the
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Abstract

Infant and Young Child Feeding Practices and Undernutrition in Rural El Salvador
By Garrett Paul Fox

Background
Child undernutrition can result in irreversible developmental impairments and increased susceptibility to illness and mortality (1). In El Salvador, malnutrition remains a moderate public health problem, with the highest burden among the rural poor (2). In 2014, only 67% of Salvadoran children were receiving a minimum acceptable diet (3). No studies as of yet have used 24-hour diet recalls to measure dietary intakes of children 6 to 24 months in El Salvador.

Objective
This study aimed to characterize infant and young child feeding (IYCF) practices among children 6 to 24 months of age, identify risk factors for anemia and stunting, and provide recommendations for government and nongovernmental nutrition programs and policies.

Methods
A laptop/tablet-based survey was used to collect data on 24-hour dietary recall, IYCF practices, anthropometry, hemoglobin, illness, and use of vitamins/supplements among 138 mother-child pairs in 4 rural municipalities of La Libertad province. These data were linked to baseline data on household demographics. Multivariate linear and logistic regression were used to model the relationship between IYCF practices and height-for-age z-score (HAZ), weight-for-age z-score (WAZ), hemoglobin concentration, stunting, underweight, and anemia.

Results
18% of children were stunted, 9% were underweight, and 58% were anemic. 55% breastfed within 1hr of birth, 62% exclusively breastfed for 6 months, and 59% continued breastfeeding at 2 years. 97% received timely introduction to complementary foods, 75% of children met minimum dietary diversity, and 75% consumed an iron-rich food/fortified foods. 87% consumed a fried food, 79% of children consumed a sugar-sweetened beverage, and 51% consumed a sugary snack in the past day. Sweet bread and thin porridge were associated with lower HAZ and WAZ. Older children and those who had stopped breastfeeding before 15 months were associated with stunting and underweight. Dietary diversity, eggs, sweet bread, bananas, and younger age were associated with improved hemoglobin levels.

Conclusions
While progress has been made in improving basic child-feeding practices in this population, further efforts are required to promote breastfeeding and improve dietary quality. This study provides guidance to improve both program activities and national level child feeding recommendations including: efforts to increase nutrient density of diets, timely introduction of complementary foods, avoidance of non-nutrient dense foods (thin porridges, broths, coffee, sugary snacks, fried foods) and promotion of locally available nutritious foods (avocados and animal-source foods such as eggs and flesh foods).

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Chapter I: Introduction

Background

Child undernutrition, marked by stunting, underweight, and anemia, increases the occurrence, severity and duration of common infections and puts children at a greater risk of mortality (1). Despite reductions in prevalence over the last decade, the global burden of child undernutrition remains immense. Among the estimated 669 million children under 5 years of age in 2015, approximately 156 million were stunted and 273 million were anemic (4, 5). The first two years of life is a period of rapid growth known as a critical window of opportunity in child nutrition (1). If a child fails to receive adequate nutrient intakes during this period, the undernourishment can lead to devastating and often irreversible development impairments including stunted growth, a weaker immune system, and poorer school achievement and work performance (6). For this reason, it is generally recognized that nutrition interventions which successfully increase nutrient intakes during the first 2 years of life may have the greatest impact (7).

According to the latest National Health Survey of El Salvador in 2014, stunting remains a moderate public health problem, estimated to affect 14.0% of children under the age of 5 (3). According to the National Family Health Survey in 2008, the most recent report for which data was available stratified by demographic variables, the children most vulnerable to stunting in El Salvador are those in rural areas, in the bottom quintile of socioeconomic status, and whose mothers had the fewest years of formal schooling (8). Prevalence of stunting has also been found to increase with age and may be slightly more common among Salvadoran boys (3).

Anemia also remains a serious public health concern in El Salvador and may even be on the rise, increasing in prevalence from 19.8% in 2003 to 22.9% in 2008 among children under the age of

5 (5). Prevalence of anemia, like stunting, has been found to be highest among children in rural areas, in the bottom quintile of socioeconomic status, and whose mothers had the fewest years of formal schooling. Unlike stunting, however, anemia prevalence in El Salvador tends to decrease as children get older and appears to affect boys and girls equally (2).

Improvement of infant and young child feeding (IYCF) practices is a highly effective strategy for reduction of stunting and anemia prevalence in low and middle-income countries (9). In 2008, the World Health Organization published a set of evidence-based guidelines—consisting of 8 core indicators and 7 additional indicators of optimal breastfeeding and complementary feeding practices—which if followed, lead to increased nutrient intakes during the first 2 years of life and reduced risk of undernutrition (10). The advantage of these indicators is that they can be assessed with a relatively concise survey and can be compared easily across countries and contexts (11). The percentages of children in El Salvador meeting the WHO IYCF indicators was published in the most recent National Health Survey of El Salvador in 2014. Breastfeeding practices were found to be inadequate in nearly half of mothers, and one-third of children 6 to 23 months of age failed to receive a "minimum acceptable diet" during the previous day (i.e. receiving 4 or more food groups and the minimum meal frequency) (3). While measurement of population-wide adherence to WHO guidelines is very useful for prioritization of national public health programming and messaging, this knowledge alone may not be sufficient to assess the adequacy of IYCF practices, since they are unable to account for the many different types of foods eaten and total nutrient intakes (12). For example, a child that receives a "minimum acceptable diet" during the previous day still may fall short of meeting his or her nutrient requirements for optimal growth (13). As the WHO indicators were designed for ease of data

collection and for making global comparisons, researchers may also overlook potentially important regionally and culturally specific foods, feeding practices, and beliefs which may help local healthcare workers, program managers, and government officials to better understand the nutrition situation of the populations they serve. With access to more in-depth dietary data, public health workers and program managers can glean insights which enable them to create more targeted and contextually relevant nutrition programming, counseling, and messaging for their beneficiaries.

A 24-hour dietary recall is nutritional assessment method which can be used to collect detailed data on daily dietary consumption among individuals and populations (14). While this survey method is more time intensive for the interviewer and interviewee than a survey designed only to measure the WHO indicators, it allows researchers to gain deeper insights into the local nutritional situation. Several useful metrics that can be calculated from 24-hour recall data include the most commonly consumed foods in the population, the average age of introduction for specific foods or food groups, the macronutrients and micronutrients which may be most lacking in the diet, prevalence of potentially problematic or beneficial foods, dietary patterns, or beliefs with regards to nutrition that are prevalent in the population. 24 hour recalls also allow researchers to assess adherence to national dietary guidelines, such as the "Technical Guidelines for the Holistic Care of Children Under 5 Years of Age" published by the Ministry of Health of El Salvador in 2014 (15). These comprehensive guidelines include recommendations for IYCF practices specific to the Salvador context, including: recommended ages of introduction for locally available foods, recommended frequency of meals, and recommended frequency of

breastfeeding according to the age of the infant. Little is known about how well nutritional caretakers understand and adhere to these guidelines in practice.

Research Gap

To our knowledge, no studies have yet been conducted in El Salvador to characterize dietary intakes and assess adherence to Salvadoran IYCF guidelines among children under 2 years of age using 24-hour dietary recalls. Assessments of IYCF practices have so far been limited to national health survey estimates of the percentage of the population meeting the WHO IYCF indicators (3, 8). While the WHO indicators are valuable tools for assessing population level trends in IYCF practices over time, their value for informing public health programs and policies may be limited because of they were not designed to account for specific foods and nutrient intakes. Additionally, their utility for accurately predicting an individual child's nutrition outcome is unclear. According to a 2014 review in Maternal and Child Nutrition of eight studies using national health survey data, associations between the WHO indicators and child stunting and wasting were often inconsistent across countries, likely due to the lack of sensitivity and specificity of many of the indicators (12).

Purpose Statement and Specific Aims

The main objective of this thesis study was to conduct a cross-sectional survey to better understand current IYCF practices and their relationship to undernutrition among children 6 to 24 months of age in rural El Salvador. The survey collected data on breastfeeding practices, dietary intakes, use of vitamin and supplements, anthropometry, hemoglobin, and recent illness.

The specific aims of this study were:

1. To characterize typical child diets in the population in terms of the most (and least) commonly consumed complementary foods
2. To assess adherence to national and international IYCF guidelines
3. To examine associations between IYCF practices, stunting, underweight, and anemia
4. To make contextualized diet-related program and policy recommendations

By better understanding the nutritional context and specific IYCF risk factors of this population, more targeted messages may be incorporated into nutrition guidelines and programs to enhance their effectiveness in preventing undernutrition in this population and similar populations throughout the country.

Project Context

The Salvadoran Foundation for Health and Human Development (FUSAL) provides its flagship infant and young child nutrition program, *Libras De Amor*, to thousands of children under 5 years of age in some of El Salvador's most vulnerable and hard to reach rural regions (16). The program's multidisciplinary teams of Salvadoran doctors, nutritionists, physical therapists, and health promoters carry out a monthly *nutripuntos* (nutrition clinics) in each of their beneficiary communities. Clinic activities include growth monitoring, early stimulation, nutritional counseling, cooking demonstrations, and distribution of food supplements and vitamins (16). In September 2015, The Mathile Institute for the Advancement of Human Nutrition partnered with FUSAL and the Ministry of Health of El Salvador to launch a collaborative project to evaluate the effectiveness of two different micronutrient fortified corn and soy flour blends designed for prevention of child undernutrition in infants and young children, *Chapuditos*® and *Super Cereal*

Plus (17). The evaluation is currently being conducted among more than 2,000 mother-child pairs enrolled in the *Libras De Amor* nutrition program in 4 rural municipalities of La Libertad province: Comasagua, Jicalapa, Tamanique, and Teotepeque. The most recent available National Health Survey with province-specific data estimated 20% of children under 5 years of age in La Libertad province to be stunted in 2008 (8). For the current study, from May 2016 to August 2016, the author conducted interviews among a random sample of 138 mother-child pair participants in the *Libras De Amor* program in La Libertad province using a laptop and tablet-based survey tool. The survey included sections for breastfeeding practices, 24-hour dietary recall, use of vitamins and supplements, anthropometry, hemoglobin, and recent illness. This data was then linked to baseline sociodemographic data gathered from November 2015 to February 2016 by the *Libras De Amor* program to form the final dataset for analysis.

Chapter II: Literature Review

Child Undernutrition

Global Burden of Stunting and Anemia and Impact on Child Health and Development

Child undernutrition, marked by stunting, underweight, and anemia, increases the occurrence, severity and duration of common infections and puts children at a greater risk of mortality (4). Stunting is defined as a height-for-age z-score (HAZ) less than 2 standard deviations below the WHO-established population mean. Anemia in children is defined as a blood hemoglobin level below 11.0 grams per deciliter (5). Despite reductions in prevalence over the last decades, the global burden of child undernutrition remains immense. Among the estimated 669 million children under 5 years of age in 2015, approximately 156 million were stunted and 273 million were anemic (4, 5). It is generally recognized that nutrient intakes during pregnancy and the first two years of life have the greatest impact on long-term health outcomes, as children failing to meet nutrient requirements during this period of rapid development may suffer devastating and often irreversible impairments including stunted growth, weakened immune function, and poorer school achievement and work performance (6, 7).

Demographics and Trends of Undernutrition in El Salvador

Stunting prevalence in Latin America and the Caribbean decreased from 18.4% in 2000 to 11.3% in 2015 (4). In Central America, stunting prevalence ranges from a low of 5.6% in Costa Rica to a high of 46.5% in Guatemala (18). In El Salvador, stunting prevalence among children under the age of 5 fell from 29% in 1998 to 19% in 2008 to 14% in 2014, remaining a moderate public health problem (2, 3). In La Libertad province, where this study was conducted, the most recent national health survey with provincial-level data available estimated 20% of children under 5

years of age to be stunted (8). In the 4 municipalities of La Libertad province where the current study was conducted, a preliminary analysis of baseline data of from The Mathile Institute/FUSAL evaluation study found the prevalence of stunting to be 18.1% in November 2015 among children 6 to 24 months of age (mean HAZ = -0.95) (17).

