Association between Infant Feeding Practices and Nutritional Status in Healthy Nicaraguan Infants

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Abstract

Adherence to the World Health Organization’s infant feeding recommendations is intended to promote optimal growth, development, and health for infants. Evidence from the scientific literature shows that cultural and family traditions play a major role in breastfeeding and complementary feeding behaviors. The objectives were to describe feeding practices during weaning stages and to examine associations between breastfeeding, bottle use, or complementary feeding practices and nutritional status, as measured by length-for-age (LAZ), weight-for-age (WAZ), and weight-for-length z-scores (WLZ) in six-month-old Nicaraguan infants. Data was collected from fifty-one healthy infant participants (29 males and 22 females) and included LAZ, WAZ, WLZ, as well as breastfeeding and complementary feeding history. A majority of participants were partially breastfed (76% males and 82% females), and 66% males and 59% females began using a bottle before the age of two months. Common supplementary foods included fruits and vegetables, with some reported intake of rice cereal, cheese, and cow’s milk. There was no statistical significance between breastfeeding and nutritional status. Consumption of cow’s milk was positively associated with LAZ (p = 0.04). This report describes infant feeding behaviors on a healthy Nicaraguan infant cohort and indicates that exclusive breastfeeding recommendations up to six months of age were not in full compliance. Long-term follow-up on growth and development outcomes following a variety of breastfeeding and weaning patterns can yield valuable information about community compliance to global and national dietary guidelines and may inform future policy.


Keywords: Breastfeeding; Complementary feeding; Nicaraguan; Nutritional status

Abbreviations


Introduction

Infant feeding recommendations set by the World Health Organization and promoted by the Nicaraguan Ministry of Health include being exclusively breastfed for the first six months of life, followed by appropriate complementary feeding with continued breastfeeding until the age of two [1-3]. Adhering to these recommendations has shown to aid in achieving optimal growth, development, and health of an infant [1,2,4,5]. More specifically, infants who are provided adequate nutrition through breast milk and complementary feeding have a reduced risk of morbidity and mortality, reduced risk of stunting, as well as improved mental and motor development [6].

Selection of infant feeding methods depends on culture, family tradition, and available food and/or economical resources [7]. Multiple Latin American countries report that majority of women do not comply with this recommendation for a variety of reasons, including but not limited to, maternal employment and family structure [8,9]. Within the Nicaraguan Ministry of Health, there is a health program called the Modelo de Salud Familiar y Comunitario (Model of Family and Community Health), or MOSAFC, that works with urban and rural communities in Nicaragua. One of the MOSAFC programs includes education on infant nutrition. Local nurses and pediatricians educate mothers about nutrition and other important health topics that aid in the development of the child [10]. However, family members beyond the nuclear family may have an influence on infant weaning behaviors that are highly related to exclusive breastfeeding prevalence, and early introduction to bottle feeding and solid foods before six months of age [8,9].

Nearly all infants between the ages 0 to 6 months are breastfed in Nicaragua, but few are exclusively breastfed. Reports indicate that Nicaraguan infants are exclusively breastfed for a median of 21 days, 58% use a bottle at less than one month of age (not adding breast milk to the bottle) and approximately 86% are introduced to solid foods before six months of age [8,9]. In Central and Latin America, mothers introduce solid foods to their children by the age of four months, and are more likely to support infant overfeeding [11,12].

Evaluating breastfeeding bottle use, and complementary feeding patterns in specific geographical locations within and across countries is necessary to determine if recommendations are adhered to, and if not, how to provide an opportunity to develop culturally-specific interventions as part of prenatal and postnatal research [7,11]. It has been shown that infants who follow the exclusive breastfeeding recommendations have a lower risk of obesity in the future compared to infants who were formula fed in the first six months [13-17]. Assessing current weaning practices is an important focus of child health and nutrition research to better understand not only short-term health outcomes, but also possible long-term health and development effects.