The most recent National Family Health Survey in El Salvador in 2008 revealed many demographic variables to be highly correlated with stunting. Children of families in the bottom quintile of socioeconomic status are affected disproportionately, with over 31.4% undernourished, compared to only 4.6% in the highest SES quintile (8). Maternal education level has also been found to be strongly related to stunting outcomes. Among mothers who have no formal schooling, 36.6% of children were stunted, whereas only 9.5% of children were stunted among mothers who have 10 or more years of formal schooling (8). Children living in rural areas in El Salvador were also at greater risk for stunting, with an estimated stunting prevalence of 24.2% among rural children and 13.5% among urban children (8). Stunting prevalence was also found to be slightly higher among boys, with a prevalence of 20.4%,

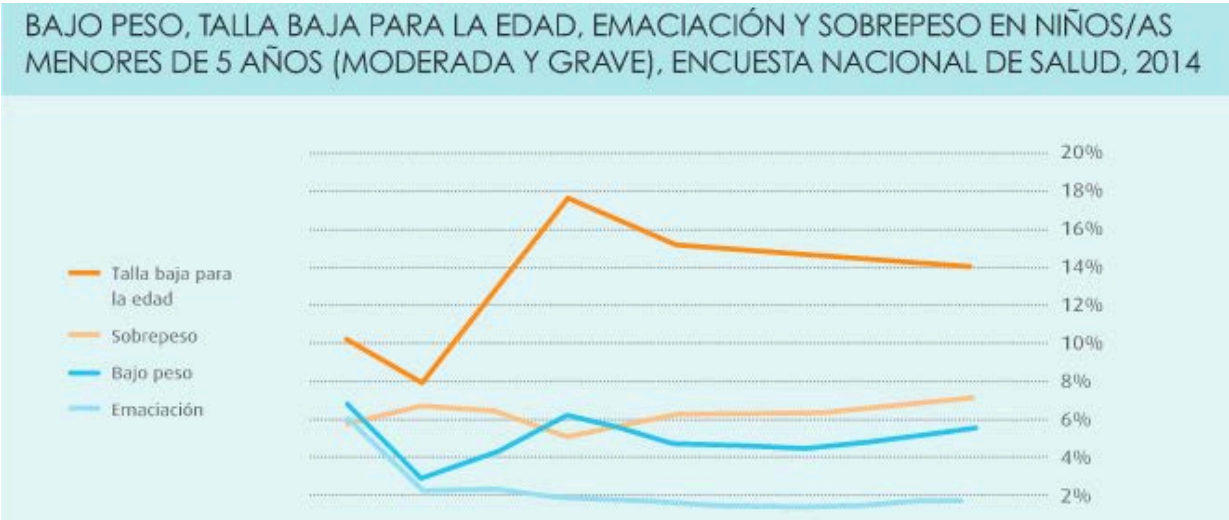

Figure 1. Prevalence of stunting (bold orange), underweight (bold blue), overweight, and emaciation among children under the age of 5 in El Salvador, National Health Survey, 2014

compared to 17.9% in girls (8). As shown in the bold orange line in Figure 1 from the 2014 National Health Survey, stunting prevalence appears to double between 10 months (9%) and 22 months (18%) of age. Prevalence of underweight also doubles from 3% to 6% over this same period (3).

Anemia prevalence among children under 6 years of age also varies widely across Central America, ranging from a low of 4.0% in Costa Rica to a high of 47.7% in Guatemala (19). As shown in Figure 2, the three most recent national surveys that measured hemoglobin levels among children under the age of 5 show anemia to be a moderate and growing public health problem, rising from an overall prevalence of 19.8% in 2003 to 22.9% in 2008 (8) A preliminary analysis of the first 1,064 children enrolled in the Mathile Institute/FUSAL nutrition program and supplement evaluation found an anemia prevalence 49.1% in November 2015 (56.1% among children 6-11 months of age; 38.2% among children 12-23 months of age; mean hemoglobin concentration = 10.9 g/dL), much higher than the national average in 2008 of 30% .

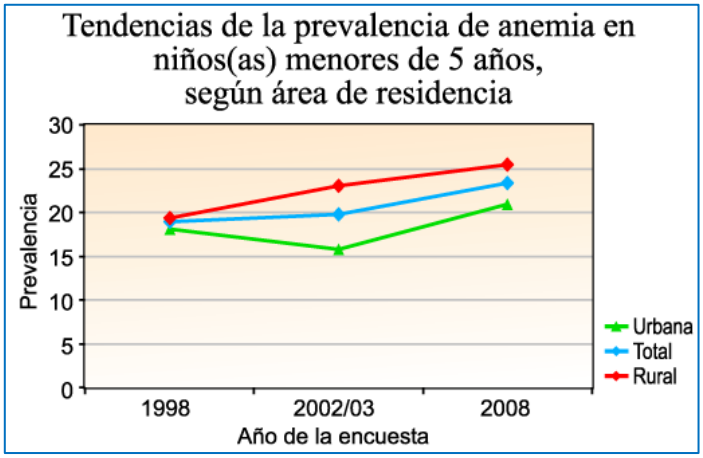

Figure 2. Anemia trends among Salvadoran children under 5 years of age according to area of residence, National Family Health Survey, 2008

The most recent National Health Survey for which a detailed breakdown of demographic data was available revealed many demographic variables that were correlated closely with anemia

prevalence in El Salvador (8). For example, there are great disparities in anemia prevalence between children belonging to the highest and lowest socioeconomic strata in El Salvador. Among children 6 to 23 months of age belonging to families in the bottom quintile of socioeconomic status, over 49.3% were anemic, compared to only 11.0% of children in the highest SES quintile. Maternal education level was also found to be strongly related to anemia prevalence. Among children 12 to 23 months of age whose mothers had no formal schooling, 43.0% were anemic, compared to 28.7% of children whose mothers had 10 or more years of formal schooling (8). Children living in rural areas were also shown to be more at higher risk for anemia. In rural areas, an estimated 43.6% of children 6 to 23 months of age were anemic, compared to 35.4% of children in urban areas (8). As shown in Figure 3, childhood anemia prevalence decreases with age in El Salvador, from 42.0% among children 12-17 months of age to 27.2% among children 18-23 months of age. No significant difference in anemia prevalence was found between male and female children (8).

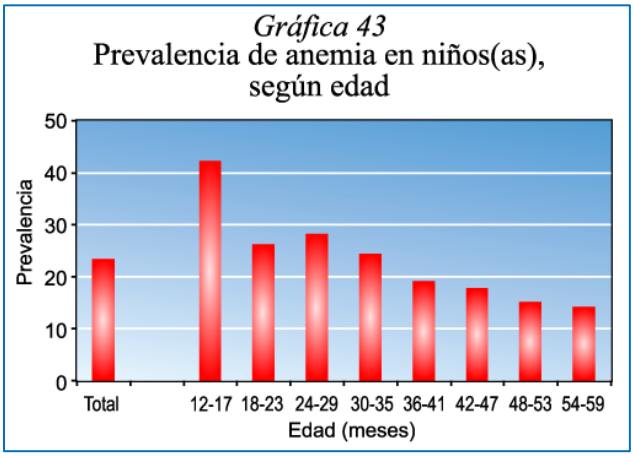

Figure 3. Prevalence of anemia among Salvadoran children 12-59 months of age, National Family Health Survey, 2008

Infant and Young Child Feeding Practices in El Salvador

Breastfeeding Practices

Breastfeeding is one of the most cost effective child survival interventions known, can provide all of a child's nutritional requirements during the first 6 months of life, and continues to be an important nutritional source for the first two years of life (9). In 2008, the World Health Organization published its updated IYCF guidelines, including 8 core indicators for breastfeeding practices and complementary feeding practices which may be measured across countries (10). These 8 core indicators include initiation of breastfeeding within one hour of birth, exclusive breastfeeding for the first 6 months of life, continued breastfeeding at 1 year, timely introduction of complementary foods at 6 months, receiving a minimum dietary diversity of 4 or more food groups per day, receiving the minimum meal frequency (2 times per day for breastfed infants 6-8 months; 3 times per day for breastfed infants 9-23 months; 4 times per day for non-breastfed children 6-23 months), receiving a minimum acceptable diet (receiving the minimum dietary diversity and minimum meal frequency in the same day), and receiving an iron-rich or iron-fortified food in the previous day (10, 11). The most recent cross-sectional National Health Survey of El Salvador in 2014 found inadequate breastfeeding practices among a large portion of the population. 42% of children were put to breast within an hour of birth, 58% of children between 0 and 5 months of age were exclusively breastfed during the previous day, 74.0% of children 12-15 months of age received any breast milk during the previous day, 57.0% of children 20-23 months of age received any breast milk during the previous day, and 48% of children 0 to 23 months of age were fed with a bottle during the previous day. 23 months was the median duration of breastfeeding among children less than 36 months of age (3). These results suggest that one third or more of children in El Salvador may not be receiving the

nutrition they need from breast milk, and efforts to encourage optimum breastfeeding practices remain an important public health strategy.

Complementary Feeding Practices

When breast milk alone no longer meets the nutrient requirements of a growing child, complementary foods should be added to the diet. Because undernutrition often begins between 6 and 24 months of age, appropriate complementary feeding practices during this vulnerable window are extremely important for the prevention of stunting and anemia (9). According to the most recent National Health Survey of El Salvador in 2014, 67% of Salvadoran children 6 to 23 months of age received the minimum acceptable diet of complementary foods during the previous day (3). Looking at the two component measures used to calculate this summary indicator, 78% of children between 6 and 23 months met the minimum dietary diversity and 86% met the minimum meal frequency during the previous day. Among non-breastfed children in the same age group, 83% received at least 2 cow's milk feedings during the previous day and 90% of children had timely introduction of complementary feeding during the recommended window between 6 and 8 months of age. Overall, these results indicate that two-thirds of Salvadoran mothers may be adhering to minimally acceptable IYCF practices, however, it remains unclear whether these children who meet the minimum dietary diversity and minimum meal frequency are in fact receiving the recommended daily amounts of macronutrients and micronutrients needed for proper growth.

Messages to promote improved breastfeeding practices among Salvadoran mothers are relatively straightforward for health workers to communicate and for mothers to interpret (put child to

breast within one hour of birth; exclusively breastfeed child until 6 months; continue breastfeeding for at least a year and 2 years if possible; breastfeed as frequently as the child desires). On the other hand, messages to promote improved complementary feeding practices may be much more difficult for health workers to communicate clearly and concisely and for mothers to remember and interpret correctly due to their length and complexity. To illustrate this point, an extensive list of recommended ages of introduction for many types of locally available complementary food published in the 2014 Salvadoran IYCF guidelines has been translated and reproduced below (15):

Table 1. "Recommendations for Mothers and Caregivers For Feeding of a Healthy Child." Source: Technical Guidelines for the Holistic Care of Children Under 5 Years of Age, Ministry of Health of El Salvador, 2014

Months of age	Recommended Complementary Foods to Introduce to Child
6	• Sweet fruits such as papaya, apple, pear, banana, or mango • Vegetable purees such as potato, carrot, plantain, sweet potato, cassava, squash
7	• Gluten-free grains such as corn, oats, and rice • Legumes such as beans • Oils such as peanut oil, soybean oil, and sunflower oil
8	• Flesh foods (especially white meats like skinless chicken), beef, fish, and liver • Egg yolks (hard-boiled) • Gluten-containing grains (e.g. wheat and barley) as bread, crackers, and noodles • Natural fruit juices. Avoid citrus fruits because of allergic reactions in infants • Avoid foods with seeds such as grapes and raw carrots that can cause choking.
9	• Chopped fruits and vegetables • Lean pork • Ice cream, homemade desserts (e.g. flan, rice pudding, bread pudding) • Avoid egg whites which are not yet assimilated by the digestive enzymes and are considered allergenic
10	• Animal fats (particularly butter) • Half of a corn tortilla 3 times per day • A sweet bread or fruit between meals
11	• Gelatins and cream cheese
12 to 24	• Chocolate • Whole eggs including whites • Other cheeses • Fried foods • Canned meats and ham • Cabbage, cauliflower, broccoli (not introduced previously because of causing flatulence), spinach, and beets. • Two snacks of a sweet bread or fruit between meals • One fried food per day

The basis for many of the above recommendations is unclear, as none of the above guidelines in the technical document were supported with citations from the literature. Additionally, much of the evidence used to form this document and guidelines may be out of date, considering the most recent publication cited in the bibliography was from the year 2003. Lengthy lists of nutritional recommendations such as this one, found on page 95 and 96 of a 147-page technical document are likely difficult for mothers, and perhaps even for health professionals, to remember. Messages that are comparatively short and simple such as "increase dietary diversity" may be much easier to interpret. However, such simplified advice may not provide clear enough guidance to mothers if they wish to make purchasing and cooking decisions according to specific foods which may have the most potential in terms of nutrient density and cost-effectiveness to improve their child's health. This study aimed to more closely examine which foods are contributing the most to child dietary diversity in El Salvador, as well as which locally available foods may have the greatest potential to further increase the diversity and nutrient density of children's diets in El Salvador. This information could be used to better contextualize, target, and simplify messaging of nutritional recommendations to mothers with young children.

Child Dietary Diversity

Child dietary diversity, the number of distinct food groups a child consumes in one day, is typically associated with increased dietary energy intake and nutrient-density and has been found to be associated with improved HAZ and decreased stunting among children 6-23 months of age in many countries. (20-25) Increased child dietary diversity has also been found to be associated with higher hemoglobin levels and reduced rates of anemia (26). The seven WHO-defined food groups for IYCF are: grains, roots, and tubers; legumes and nuts; dairy; flesh foods; eggs;

vitamin A-rich fruits and vegetables; and other fruits and vegetables (10). In 2014, an estimated 22% of infants and young children in El Salvador were not consuming the WHO's recommended minimum dietary diversity of at least 4 food groups (3). 24 hour recalls can be used to help identify which local foods are contributing most to child dietary diversity in the population, as well as which locally available foods may need to be promoted more to increase the diversity, nutrient density, and cost-effectiveness of children's diets (13).

Dietary diversity at the household level has also been found to be associated with stunting (27). One study in 2014 in El Salvador measured household-level dietary quality—defined as adherence to the recommended servings per person for each food group in the 2008 Salvadoran Dietary Guidelines—among a sample of low SES, rural communities. The study found that these families' diets were most deficient in servings of fruit, vegetables, meats, dairy, total fat, and eggs, while simultaneously exceeding recommended intakes of sugar, vitamin A, and iron (28). It is possible that such deficiencies and excesses in household-level diets could be observed in the diets of infants and young children living in these same households. National levels of food production per capita can also influence food availability and prices, and consequently, household food purchases and consumption. Compared to other Latin American and Caribbean countries, El Salvador has some of the highest availability per capita of cereals, legumes, sugar, fruits, and dairy products, and the fifth lowest availability of meat per capita (18). At the same time, El Salvador has one of the highest proportions of income spent on staple foods in the Latin American and Caribbean region, with 33.5% of family income destined towards buying the "basic basket" of staple foods (18). As many as 16.3% of rural Salvadoran families may not be able to cover the cost of the basic basket of staple foods (18). Given these

agro-economic conditions, it is not difficult to imagine that many families may choose to purchase more cereals, legumes, sugar, and dairy foods which have a much lower cost per calorie, and less of the meats, fruits, and vegetables, which have a higher cost per calorie (18).

Sugar-Sweetened Beverages, Sugary Snack Foods, and Overweight/Obesity

Many countries in Latin America including El Salvador are experiencing a "double burden" of undernutrition among children and overweight and obesity among adults, adolescents, and children as they undergo a nutrition transition (29). The 2014 National Survey of Chronic Disease in El Salvador found overweight and obesity now affects an estimated 65.2% of Salvadoran adults over the age of 20 (37.9% overweight; 27.3% obese) and diabetes mellitus affects an estimated 12.5% (30). The 2014 National Health Survey found that 6% of Salvadoran children under the age of 5 are overweight (3). Consumption of sugar-sweetened beverages (SSBs), such as juices and soft drinks, in young children can cause acute health problems such as diarrhea and flatulence, hinder proper growth by reducing consumption of breast milk and displacing more nutritious foods, and increase a child's risk of developing obesity or type 2 diabetes later in adolescence or adulthood (31). 81% of Salvadoran adults consumed sugar-sweetened beverages (30). One study among infants 6 to 8 months of age in a rural area of Nicaragua found that 32% had already consumed SSBs and 42% had already consumed highly processed (HP) snack foods (32). In many countries, the proportion of children under 2 years of age consuming sugary snack foods is higher than the proportion consuming fruit, fortified infant cereals, and eggs (33). In rural areas of El Salvador, beverage and snack companies advertise their products primarily using posters on the walls of small local stores, emphasizing themes of cheap price, fast, and large size (34). Little is known about the prevalence of consumption and

potentially harmful effects of SSBs and HP snack foods among infants and young children in El Salvador.

Programs to Address Child Nutrition in El Salvador

The government of El Salvador currently mandates micronutrient fortification of many of its staple foods, including wheat flour (iron, folic acid, niacin, thiamin), corn flour (iron, folic acid, niacin, thiamin), and sugar (vitamin A), however, to our knowledge, there have been no comprehensive studies to evaluate the impact of large-scale food fortification in El Salvador (18). Another nationwide nutrition program, *Nutrimos El Salvador*, was inaugurated in 2016 by the World Food Programme and the Ministry of Health. The program is currently in its second phase of implementation, with the objective of distributing Super Cereal Plus—a micronutrient fortified supplement made of corn flour, soy flour, sugar, and powdered milk—to thousands of children at risk for undernutrition throughout El Salvador (18). A third nationwide nutrition program, *Libras De Amor*, launched in 2006 by the Salvadoran Foundation for Health and Human Development (FUSAL) provides comprehensive nutritional care to over eleven thousand children in 18 of El Salvador's most impoverished and remote rural municipalities (16). The program's team of doctors, nutritionists, and trained health promoters carry out monthly *nutripuntos* (nutrition clinics) in each of their beneficiary communities consisting of the following activities: growth monitoring, early stimulation, nutritional counseling, cooking demonstrations, and distribution of fortified foods and vitamins. In 2015, The Mathile Institute for the Advancement of Human Nutrition partnered with FUSAL and the Ministry of Health of El Salvador to launch a five-year long evaluation study to compare the effectiveness of Chapuditos®, a micronutrient fortified corn and soy flour supplement, with the current

government standard protocol of Super Cereal Plus and ferrous sulfate drops (17). All participants in the study, in both the treatment and the comparison group, were simultaneously enrolled in FUSAL's *Libras de Amor* nutrition program in 4 rural municipalities of La Libertad province, receiving the same monthly benefits of program activities. The treatment group receives a monthly package of Chapuditos® and is comprised of all *Libras De Amor* participants in the municipalities of Comasagua and Tamanique, while the comparison group receives a monthly package of Super Cereal Plus and ferrous sulfate drops and is comprised of all *Libras De Amor* participants in the municipalities of Jicalapa and Teotepeque. For this thesis project, the author conducted interviews among a random sample of 138 mother-child pair participants in the *Libras De Amor* program and supplement evaluation study in 47 different communities of these 4 municipalities. The survey included sections for breastfeeding practices, 24-hour dietary recall, use of vitamins and supplements, anthropometry, hemoglobin, and recent illness. This data was then linked to baseline data on socioeconomic status and maternal education level gathered a few months prior from November 2015 to February 2016 by FUSAL.

Chapter III: Manuscript

Introduction

Undernutrition, marked by stunted growth, underweight, and anemia, increases the occurrence, severity and duration of common infections and puts infants and young children (IYCF) at a greater risk of mortality (4) . Despite recent reductions in prevalence globally, it is estimated that among children under 5 years of age, 156 million (23%) are stunted and 273 million (43%) are anemic (4, 5). Poor nutrition during the first two years of life can lead to irreversibly stunted growth, impaired cognitive ability and immune function, and poorer school achievement and work performance (6). Interventions to improve child nutritional outcomes may be especially impactful during this critical window of opportunity (7).

Stunting and anemia remain moderate public health problems among children in El Salvador (3, 5). Among Salvadoran children under the age of 5, it is estimated that 14% are stunted and 30% are anemic (3, 8). Anemia is estimated to affect 40% of children 12-17 months of age and 26% of children 18-23 months of age (8). Rural Salvadoran children may be twice as likely to be undernourished as their urban counterparts, yet little is known about infant and young child feeding (IYCF) practices at the level of specific foods and their relationships to undernutrition among these vulnerable populations (3).

At the same time, El Salvador is experiencing a growing burden of overweight and obesity, now estimated to affect 65.2% of Salvadoran adults and 6% of children under the age of 5 (30). This nutritional dual burden (stunted or underweight children living in the same household or community as overweight or obese children and adults) is a trend becoming all too common

across Latin America among countries undergoing a nutritional transition (29). Studies have demonstrated that dietary patterns begun early in life during the complementary feeding period are strongly associated with future obesogenic and/or diabetogenic dietary patterns later in childhood, adolescence, and adulthood (35) (36) (37).

Improvement of IYCF practices are a key strategy to improving child growth and development (9). The World Health Organization has published general guiding principles of recommended IYCF practices which may be promoted and assessed by measuring 8 core indicators (10, 11). According to a 2014 review of eight studies using national health surveys, associations between the WHO indicators and child stunting and wasting were often inconsistent across countries, likely due to the lack of sensitivity and specificity of many of the indicators (12). As a result, additional dietary information at the more detailed level of specific foods, portion sizes, macronutrients, and micronutrients may be necessary to understand how specific IYCF practices relate to stunting and anemia in the Salvadoran context. In 2014, the Ministry of Health of El Salvador published its most updated version of IYCF guidelines with a detailed list of recommendations including: age of introduction for specific complementary foods, recommended frequencies of meals and breastmilk feedings by age, and recommended methods for preparing locally available foods (15). Little is known about how well Salvadoran mothers adhere to these guidelines in practice.

The objective of this study was to assess IYCF practices, including dietary intakes using a 24-hour recall, to characterize child diets in rural El Salvador, identify potential risk factors for stunting, underweight, and anemia among children 6 to 24 months of age, and provide targeted

recommendations to government and non-governmental organizations conducting nutrition programs in these regions.

Program Description

The current study is part of a larger evaluation study occurring within the Salvadoran Foundation for Health and Human Development's (FUSAL) flagship infant and young child nutrition program, *Libras De Amor* (16). This program serves over ten thousand children in some of El Salvador's most vulnerable and remote rural regions. The program's team of doctors, nutritionists, and trained health promoters carry out monthly nutrition clinics in each of their beneficiary communities consisting of the following components: growth monitoring, early stimulation, nutritional counseling, cooking demonstration, and food/supplement distribution (16). In September 2015, The Mathile Institute for the Advancement of Human Nutrition partnered with FUSAL and the Ministry of Health to launch an evaluation study to compare the effectiveness of two different fortified supplement regimens, Chapuditos® fortified corn-soy blend vs. Super Cereal Plus fortified corn-soy-milk-sugar blend and ferrous sulfate drops, distributed to all participants of FUSAL's *Libras De Amor* program in 4 rural municipalities of La Libertad province: Comasagua, Jicalapa, Tamanique, and Teotepeque. The larger evaluation study aims to assess the impact of the program's educational activities, the effectiveness of the fortified corn and soy flour blends, and the relationship between IYCF practices, growth, and hemoglobin levels.

Methods

Study Setting and Participants

To assess IYCF practices, dietary intakes, and use of vitamin and supplements, a sample of 138 mother-child pairs participating in the *Libras De Amor* program were randomly selected and enrolled in the current study from May 2016 to August 2016. This sample included participants from 47 communities in 4 municipalities of La Libertad province. Among all mothers who attended *Libras De Amor* program activities, mothers were randomly selected and consented to participate in an interview. Ethics approval was obtained from National Committee of Health Research Ethics of El Salvador (IRB No. 0005660) and the Emory Institutional Review Board. Interviews lasted 30 to 45 minutes on average and all answers were recorded electronically. The first 42 interviews were collected in Microsoft Word survey forms on a laptop. The data for the remaining 96 interviews were collected on Android tablets using a survey application designed with CommCare® software.

Anthropometry, age, sex, and illness data

At each monthly site visit, children were measured on site by trained FUSAL staff, with length/height and weight recorded in the program database. Length was measured using a wooden reclined stadiometer (Shorrboard®) and recorded with a precision of 0.1cm. Weight was measured using a digital scale (Tanita HD 314®) with a precision of 0.05kg, and all weights were measured in duplicate and averaged. The child's sex and birth date were recorded from the child's government-issued immunization and growth monitoring pamphlet or otherwise from FUSAL's program participant database, from which an exact age in days was calculated. Height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), and weight-for-height z-scores

were calculated from the height, weight, and age data using a SAS program for the WHO Growth Charts (38). Overall stunting was classified as HAZ < -2, further categorized into severe stunting (HAZ < -3), moderate stunting (-3 ≥ HAZ < -2), and mild stunting (-2 ≥ HAZ < -1). Overall underweight was defined as WAZ < -2.0. All 138 children had complete anthropometry data. Data from 3 stunted children who were premature and/or hospitalized for 1 month or more due to birth complications were included in Table 1 and food counts but excluded from diet-disease models due to the strong confounding effect with stunting and anemia. Mothers were also asked if the child had experienced symptoms of acute respiratory infection or diarrhea in the past week.

Hemoglobin data

All hemoglobin concentrations were measured by a trained physician. Blood was drawn using a finger prick, loaded into a glass slide, and placed into the Hemocue Hb 201® device for processing. For 54% (n=74) of children, hemoglobin was measured on the same day as the dietary assessment interview. For 20% (n=27) of children, hemoglobin concentration measured 28-38 days prior to the dietary assessment was available. For an additional 20% (n=27) of children, hemoglobin concentration measured 52-63 days prior to the dietary assessment was available. Anemia was defined as a blood hemoglobin concentration below 11.0 g/dL.

Socioeconomic and demographic data

From November 2015 to February 2016, socioeconomic and demographic questionnaires were administered to enrollees to collect information on household assets, parental income, maternal

age, and maternal education (years of formal schooling). A wealth index was created from these variables using SAS 9.3's principal component analysis procedure to create a standardized index score, which was then split into quintiles. Data on wealth index and maternal education were missing for 4 study participants. The variable, "Treatment group", was coded as 1 if child resided in the municipalities of Comasagua or Tamanique (assigned to receive Chapuditos®) and 0 if residing in the municipalities of Jicalapa or Teotepeque (assigned to receive Super Cereal Plus and ferrous sulfate drops).

Child feeding practices and dietary assessment

The survey included a 24-h dietary recall, in which the interviewer assisted the primary caregiver to describe all foods and beverages the child consumed the previous day and night. The primary caregiver was the mother in all but 2 cases, therefore, primary caregivers will henceforth be referred to as mothers. The 24-h recall followed the multiple-pass method, using calibrated dishes, cups, bottles, spoons, and salted replicas of common foods such as tortillas, beans, potatoes, and cheese for more accurate portion size estimation (14). 24-h recall items were later categorized into one of seven IYCF food groups defined by the WHO to calculate the total number of different food groups consumed by each infant during the previous day, known as the dietary diversity (DD) score (11). 24-h recall items were also later assigned a code according to their corresponding code in the most recent edition of the Nutrition Institute of Central America and Panama (INCAP) Food Composition Table (39). To assess changing diet, children were stratified into the following age groups: 6.0-8.9 months, 9.0-11.9 months, 12.0-17.9 months, and 18-23.9 months. Information was also collected on age of introduction to complementary foods,

first foods, early initiation of breastfeeding, continued breastfeeding, and months of exclusive breastfeeding.

Data Analysis

Data analysis was performed in SAS (version 9.3, SAS Institute). Descriptive statistics were obtained using univariate analysis and frequency commands. Multiple linear regression modeling was used to identify variables significantly associated with height-for-age z-score, weight-for-age z-score, and hemoglobin concentration and beta coefficients and p-values were recorded. Multiple logistic regression modeling was used to identify variables significantly associated with stunting, underweight, and anemia and odds ratios, Wald 95% confidence intervals, and p-values were recorded. Model selection began with the identification of significant variables from bivariate analyses and addition of variables suggested as potentially important from the literature review. Collinearity was assessed by examining variance inflation factors (<10). When two variables were correlated (Pearson correlation coefficient $r > 0.25$; $p < 0.05$), the variable with the lower p-value was selected. Statistical significance was considered at $p < 0.05$.

Results

Study participants

The characteristics of 138 children and their caregivers that participated in this study are shown in Table 1.

Table 1. Characteristics of 138 infants and young children from 47 communities in 4 rural municipalities of La Libertad province, El Salvador

Characteristic	% or mean ± SD
Child age (months)	
6-8.9 months	21.7%
9-11.9 months	22.5%
12-17.9 months	23.9%
18-24 months	31.9%
Child sex (female)	44.2%
Child height-for-age- z-score (HAZ)	-1.07 ±1.2
Child stunting	18.8%
Child weight-for-age z-score (WAZ)	-0.56 ± 1.1
Child underweight	9.4%
Child wasting	4.4%
Child overweight	1.5%
Child hemoglobin concentration [a] (g/dL)	10.7 ± 1.0
Child anemia [a] (Hb < 11.0)	56.8%
Maternal age [b] (years)	26.4 ± 6.1
Maternal education [b] (years)	5.6 ± 3.4
Monthly family income [b] ($)	132.6 ±120.6
Municipality of residence	
Comasagua	40 (29.0%)
Jicalapa	26 (18.8%)
Tamanique	36 (26.1%)
Teotepeque	36 (26.1%)

[a] Measured on same day as 24-h recall interview for 74 participants

[b] Data available for 134 participants

Stunting, underweight, and anemia prevalence

The overall prevalence of stunting was 18.8%, with 13.0% moderately stunted, 5.8% severely stunted, 33.3% of children mildly stunted, 47.8% were classified as normal. As shown in Figure 1, a significant decrease in mean HAZ, WAZ, and WHZ was observed as age increases from 6 to 24 months, with a concurrent increase in stunting, underweight, and wasting. Mean HAZ, WAZ, and WHZ did not vary significantly when stratified by socioeconomic status, maternal education level, or sex.

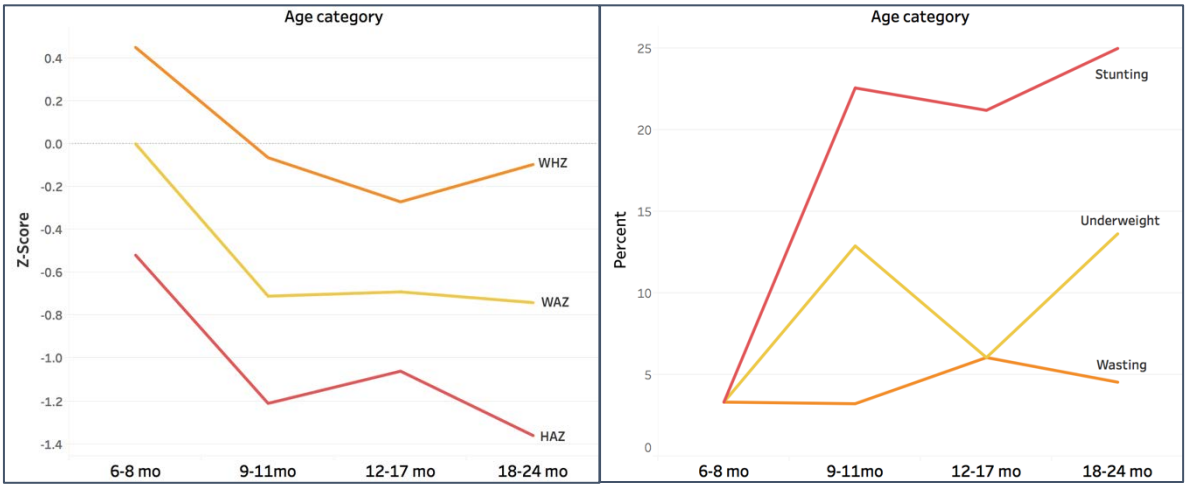

Figure 1. Height-for-age, weight-for-age, and weight-for-height z-scores and concurrent growth outcomes among 138 infants and young children 6 to 24 months of age in 4 rural municipalities of El Salvador

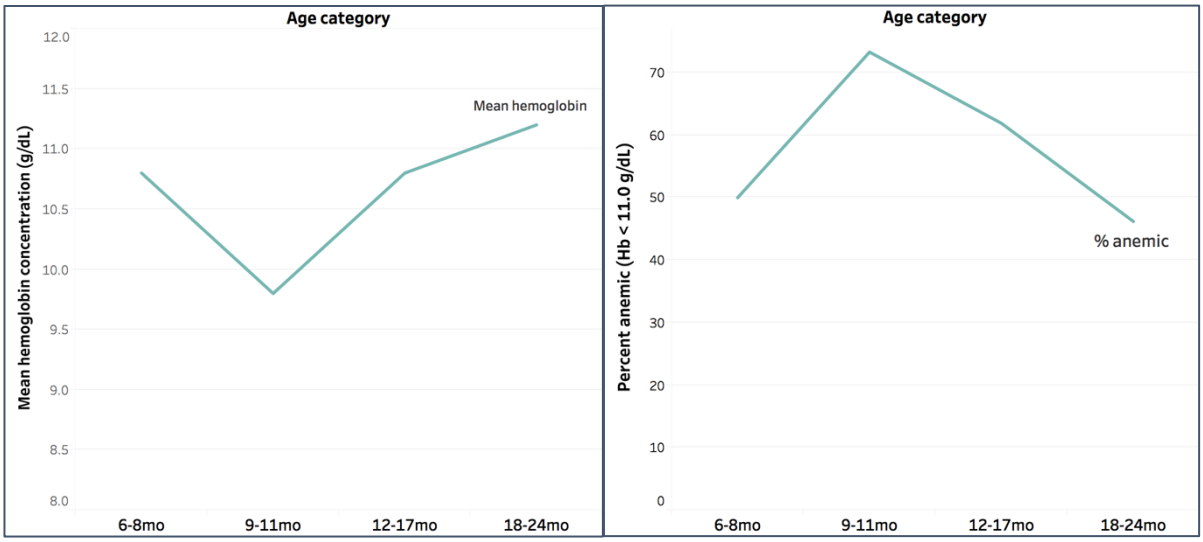

***Figure 2*.** Mean hemoglobin concentration and anemia prevalence by age groups among 74 infants and young children 6 to 24 months of age in 4 rural municipalities of El Salvador

As shown in Figure 2, a significant increase in mean hemoglobin is observed as age group increases from 6 to 24 months, with a concurrent decrease in anemia prevalence as age group increases. Mean hemoglobin and anemia prevalence did not vary significantly when stratified by socioeconomic level, maternal education years, or sex. 15.2% of children were reported to have had respiratory infection within the last week and 10.1% were reported to have had diarrhea within the last week.

WHO Infant and Young Child Feeding Indicators

The percent of the study population meeting each of the WHO's Infant and Young Child Feeding Indicators is shown in Table 2.

Table 2. WHO Infant and Young Child Feeding Indicators [a] among 138 children in 4 rural municipalities of La Libertad province, El Salvador

IYCF Indicator	*n*	% meeting indicator	% meeting indicator nationally [b]	Definition of indicator
1. Early initiation of breastfeeding	56	55%	42%	% of children reported to have been put to breast within 1h of birth
2. Exclusive breastfeeding for 6 months	61	62%	58%	% of infants reported to have been fed only breast milk until 6 months
3. Continued breastfeeding at 1 year	22	95%	74%	% of children 12-15 months of age fed breastmilk
4. Introduction of solid, semi-solid, soft foods	31	97%	90%	% of children 6-9 months of age who received solid, semi-solid, or soft foods
5. Minimum dietary diversity	138	75%	78%	% of children 6-24 months of age who received ≥4 food groups
8. Consumption of iron-rich or iron-fortified foods	138	75%	--	% of children 6-24 months of age who received an iron-rich food or iron-fortified food for children
9. Children ever breastfed	138	97%	96%	% of children < 24 months who were ever breastfed
10. Continued breastfeeding at 2 years	22	59%	57%	% of children 20-23 months of age received any breast milk during previous day

[a] (World Health Organization, WHO 2008) Meal frequency data for indicators 6 and 7 were not available

[b] Data source: Ministry of Health of El Salvador, National Health Survey, 2014

Breastfeeding and bottle-feeding

55% of children were put to breast within 1 hour of birth, 62% of mothers reported exclusive breastfeeding during the first 6 months, 95% of mothers continued breastfeeding at 1 year, and 59% continued breastfeeding at 2 years. Of the 19% of mothers who were no longer breastfeeding at the time of the interview, 4 never breastfed their child at all, and the remaining 15 reported a mean age of cessation of breastfeeding of 11 months (note: this is much earlier cessation than the national average of 23 months). As shown in Figure 4, 88% of mothers of children between 6 and 17 months of age were breastfeeding, at which point breastfeeding prevalence drops to 64% for those between 18 and 23 months of age. 44% of children were fed from a bottle during the previous day, an average of 3.2 times per day. Breaking down this 44% of bottle-fed children, the most common bottle ingredients, usually mixed with water, were powdered milk (27%), fortified cereal/corn-soy blends (14%), and baby formula (5%).

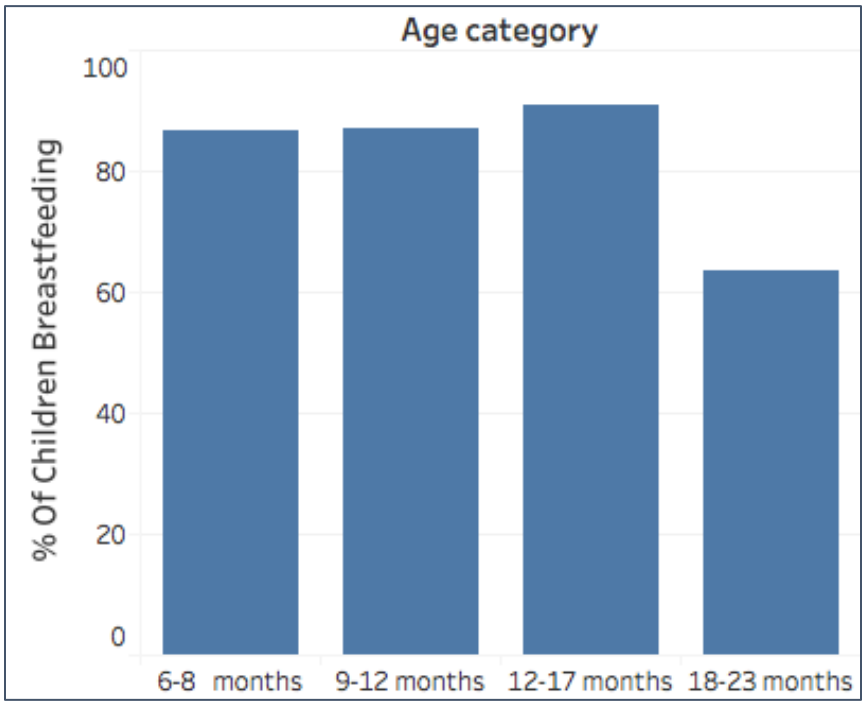

Figure 4. Percent of children still breastfeeding by age group among 138 mother-child pairs in 4 rural municipalities of La Libertad province, El Salvador

Introduction to complementary foods

From the 24-h recall data, 97% of infants between 6 and 8 months of age consumed a solid, semi-solid, or soft food during the previous day. However, as shown in Figure 5, when a subsample of 56 mothers were asked to recall at what age they introduced the first solid, semi-soft, or soft food to their child, 6% of these mothers reported starting CF at 3 months of age, while 10% reported starting CF later than recommended at 7 or 8 months of age. Potato was by

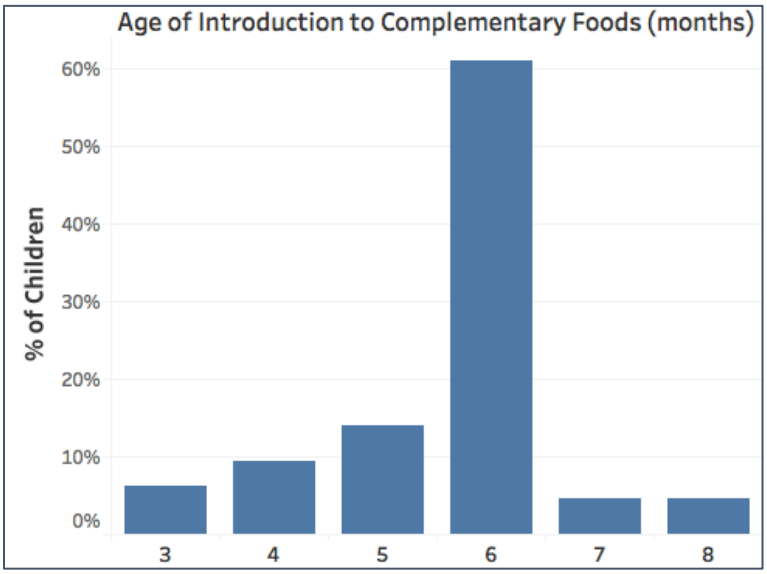

Figure 5. Reported age of introduction of first complementary food among a subsample (n=56) of mother-child pairs in 4 rural municipalities of La Libertad province, El Salvador

far the most commonly reported first foods introduced at weaning, consumed by 57% of children, followed by güisquil (13%), Nestum®/Gerber® cereal (13%), bean broth (11%), banana (8%), processed fruit puree (8%), and soup (8%).

Introduction to flesh foods and eggs

As mentioned, WHO guidelines recommend introduction to CF at 6 months, while some international guidelines recommend 4 to 6 months as a safe and optimal age of introduction to flesh foods and eggs along with all other CF (10, 40). Salvadoran IYCF guidelines recommend delaying introduction of flesh foods and egg yolks until 8 months of age, although the evidence

base for this recommendation is unclear (15). As shown in Figure 6, many mothers delayed the introduction of flesh foods and egg yolks well later than recommended by both international and Salvadoran guidelines. 28% of children in the sample had never been introduced to a flesh food at all and 22% had never been introduced to eggs. 68% of these children who had never been introduced to a flesh food and 54% of those who had never been introduced to eggs were already 8 months or older, some as old as 21 months. When mothers who had not introduced eggs were asked why they had delayed or chosen not to introduce eggs, 24% (11 of 45) mothers cited nutritional advice from a health professional to avoid eggs and/or egg yolks entirely, or to introduce eggs after 12 months, because of alleged allergenic or diarrheagenic properties. lending evidence to these qualitative reports. Lending evidence to these qualitative reports, among mothers who introduced eggs at 9 months or later, the mean age of introduction to eggs was 12 months. No children in the sample had a current egg allergy. 1 child experienced symptoms of an egg allergy when introduced to egg at 12 months. This same child was introduced to egg again at 23 months successfully with no allergic reaction.

Dietary Diversity

During the previous day, 75.3% of children received the WHO's recommended minimum dietary diversity of 4 or more food groups. As shown in Figure 3, the most commonly consumed food groups were grains, roots, and tubers (97.8%), dairy (84.8%), legumes (76.8%), and other fruits and vegetables (68.8%). Less frequently consumed were vitamin A-rich fruits and vegetables (37.7%), eggs (32.6%), and flesh foods (21.7%). Overall child dietary diversity score did not vary significantly with age ($p=0.49$), socioeconomic status ($p=0.40$), or maternal education level ($p=0.47$).

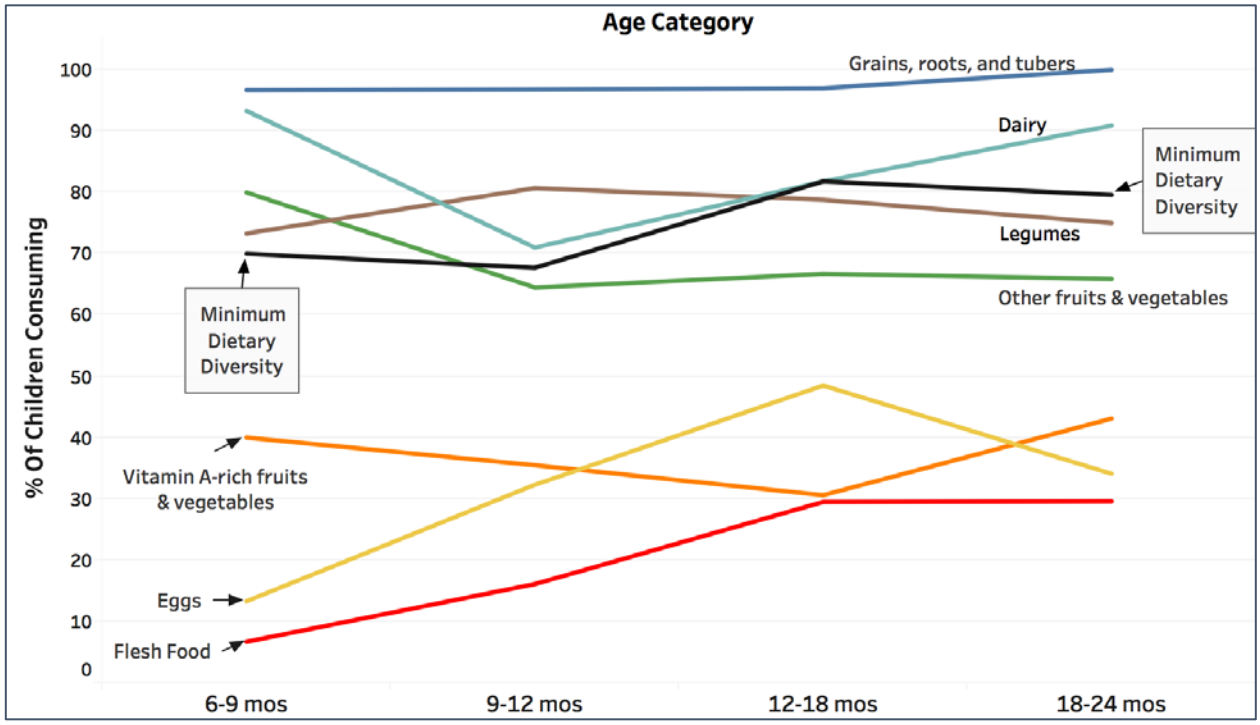

Figure 6. Dietary diversity among infants and young children 6-24 months in rural El Salvador, measured by % of children in each age group consuming that food group in a single 24-h recall

Most commonly consumed foods and beverages from 24-hour recall

As shown in Table 3, the most commonly consumed foods and beverages by children 6 to 24 months of age during the previous day from the 24-h recalls were corn tortilla, fortified starch blend, bean, fruit fresco/juice, potato, cheese, sugary snack, soup, rice, milk, bean broth, banana, cream, egg, sweet bread, plantain, güisquil (local squash variety), cookie, bread, carrot, chicken, tomato, apple, pasta, coffee, mango, and processed fruit puree (Gerber®, Heinz®). The most commonly consumed solid or semi-solid foods were corn tortilla (84%) and pureed beans (62%). During the previous day, 51% of children consumed a form of soup: 14% soup with starch only (e.g. noodle, rice, potato), 31% soup with starch and vegetables (e.g. carrot, güisquil), and 6% soup with starch, vegetables, and protein (e.g. chicken breast, egg, soy protein). Bean broth was typically served in a bowl along with small amounts of corn tortilla, cheese, or cream.

Table 3. Most commonly consumed complementary foods and beverages from 24 hour recalls among 138 children 6 to 24 months of age in 4 rural municipalities of La Libertad province, El Salvador

	Children consuming		Times per Day		Households consuming[c]
Food or beverage	*n*	Percent	Mean	SD	Percent
Corn tortilla	114	83%	1.8	0.8	94%
Beans or bean broth	110	80%	1.8	0.7	84%
Fortified starch blend [a]	97	70%	1.8	1.0	--
Cheese/cream	92	67%	1.7	0.9	--
Beans (pureed/fried)	85	62%	1.6	0.8	84%
Fruit fresco/juice	84	61%	1.3	0.6	55%
Potato	81	59%	1.3	0.5	68%
Banana/plantain	73	53%	1.2	0.4	--
Soup	71	51%	1.1	0.3	77%
Cheese	70	51%	1.4	0.7	81%
Sugary snack [b]	70	51%	1.3	0.5	--
Milk	69	50%	1.6	0.9	25%
Rice	68	49%	1.1	0.4	85%
Bean broth	59	43%	1.1	0.4	--
Sugar	59	43%	1.1	0.4	81%
Banana	52	38%	1.1	0.4	43%
Cream	47	34%	1.1	0.3	47%
Egg	45	33%	1.1	0.3	88%
Sweet bread	43	31%	1.1	0.3	87%
Plantain	37	27%	1.0	0.2	43%
Güisquil (squash)	35	25%	1.1	0.3	37%
Cookie	35	25%	1.1	0.2	47%
French bread	32	23%	1.0	0.0	80%
Carrot	27	20%	1.1	0.4	24%
Chicken	21	15%	1.0	0.0	68%
Tomato	19	14%	1.1	0.1	86%
Apple	18	13%	1.0	0.0	21%
Pasta noodles	15	11%	1.1	0.2	40%
Coffee	15	11%	1.0	0.0	--
Mango	13	9%	1.1	0.1	21%
Processed fruit puree	13	9%	1.0	0.0	--

[a] 46% Chapuditos®, 20% Super Cereal Plus/"incaparina", 7% Nestum® cereal, 4% Potato-W®, 2% Manna Pack® Rice/Soy

[b] 31% sweet bread, 25% cookies, 3% other sweets/dessert (cake, jelly, flan, chocolate)

[c] Rural households consuming these foods nationwide based on 2006 food expenditure data, ENIGH-2006

The most commonly consumed animal-source foods were cheese (51%), cow's milk (50%) cream (34%), eggs (33%), and chicken meat (15%), yogurt (7%), hot dog/chorizo (4%), shrimp (2%), fish (1%), and chicken liver (1%). The most commonly consumed vegetables were güisquil (25%; a local squash variety), carrot (20%), tomato (14%), leafy greens (11%), spaghetti sauce (10%), *pipián* (7%; a local squash variety), mora leaf (7%), onion (4%), green bean (3%), cucumber (2%), celery (1%). The most commonly consumed vitamin A-rich vegetables, 99% of which were consumed chopped and boiled in soup, were carrot (20%), leafy greens (11%: 9% chipilín, 1% chaya, 1% spinach), and *pipián* squash (7%). Most vegetables and meats were served chopped and boiled in soups (e.g. dehydrated noodle soup with water, potato, rice, carrot, güisquil, and/or chipilín). 30% of soups contained only water and a starch (e.g. potatoes, noodles, or rice) with no vegetables or meat. Only 5% of children consumed a vegetable in a form besides soup (e.g. puree of güisquil, carrot). The most commonly consumed fruits, typically consumed raw or sometimes as a puree, were banana (38%), apple (13%), mango (10%), processed fruit purees (9%), avocado (4%), orange (4%), and watermelon (3%). The only vitamin-A rich fruit consumed was mango (10%). The most common beverages *atol/fresco* of Chapuditos® or Super Cereal Plus (63%), cow's milk (50%: 47% powdered; 3% liquid), *fresco natural* (41%; juice made with real fruit), processed juice (28%), coffee (11%), *Nestum*® cereal (7%), yogurt (7%), baby formula (5%), and artificially fruit-flavored *fresco* (5%).

Low nutrient-density foods

As shown in Figure 7, consumption of low-nutrient density foods began early at 6-8 months and increased with age. 78% of children consumed a sugar-sweetened beverage (juice, fresco, atol, milk, coffee with sugar). 51% of children consumed a sugary snack (31% sweet bread, 25% cookies, 4% other) and 87% consumed a fried food.

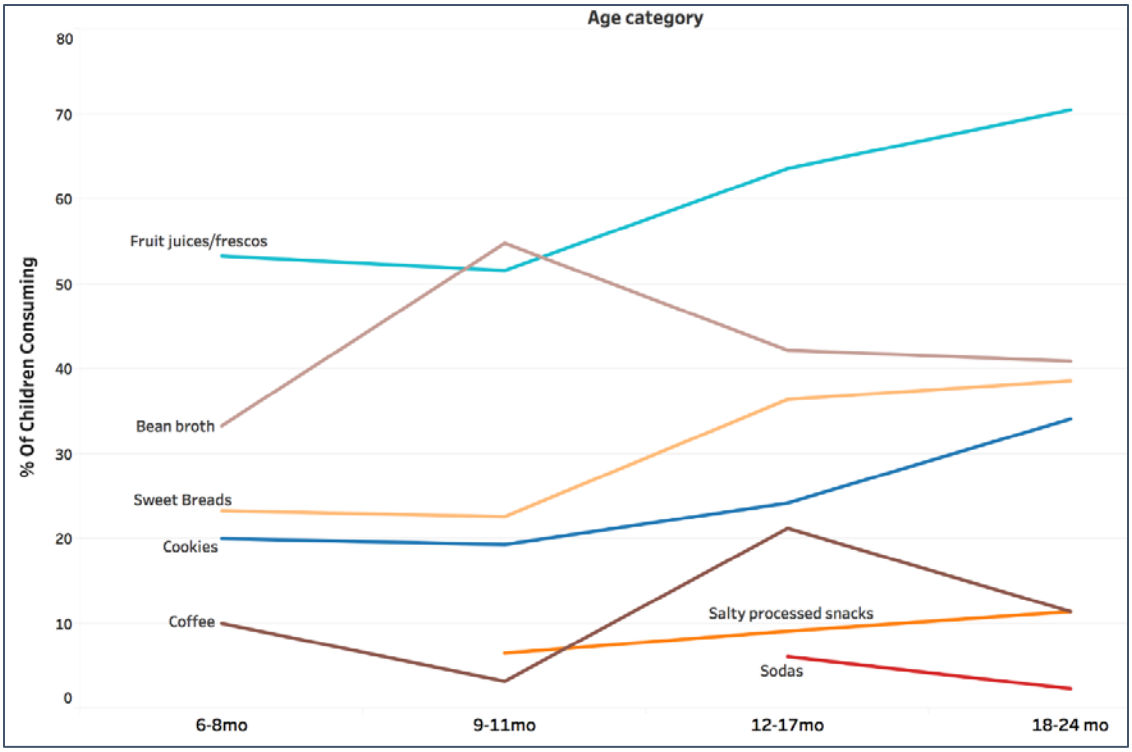

Figure 7. Consumption of low-nutrient density foods and beverages by age group in 4 rural municipalities in La Libertad province, El Salvador

High nutrient density foods

As shown in Table 4, besides eggs and chicken, other locally available animal-source foods and avocados were rarely consumed compared to the number of low-income and rural households reported to consume these foods in national household expenditure surveys (41).

Table 4. Consumption of selected locally available nutrient dense foods among 138 children 6 to 24 months of age in 4 rural municipalities of La Libertad province, El Salvador

	Percent of children consumed item yesterday[a]	Percent of children consumed item ever[a]	Percent of households consumed item[b]
Foods			Percent
Fish/seafood	3%	47%	43%
Sausages	4%	8%	31%
Beef	<1%	29%	21%
Avocado	5%	56%	21%
Liver	<1%	37%	NA

[a] Children > 8 months only. 8 months is age of introduction for ASF in Salvadoran IYCF guidelines

[b] Among rural households surveyed in the National Survey of Household Expenditures, ENIGH 2006

Fortified foods designed especially for children

As shown in Figure 8, consumption of fortified foods was much higher among the treatment group (Comasagua, Tamanique) than the comparison group (Jicalapa, Teotepeque). 70% of all children (97 of 138) consumed a fortified food designed especially for children during the

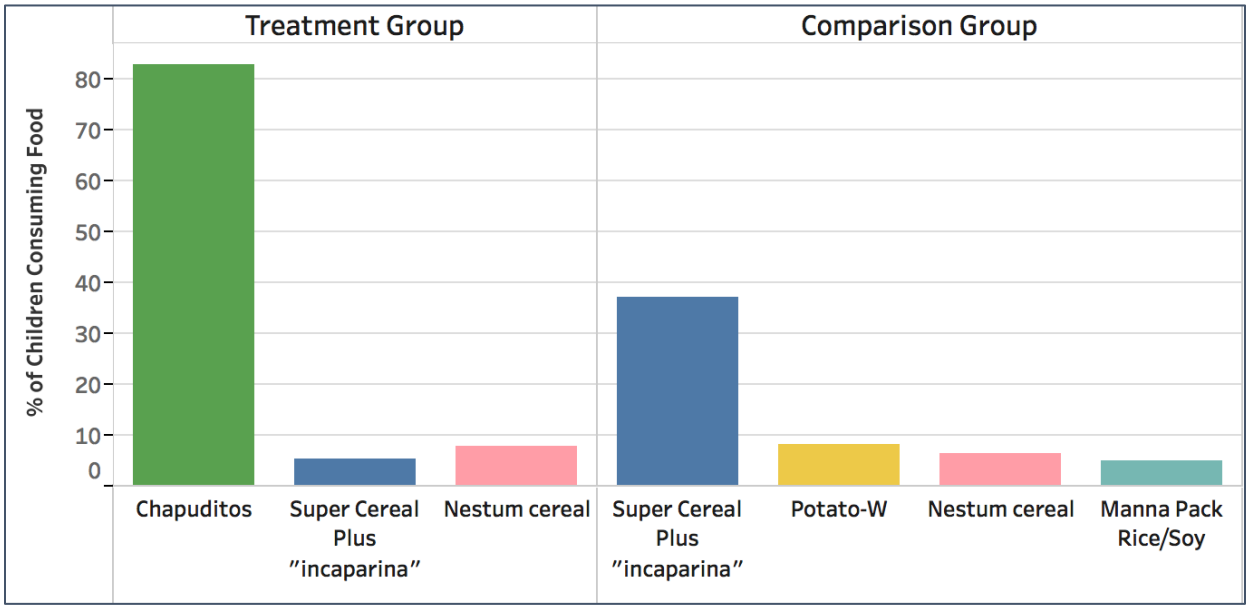

Figure 8. Consumption of fortified foods especially designed for children in treatment group vs. comparison group municipalities in Libras De Amor program, La Libertad province, El Salvador

previous day. 90% (87 of 97) of these children consumed a fortified food in the form of a fortified corn-soy flour (FCSF), either Chapuditos® or Super Cereal Plus/"incaparina". 62% (54 of 87) children who consumed an FCSF consumed it in the form of an *atol* or *fresco* (thin porridge served warm or cool mixed with water, milk, and/or sugar). 46% (40 of 87) children consumed an FCSF along with powdered milk. 65% (35 of 54) of the children who drank FCSF in the form of *fresco* or *atol* reported sweetening the beverage with table sugar. 38% (33 of 87) consumed the FCSF in a form other than *fresco* or *atol*, added to foods such as soup, beans, or banana. Out of all 138 children, the prevalence of consumption of fortified foods was as follows (see Figure 1): Chapuditos® (46%), Super Cereal Plus/Incaparina® (20%), Nestum® brand cereal (7%), Potato-W® (4%), and Manna Pack® Rice and Soy (2%). Measuring the WHO IYCF

Indicator number 8 revealed that 75.4% of children consumed an iron-rich or iron-fortified food during the previous day. Breaking apart this 75.4% of children, 53.6% consumed an iron-fortified food only (e.g. Chapuditos®, Super Cereal Plus, Incaparina®, Nestum® cereal, Potato-W®), 16.7% an iron-fortified food and a flesh food, and 5.1% a flesh food only (e.g. chicken meat, hot dog). 23.2% of children consumed an iron supplement during the previous day (e.g. ferrous sulfate drops, ferrous fumarate tablet).

Risk factors for stunting, underweight, and anemia

The following model results are to be interpreted with caution due to the small sample size and relatively wide confidence intervals. Multivariate linear regression models were run for HAZ and WAZ testing different IYCF practices, food groups, and foods as exposures and controlling for child age, household wealth index, and maternal education. The results of the models with the most significant associations and highest plausibility between the exposures and HAZ and WAZ are presented in Table 5. Multivariate logistic regression models were built by testing potential IYCF risk factors in this population as suggested by the literature review, bivariate associations with food variables, and the above linear regression results. The odds ratios obtained from the final models are presented in the lower half of Table 5. Dietary diversity showed no significant association with HAZ, WAZ, stunting, or underweight. Consumption of sweet bread (*pan dulce)* was significantly associated with lower HAZ and WAZ and increased risk of underweight. Children who stopped breastfeeding for any reason before 15 months of age were associated with an increased risk of stunting and underweight and lower HAZ. Belonging to the treatment group was found to be associated with lower HAZ and stunting. To further investigate this association, two more models were run, replacing the treatment group variable

with consumption of *any* FCSF, FCSF *with milk*, or FCSF *without milk*. The association disappeared among children consuming an FCSF *with milk*, while those consuming an FCSF *without milk* remained associated with lower HAZ and WAZ. Children were less likely to be underweight if their mother had completed more years of formal schooling. Children were more likely to be stunted with each month of increasing age.

Table 5. Associations between IYCF practices and HAZ, WAZ, stunting, and underweight using linear and logistic regression models

	Height-for-age z-score		**Weight-for-age z-score**	
Linear Regression Model [a]	β (SE)	*p*	β (SE)	*p*
Treatment group	-0.44 (0.20)	0.03*	-0.22 (0.19)	0.24
Sweet bread	-0.53 (0.21)	0.01*	-0.51 (0.20)	0.01*
Stopped breastfeeding before 15 months	-0.66 (0.31)	0.04*	-0.36 (0.30)	0.23
Daily bottle-feeding	0.36 (0.22)	0.10	0.18 (0.21)	0.40
Child age (months)	-0.04 (0.02)	0.02*	-0.04 (0.02)	0.03*
Wealth index	-0.05 (0.10)	0.60	-0.11 (0.10)	0.29
Maternal education (years)	0.03 (0.03)	0.30	0.06 (0.03)	0.04*
	Stunting (HAZ < 2.0)		**Underweight (WAZ < 2.0)**	
Logistic Regression Model [a]	OR (95% CI)	*p*	OR (95% CI)	*p*
Treatment group	3.4 (1.1, 10.4)	0.03*	3.7 (0.8, 16.8)	0.09
Sweet bread	1.9 (0.7, 5.2)	0.21	10.4 (2.2, 49.7)	0.01*
Stopped breastfeeding before 15 months	4.0 (1.2, 13.9)	0.03*	8.7 (1.6, 47.6)	0.01*
Child age (months)	1.1 (1.0, 1.2)	0.03*	1.1 (0.9, 1.2)	0.24
Wealth index	0.9 (0.6, 1.6)	0.77	1.8 (0.9, 3.6)	0.10
Maternal education (years)	0.9 (0.8, 1.1)	0.36	0.7 (0.6, 0.9)	0.01*

[a] Total sample for models: n=132; 2 excluded due to major hospitalization/operation; 4 due to missing wealth index/maternal education

*Statistically significant at alpha level of 0.05

Risk factors for anemia

The following models are to be interpreted with caution due to small sample size and wide confidence intervals. Multivariate linear regression models were run for hemoglobin (Hb) using

child dietary diversity (DD) as the exposure variable and controlling for child age, household wealth index, and maternal education, and treatment group. The results are presented in Table 7. Hb tended to increase with child age and dietary diversity. To further investigate the relationship of DD to Hb, each of the 7 food groups that make up DD were tested, with egg consumption found to be the only food group significantly associated with increased Hb levels. Consumption of two common between-meal snacks, sweet bread and banana, were also found to be associated with increased Hb levels. In logistic regression for, only egg and banana had a significant protective association with anemia.

Table 7. Associations between IYCF practices and hemoglobin concentration [a], anemia using linear regression and logistic regression models [b]

	Linear Regression Model		**Logistic Regression Model**	
	Hemoglobin (g/dL)		**Anemia (Hb< 11.0)**	
Variables	β (SE)	*p*	OR (95% CI)	*p*
Dietary Diversity Model				
Child dietary diversity [c]	0.22 (0.09)	0.01*	0.8 (0.5, 1.1)	0.18
Child age (months)	0.06 (0.02)	0.02*	1.0 (0.9, 1.1)	0.31
Wealth index	0.14 (0.12)	0.27	0.7 (0.5, 1.2)	0.23
Maternal education (years)	-0.02 (0.03)	0.66	1.0 (0.9, 1.2)	0.98
Treatment group	0.13 (0.25)	0.60	0.7 (0.3, 2.0)	0.38
Associated Foods Model				
Egg	0.60 (0.26)	0.03*	0.29 (0.10, 0.85)	0.03*
Banana	0.49(0.25)	0.05*	0.17 (0.05, 0.58)	0.01*
Sweet bread	0.58 (0.26)	0.03*	0.48 (0.15, 1.6)	0.23
Child age (months)	0.06 (0.02)	0.01*	0.9 (0.9, 1.04)	0.27
Wealth index	0.06 (0.12)	0.63	0.9 (0.5, 1.4)	0.57
Maternal education (years)	-0.01 (0.03)	0.80	1.0 (0.8, 1.1)	0.62
Treatment group	0.17 (0.23)	0.47	0.8 (0.3, 2.1)	0.63

[a] Measured on same day as 24-h recall interview

[b] Total sample for models: n=70; 64 excluded due to missing Hb; 2 due to major hospitalization/operation; 4 due to missing wealth index/maternal education

[c] Total number of WHO-defined IYCF food groups consumed during the previous day (Range: 0-7)

*Statistically significant at alpha level of 0.05

Key Findings

Undernutrition Prevalence

- Anemia: high (58%), Stunting: moderate (19%), Underweight: low (9%)

Breastfeeding Practices

- Early initiation within 1st hour: low (55%), better than national average
- Exclusive breastfeeding for 6 months: low (62%), better than national average
- Continued breastfeeding at 1 year: high (95%), much better than national average
- Continued breastfeeding at 2 years: low (59%), slightly better than national average

Complementary Feeding Practices

- Introduction of complementary foods too early (30%) or too late (10%) was high
- Introduction of animal-source foods (i.e. egg yolks, flesh foods) later than 8 months was common
- Consumption of sweet breads, cookies, sugary drinks, sugar, coffee, and fried foods is high
- Consumption of thin consistency foods such as bean broth, watery soups/atols/frescos is high
- Consumption of commonly available nutrient-dense foods such as egg, chicken meat, fish/seafood, sausage, beef, avocado, and chicken liver is very low
- Consumption of fortified foods is high in treatment group and low in comparison group

Stunting/Underweight

- Higher risk: Older infants
- Higher risk: Those who stop breastfeeding before 15 months
- Higher risk: Consumption of sweet breads
- Higher risk: Treatment group and/or consumption of fortified corn-soy flours without milk
- Lower risk: More years of maternal education (for underweight only)

Anemia

- Higher risk: Younger infants
- Lower risk: More diverse diet

  Lower risk: Consumption of eggs (common at breakfast) and bananas (common between meals)

Discussion

This study provides an overview of infant and young child feeding (IYCF) practices and potential risk factors for child undernutrition among children 6 to 24 months of age participating in the *Libras De Amor* nutrition program in 47 communities in 4 rural municipalities of El Salvador. To our knowledge, this study is the first to examine complementary feeding practices in El Salvador at the level of individual foods using 24 hour recalls. Information gained from this study will be used to inform child nutrition program activities in El Salvador. Interpretation of regression models should be made with caution because of low statistical power and wide confidence intervals. However, data provide some insight on the importance of early breastfeeding and dietary quality to improve child nutrition in these regions. High rates of anemia (58%) and moderate rates of stunting (19%) and underweight (9%) were found among infants in this population. Several IYCF practices were identified as potential protective factors or risk factors for stunting, underweight, and anemia in this population.

Breastfeeding practices

The prevalence of mothers practicing early initiation of breastfeeding (sample: 55%; national: 42%), exclusive breastfeeding for 6 months (sample: 62%; national: 58%), and continued breastfeeding at 1 year (sample: 95%; national: 74%) were higher than the prevalence observed nationally. Mother's in these communities have been engaged in the Libras De Amor program's education and counseling activities, which may be contributing to the improved practices. However, the intent of the project was simply to provide a snapshot of current feeding practices, not evaluate the program, so other contributing factors cannot be ruled out. Despite improvements, nearly 1 in 2 women are still not meeting the breastfeeding recommendations.

These results support the need for increased promotion and monitoring of early, exclusive, and continued breastfeeding among these children.

Timely introduction of complementary foods

According to the WHO and Salvadoran IYCF guidelines, the optimal age of introduction to CF is 6 months, while some international guidelines recommend 4 to 5 months as a safe age of introduction to CF (10, 40). In the current study, 6% of mothers reported breastfeeding at 3 months, while 10% reported introducing CF at 7 or 8 months (Figure 4). The positions of institutions such as the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition, based on accumulated evidence from multiple clinical trials, however, indicate "gastrointestinal and renal functions are sufficiently mature by approximately 4 months to enable term infants to process CF" (40). Modifications of the Salvadoran IYCF guidelines to recommend exclusive breastfeeding until at least 4 months, and introducing solid foods no later than 6 months, as recommended in recent European and Australasian guidelines, may help increase the percentage of mothers who introduce solid foods during the recommended window (40, 42).

Consumption of avocados

Avocados, apples, carrots, and milk have been found to be consumed by 21-25% of rural and low-income Salvadoran households in national surveys, yet in the current study, avocado consumption was found to be much rarer than these other foods among all age groups (41). One explanation is that the Salvadoran IYCF guidelines fail to mention avocado as a recommended complementary food (15). This is an unfortunate omission, considering that avocados have an

ideal texture and neutral flavor for a first food, along with a unique nutritional profile, high in fiber and monounsaturated fatty acids often lacking in infant diets (43). Low consumption of avocados may be partly due to other considerations like a shorter shelf life or higher cost per calorie when compared to other complementary foods. However, economic considerations may not be the only factors, as consumption of plantains (27%) among infants was much more common than consumption of avocados (4%), even though both were selling at virtually the same price as of April 2017 ($16.50 per 100 plantains; $15.30 per 100 avocados) (44). It is also possible that infants themselves come to prefer the sweet, caramelized flavor of fried plantains and sweet breads over relatively bland avocado. However, avocados could feasibly be added to more flavorful soups and bean broths commonly consumed by infants and/or served mashed with condiments such as lime juice to increase palatability. Taking into account the availability of avocados in at least 1 in 5 rural low-income households, the evidence in support of avocado as a nutritious complementary food, and similarity in price to commonly consumed baby foods such as ripe, fried plantains, inclusion of avocado as a recommended first food and source of nutrient-dense fats in the Salvadoran IYCF guidelines seems warranted. Increased promotion of avocado as a complementary food in nutritional counseling and cooking demonstration components of programs such as *Libras De Amor* may also lead to increased use of avocado as a complementary food in these communities.

The *Libras De Amor* program currently includes a food security component which aims to increase local production of nutritious foods such as eggs and vegetables. A single avocado tree can yield 50,000 to 100,000 calories per year in fruit (assuming a harvest of 200 to 300 fruits). Given this enormous potential for increasing local child nutrient intakes, research by food

security program directors and agronomists into the feasibility of increasing local agricultural production of avocados through increased planting of avocado trees in communities at high risk for undernutrition is warranted. If planted soon, avocado trees would begin to bear fruit after approximately 3-5 years (and continue to bear fruit for decades), coinciding closely with the time that the *Libras De Amor* program plans to phase out in many of these communities. Avocado tree-planting initiatives therefore may have great potential to complement current short-term nutrition and food security initiatives and sustainably contribute to increasing child nutrient intakes in beneficiary communities for years to come.

Consumption of eggs

Eggs, the third most common food category in El Salvador, are consumed by 88% of rural households and 92% of low and middle income households (41). Although the evidence base is unclear, Salvadoran IYCF guidelines recommend introducing egg yolks to infants at 8 months of age and egg whites at 12 months (15). In the current study, over half of mothers (57.7%) reported introducing egg yolks later than recommended, at 9 months or later. Among these mothers who delayed egg introduction, the mean age of introduction to eggs was 12 months, suggesting many mothers may be confusing the recommended age of introduction in the Salvadoran guidelines for egg whites (12 months) with that of egg yolks (8 months). This discrepancy could be due to fears that high cholesterol in egg yolks may be harmful to babies, or due to conflicting advice received from health professionals. In fact, in the current study, 1 in 4 of these mothers who delayed egg introduction cited advice from their doctor that eggs and/or egg yolks should be avoided in young infants because of alleged allergenic or diarrheagenic properties. Concerns of the cholesterol content of egg yolks may be assuaged by citing evidence

from a recent randomized controlled trial that evaluated the nutritional effects of consuming egg yolks (4 per week) in infants beginning at 6 months of age. The trial found no significant effect on plasma cholesterol levels at 12 months compared to controls (45). To relieve the worries of mothers who cited nutritional advice from a health professional that egg consumption before 12 months can cause allergies or diarrhea, health professionals can cite a 2016 systematic review and meta-analysis in the Journal of the American Medical Association which concluded there is now "moderate-certainty evidence from 5 trials that early egg introduction at 4 to 6 months is associated with reduced egg allergy risk"(46). Modifications to the Salvadoran IYCF guidelines to account for the latest scientific evidence in support of earlier introduction of eggs, at any point between 4 to 6 months, especially soft, nutrient-dense egg yolks, may help alleviate the concerns of many Salvadoran health professionals and mothers and lead to increased promotion and consumption of this universally available and nutritious complementary food.

While some previous research has suggested egg white may decrease iron absorption in infants, in the current study, egg consumption during the previous day was associated with increased hemoglobin levels. Studies have shown egg yolks in particular to be a beneficial and safe first food for infants because of their soft texture, nutrient density, iron content, and lack of any allergenic proteins (45). While results of the models should be interpreted cautiously due to small sample size and causal relationships cannot be determined due to the cross-sectional study design, the observed association could be hypothesized as a direct effect of eggs on iron stores, or as eggs as a marker for improved dietary quality. In support of a direct effect of egg yolks on iron status, one randomized clinical trial found infants consuming 4 egg yolks per week beginning at 6 months of age had significantly improved plasma iron and transferrin saturation at

12 months (45). In support of eggs as a marker for improved dietary quality, in the current study, eggs were most commonly consumed at breakfast time, which may be a marker of mothers who regularly feed their child a wholesome breakfast.

The current study found that eggs (consumed by 33% of children in previous day) are currently twice as popular among mothers as a complementary food compared to leafy greens, consumed by 16% of children in tiny amounts in soups. In a handful of selected rural communities with low food security, *Libras De Amor* program agronomists conduct food security workshops aimed at empowering community members to raise hens and plant gardens for increased local production and consumption of eggs and vegetables (primarily leafy greens such as chipilin, chaya, mora, and moringa) (16). In the current study, the average daily portion size of eggs consumed (35 grams=58 calories) consumed by infants provided 29 times more calories than the average portion size of leafy greens consumed (4 grams = 2 calories). Considering the relative popularity of eggs as a complementary food, the much higher number of calories provided in each portion, and the limited monetary and human resources available for food security program activities, decreased investment in the local vegetable garden initiatives and increased allocation of resources towards the local hen-raising and egg production components of the *Libras De Amor* program may lead to much higher impact on prevention of child undernutrition in these communities.

Consumption of flesh foods

According to national household expenditure surveys, 43% of rural and low-income Salvadoran households consume fish and 21% consume beef, yet in the current study, only 3% and 1% of

children under 2 years of age consumed one of these foods in the previous day (41). Consumption of other flesh floods like sausages and chicken livers were also rarely consumed by infants in the current study. Considering the high prevalence of anemia in these communities and that flesh foods are some of the best sources of dietary protein, iron, zinc and other nutrients often lacking in the diets of infants, the low prevalence of consumption of flesh foods despite their availability in Salvadoran households is concerning (47). Also of note, Salvadoran IYCF guidelines recommend introducing flesh foods to infants beginning at 8 months, yet in the present study, 26% of children 6 to 24 months had never been introduced to a flesh food (15). This suggests 1 in 4 mothers may lack the access or money to obtain flesh foods, which is plausible considering their relatively high cost per calorie in El Salvador (18). Alternatively, many of these mothers may not be aware that their young infant is already biologically capable of consuming and digesting flesh foods. Indeed, in the current study, when asked why they had postponed introduction, several mothers mentioned avoiding flesh foods because of a perceived choking hazard or a belief that their child is biologically incapable of chewing and/or digesting such foods. Additionally, hesitation of mothers to introduce flesh foods may also be related to the Salvadoran IYCF guidelines, which recommend delaying introduction until 8 months of age. However, the latest positions of institutions such as the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition, based on accumulated evidence from multiple clinical trials, indicate that “gastrointestinal and renal functions are sufficiently mature by approximately 4 months to enable term infants to process CF” (40). Modification of the Salvadoran IYCF guidelines to account for the latest evidence on age of introduction, and improving awareness through nutrition education of flesh foods as safe and beneficial weaning foods may lead to increased consumption, boost the nutrient density of Salvadoran infants’ diets,

and reduce the high prevalence of anemia in these communities. Nutrition programs might also consider using nutrition education and cooking demonstrations to teach mothers how to feed these foods to their children safely as early as 4 to 6 months in easily digestible pureed forms (48). The Ministry of Health and/or FUSAL might also consider publishing online and printing a concise complementary food guide for mothers, which might include a pictographic summary and/or timeline of all recommended locally available complementary foods, ranked by their nutrient density and categorized by their safe and optimal age of introduction.

Consumption of sugar-sweetened beverages, sugary snacks, and fried foods

In this study, consumption of sugar-sweetened beverages (78%), sugary snacks (51%), and fried foods (87%) during the previous day was alarmingly high among infants (Table 2). Notably, sweet bread (*pan dulce)* was the only food found to be significantly associated with increased risk of stunting and underweight, though models are to be interpreted with caution due to small sample size. The observed high prevalence of sweet bread consumption among Salvadoran infants is not surprising, as sweet bread is the fourth most common food in the Salvadoran diet, consumed by 87% of rural households and 84% of low and middle income households (41). High consumption of sweet breads has been found previously in populations with dual burden of undernutrition (stunting, underweight) and overnutrition (overweight/obesity) (49). It is not uncommon to observe such a dual burden of undernutrition among young children and overnutrition among older children, adolescents, and adults in the same population in countries undergoing a nutritional transition with increasing consumption of foods high in sugar, salt, and fat content (50). In El Salvador, while the burden of stunting and underweight has declined greatly over the past two decades, overweight and obesity has grown to epidemic proportions,

now estimated to affect 67% of adults over the age of 20 (30). If El Salvador continues to follow this trend, it may end up like nearby Mexico, where increasingly higher sweets consumption among young children has been linked to increasing rates of overweight and obesity among older children, adolescents, and adults (51, 52). Stunted children are at an increased risk of developing overweight/obesity later in life (28, 53). Studies have also shown that 9-month old infants with dietary patterns higher in energy dense foods like fried foods and sweet desserts are much more likely to continue these habits at 6 years and develop overweight or obesity (35). Infants from households with the highest expenditures on sugar and cooking oils are at higher risk of underweight and wasting compared to infants from households with higher expenditures on proteins from soybeans and/or animal-source foods (54). Such associations are likely due to the energy-dense but nutrient poor nature of these foods with high sugar and oil content (55). In El Salvador, a much higher percent of rural households compared to urban households spend money on sugar (rural: 81%, urban: 65%) and cooking oil (rural: 59% vs. urban:49%), which may partly explain the higher prevalence of stunting, underweight, and wasting among rural children (8) (41). The tendency of rural Salvadoran households to spend their money on more energy dense foods is not surprising, over 33% of average monthly income is required to purchase the "basic basket" of food staples (e.g. corn flour, beans, sugar, oil), and the cost per calorie of sugar (<$0.05 per 100 calories) is much lower than all other foods like that of meat ($0.30 per 100 calories) (18).

Another factor that may influence the widespread consumption of sweet breads and fried foods among infants and young children in El Salvador is that in the Salvadoran IYCF guidelines, these foods are specifically recommended as foods to be consumed on a daily basis. In the latest

edition, caretakers are instructed to introduce sweet breads and cookies to infants at 8 months, feeding “one snack per day of sweet bread or fruit” to infants from 9 to 12 months, and feeding “two snacks per day of sweet bread or fruit” to infants from 12 to 24 months. Considering the large amount of evidence linking consumption of sugary snacks, sweet breads, and cooking oils to stunting, underweight, and wasting in children and overweight and obesity in adults, significant modifications to the current Salvadoran IYCF guidelines are warranted. Replacement of recommendations for daily consumption of sweet breads and fried foods beginning at 9 months of age with suggestions to avoid consumption of these foods is warranted (15). Updating these guidelines would likely increase awareness among Salvadoran health professionals and parents of the short term and long-term health risks of regular consumption of sugary and fried foods and lead to decreased consumption. Decreased consumption of low nutrient density calories from these foods may result in children consuming more diverse and nutrient-dense diets, help children form healthier dietary habits from a young age, and provide the double benefit of preventing undernutrition in infants and future development of overweight and obesity in adolescence and adulthood.

In the current study, consumption of sweet breads was also found to be associated with an increase in hemoglobin concentration. It is plausible that infants regularly consuming sweet breads may have increased iron intakes, due to the mandatory fortification policy of wheat flour in El Salvador with 2.87mg per 100 grams of ferrous fumarate (56). However, any potential benefit of increased iron intakes from sweet breads would be negated if they simultaneously tend to displace consumption of other more nutrient-dense foods and lead to undernutrition in infancy and overnutrition later in life. Overall, increased caution in the use of sweet breads as a

complementary food along with further research into their health effects in Salvadoran children seems warranted.

Consumption of soups, bean broths, and thin porridges

The high consumption of soups, bean broths (*sopa de frijol)*, and thin starchy porridges (*atol/fresco*) found among infants in the current study may also be of concern. If soups, broths, and porridges are regularly served with a consistency that is too thin, the lack of energy and nutrient density may make a child more likely to be stunted or underweight by falling short of his/her daily nutrient requirements (57, 58). Out of the 71 mothers who reported serving a soup to their child in the previous day, 1 in 3 children consumed a relatively nutrient poor mix of broth and starch only (e.g. Maggi brand dehydrated soup with noodles, boiled with water, potatoes, and/or rice). The WHO recommends first foods to be consumed as mashed or pureed, while by 8 months children can eat foods solid enough to pick up with their fingers, and by 12 months most children can eat foods of the same consistency eaten by the rest of the family (48). Although soups, potatoes from soups, bean broths, and thin porridges were among the most common foods consumed by infants in the current study, the Salvadoran IYCF guidelines do not include any explicit guidance with regards to the ideal consistency and content of soups and broths for infants. Considering the popularity of soups and broths as baby foods found in the current study, Salvadoran mothers would benefit from increased guidance in the Salvadoran IYCF guidelines on the adequate consistency of these foods and increased promotion of the benefits of adding foods such as vegetables, cheese, cream, eggs, meat, and avocados to these soups and broths to increase their nutrient density.

In the current study, an association was also found between stunting and underweight and the consumption of thin porridges made of fortified corn-soy flours served mixed with water (as opposed to cow's milk). One possibility is that children who consume these starchy beverages diluted in water may be consuming far less calories per serving than children who consume the same fortified flour mixed in with powdered milk. For example, a common daily preparation for infants found in the current study of a 100mL serving of water mixed with 1 tablespoon of a fortified corn and flour blend and 1 teaspoon of sugar (11 calories, 1.8g carbohydrate, 0.6g protein, and 0.14g fat) may not be calorie dense enough to meet a child's daily energy requirements. Future research might further explore this link and determine whether children consuming fortified flour blends in thicker forms and/or mixed with powdered milk tend to receive benefits over children consuming fortified porridges mixed with water only.

Associations between undernutrition, child age, maternal education, and poverty

As expected, older children were at higher risk for stunting and underweight, while younger children were at higher risk for anemia in the current study. Also in concordance with national trends, children of mothers with less years of formal schooling were more likely to be underweight. This finding serves to emphasize the importance of programs like *Libras De Amor,* which provide additional nutrition education, food supplements, and vitamins to mothers with few years of formal schooling. Although wealth index was not significantly associated with stunting, underweight, or anemia in the current study, this could be due to the relatively homogenous population of participants in nutrition programs like *Libras De Amor* which target undernourished children from low-income households. Data from the National Health Survey in 2008 support this socioeconomic homogeneity hypothesis, showing an anemia prevalence of

39.1% in the bottom SES quintile and 39.6% in the second to bottom quintile among children 12-23 months of age. Still, data from the Salvadoran National Health Survey as well as agro-economic data from the Food and Agricultural Organization support a strong association between poverty, food insecurity, and child malnutrition in El Salvador; therefore, nutrition programs and policies should remain especially attentive to the needs of these more vulnerable children belonging to rural, poor, and less-educated households (8, 18).

Strengths

One strength of this study is that it provides previously unavailable data on dietary content and quality among Salvadoran children under 2 years of age which can be incorporated immediately into child nutrition guidelines and programs, while at the same time, enabling the generation of many hypotheses for future investigations into the root causes of undernutrition in El Salvador. Another strength of this study was that children of all ages between 6 and 24 months were surveyed, revealing how infant diets change over time. A third strength of this study is that participants were randomly sampled from 47 different rural communities scattered throughout La Libertad province, and therefore likely constitute a representative sample of households in the region. Another strength of this study was that the socioeconomic, maternal education, and anthropometry data were collected by trained and experienced health workers and measurement of hemoglobin concentrations were performed by a licensed physician. All surveys on IYCF practices were collected, entered, and analyzed by the same interviewer who was trained by local Salvadoran nutritionists, decreasing the likelihood of differential use of techniques that may occur in studies employing multiple interviewers or analysts. Data entry errors were reduced by using electronic data collection, with the first 42 surveys collected directly in a Microsoft word

form on a laptop, while the remaining 96 surveys were collected using an Android tablet-based survey tool designed with CommCare software.

Limitations

One limitation of this study is related to it cross-sectional study design, thus we can only examine associations, not causal relationships. Also, using foods consumed from a single 24-h recall (as opposed to using multiple 24 hour recalls or a food frequency questionnaire) as exposures for nutritional outcomes in regression models limits the interpretability and predictability of the models. For example, a child that consumed a sweet bread yesterday may not actually consume sweet breads regularly, and a child that did not consume a sweet bread yesterday may actually consume sweet breads quite frequently. The generalizability of IYCF practices observed in this study may be limited, considering all mother-child pairs were enrolled in a monthly growth monitoring and nutrition education program and may have modified their feeding practices accordingly. If anything, however, the results from the current study may paint a rosier picture of IYCF practices in rural El Salvador than might be expected among mother-child pairs not receiving monthly nutrition education and food distribution from a program like *Libras De Amor*. For example, it was against the rules to even enter the premises of a *Libras De Amor* clinic with any foods labeled as *chatarra* (junk) such as sodas, cookies, corn crisps, potato chips. Therefore, the finding that only 3 of 138 babies consumed any soda during the previous day could be due to mothers adhering well to *Libras De* Amor program advice. Alternatively, it is possible that many more mothers did in fact serve these "junk" foods to their babies, but were embarrassed to admit feeding their child one of these foods for fear of being chastised by program staff. In this light, the results of this study, showing a fairly high prevalence of highly

processed foods and a low prevalence of many high-nutrient density animal-source foods, avocados, and vegetables is all the more cause for concern. Another limitation of this study was the low statistical power due to the small sample size, which resulted in relatively wide 95% confidence intervals for several measures. Another limitation of this study is that the individual who carried out the 24-hour recall interviews was not a trained nutritionist from El Salvador and therefore may have failed to ask all of the probing questions that would be more obvious to a Salvadoran interviewer. If anything, this may have resulted in under-reporting of foods in the 24-hour recalls.

Conclusions

As the first study to characterize complementary feeding practices among infants under 2 years of age in El Salvador and identify potential IYCF risk factors for stunting, underweight, and anemia in this population, this study provides important contextual information and implications for child nutrition programs and policies in El Salvador. The high rates of anemia (58%) and moderate rates of stunting (19%) and underweight (9%) in these mostly rural and poor communities reinforce the need for public health nutrition programs like those implemented by FUSAL, The Mathile Institute, and the Ministry of Health in these regions. Stopping breastfeeding before 15 months, consumption of sweet breads, older child age, and lower maternal education may increase a child's risk of developing stunting and underweight. Consumption of a more diverse diet (especially from the addition of eggs) and older child age were identified as potential protective factors against anemia. Percentages of mothers practicing early initiation of BF, exclusive BF for 6 months, and continued breastfeeding at 2 years were low and therefore promoting increased adherence to these practices should be maintained as a

top priority of pediatricians and nutrition programs working in these regions. It is important to note this study was not designed or statistically powered to evaluate the impact of the *Libras De Amor* program nor the fortified corn and soy flour blends being compared in the larger study. Other program evaluations are pending and may provide more insight on program effectiveness.

Future Recommendations

Increased promotion and monitoring of early, exclusive, and continued breastfeeding among children in this population is highly recommended. Introduction to CF and nutrient dense foods often occurred too early or too late, therefore, updating the Salvadoran IYCF guidelines to recommend introducing solid and semi-solid foods as early as 4 months but no later than 6 months, as recommended in recent European and Australasian guidelines, may help increase the percentage of mothers who introduce solid foods during the recommended window. Publication online, printing, and distribution of a complementary foods guide for mothers to reference that include the optimal age of introduction for each locally available complementary food is highly recommended. Removing instructions for daily consumption of sweet breads and fried foods in the Salvadoran IYCF guidelines is recommended. Inclusion of avocado as a recommended first food and source of nutrient-dense fats in the Salvadoran IYCF guidelines, as well as increased promotion of avocado as a complementary food during nutrition education and cooking demonstration activities is warranted. Modifications to the Salvadoran IYCF guidelines to account for the latest scientific evidence in support of earlier introduction of eggs, at any point between 4 to 6 months, especially soft, nutrient-dense egg yolks, may help alleviate the concerns of many Salvadoran health professionals and mothers and lead to increased promotion and consumption of this universally available and nutritious complementary food. Considering the

relative popularity of eggs as a complementary food, the much higher number of calories provided in each portion, and the limited monetary and human resources available for food security program activities, decreased investment in the local vegetable garden initiatives and increased allocation of resources towards the local hen-raising and egg production components of the *Libras De Amor* program may lead to much higher impact on prevention of child undernutrition in these communities. Modification of the Salvadoran IYCF guidelines to account for the latest evidence on age of introduction, and improving awareness through nutrition education of flesh foods as safe and beneficial weaning foods may lead to increased consumption, boost the nutrient density of Salvadoran infants' diets, and reduce the high prevalence of anemia in these communities. Nutrition programs might also consider using nutrition education and cooking demonstrations to teach mothers how to feed these foods to their children safely as early as 4 to 6 months in easily digestible pureed forms. Replacement of recommendations for daily consumption of sweet breads and fried foods beginning at 9 months of age with suggestions to avoid consumption of these foods is warranted. Salvadoran mothers would benefit from increased guidance in the Salvadoran IYCF guidelines on the adequate consistency of these foods and increased promotion of the benefits of adding foods such as vegetables, cheese, cream, eggs, meat, and avocados to these soups and broths to increase their nutrient density. Finally, future research to determine whether children consuming fortified flour blends in thicker forms and/or mixed with powdered milk tend to receive benefits over children consuming fortified porridges mixed with water only, and into the potential of egg yolks to improve iron stores and prevent anemia in undernourished is warranted.

Key Recommendations for Libras De Amor Nutrition Program
• Promotion of proper BF practices such as early initiation, exclusivity for 6 months, and continuation until 2 years should be maintained as a top priority • Printing and distribution of a guide for mothers of optimal breastfeeding and complementary feeding with a concise pictographic summary of all locally available foods (including breastmilk) ranked by their nutrient density • Shifting resources for the food security program more towards increasing local production and consumption of calorie and nutrient dense eggs and avocados • Including avocados, egg yolks, pureed meats and seafood more often in cooking demonstrations • Mobile data collection on tablets and smartphones is highly recommended to increase efficiency of data collection, lead to faster insights, and eliminate the need for the time-consuming and data-degrading practice of using paper followed by a second data entry

Key Recommendations for Changes to Salvadoran National IYCF Guidelines
• Endorsement of earlier age of introduction to complementary foods like nutrient-dense avocados, egg yolks, and means which are safe and beneficial based on RCT evidence • Removal of recommendations for daily consumption of sweet breads and fried foods beginning at 9 months would likely have the double benefit of preventing undernutrition in the short-term and overweight/obesity in the long-term • Addition of guidelines on consistency of foods such as soups, broths, frescos, and atols that should be prepared with at least semi-solid consistency and when possible should be served with vegetables, cheese, cream, eggs, meat, or avocados to increase dietary diversity and nutrient intakes

Chapter IV: Conclusions and Recommendations

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