This present study utilized baseline data from an infant cohort enrolled in a prospective trial located in León, Nicaragua.
Information about breastfeeding, bottle use, and complementary feeding practices were collected, alongside nutritional status. The objectives were to describe breastfeeding and weaning practices at six months of age, and to examine any association between breastfeeding, bottle use, or complementary feeding practices and nutritional status, as measured by length-for-age (LAZ), weight-for-age (WAZ), and weight-for-length z-scores (WLZ). We hypothesized that breastfeeding prevalence in this area of Nicaragua would be similar to other areas in Nicaragua that have been previously reported between 1998-2015 [4,8,9,18] and that breastfeeding, bottle use, and common complementary foods would be associated with nutritional status.

Methods

Study Design

Infant participants and their families living in León, Nicaragua were enrolled in a randomized-controlled dietary intervention trial to assess the feasibility of consuming heat-stabilized dietary rice bran. The intervention occurred between March 2015 and October 2015 (NCT02615886). Eligibility included:

- Infants between the ages of 4-6 months at time of recruitment with no diarrheal episodes and received three doses of rotavirus vaccination
- No prior hospitalization
- Not taking antibiotics or on prophylactic treatment
- No current illness, known immune-compromising condition, or use of medications.

Participants were recruited from public health rosters provided by the local health ministry from the Perla Maria and Sutiava health sectors of León, Nicaragua.

The Institutional Review Boards at Colorado State University, Universidad Nacional Autónoma de Nicaragua – León, University of North Carolina at Chapel Hill, and Virginia Polytechnic Institute and State University approved this study (protocol #s 14-5233H, 00003342, 14-2501, and 00000657, respectively). Written informed consent was obtained from the infant’s parents or responsible guardian prior to any data collection. Data used in this study was collected when the infant participants were six months of age before the dietary intervention parent study began.

Data Collection

Participants who met the eligibility criteria and completed the informed consent were assigned a study identification number. At the first study visit, a study coordinator interviewed a family member (e.g. mother, father, or grandparent) using a questionnaire that gathered breastfeeding and complementary feeding history (Supplementary Figure 1). The breastfeeding questions included if the child was still receiving breast milk, whether the child received breast milk the previous day, and if the child was using a bottle and at what age that started. The complementary feeding history included a list of eleven common Nicaraguan foods that are introduced to infants during weaning. Family members answered how often the infant consumed each of the eleven foods based on predetermined options. A household survey was also completed to collect mother’s education level, drinking water source, household flooring type, and animals present in the household (Supplementary Figure 2).

Infant participants were measured for length and weight at this house visit via a portable Stadiometer and weighing balance for children. Length was collected to the nearest centimeter and weight to the nearest 0.1 kg. The length and weight from infant participant’s well visit at the health clinic was collected as a second measure and to confirm field data. This data was then calculated for LAZ, WAZ, and WLZ following the World Health Organization (WHO) child growth standards using the WHO Anthro software (version 3.2.2) [19]. Birth weight and premature status were also collected for descriptive purposes.

Statistical Methods

Statistical analyses were completed on participant characteristics, breastfeeding, bottle use, and complementary feeding data using IBM SPSS® Statistics 23.0. The food types were dichotomized where ‘0’ was equal to the child never has been given this food or used to give this food, but not anymore, and ‘1’ was equal to any current consumption of the food type. Pearson’s chi-square was used to assess differences between males and females for food types consumed breastfeeding, bottle use, and household characteristics independently. Multiple linear regression models were performed in order to evaluate the association between LAZ, WAZ, and WLZ and food types independent of sex, as well as number of food types consumed. Participant characteristics are presented as mean ± standard deviation or percent of study population. Breastfeeding bottle use, and complementary feeding are presented by percent of study population. Significance was defined as p ≤ 0.05 for all analyses.

Results

A total of 51 six-month-old infants (n = 29 males and 22 females) were recruited to participate, after meeting eligibility criteria. Participant characteristics are shown in Table 1. While the length of six months of age was not statistically significantly different between sexes, there was a significant difference between males and females for LAZ (p < 0.01). No other significant differences between anthropometric data and sex were found. All participants received water from indoor municipal systems as opposed to communal municipal, wells, streams, or other public sources. Household sanitation consisted mostly of indoor toilets (67%) followed by latrines (29%). There was one female participant who did not have either. No significant differences between the household environment factors and sex were found.

Breastfeeding and Bottle Feeding Practices

Breastfeeding practices are shown in Figure 1a. The majority of male (76%) and female (82%) infants were partially breastfed at six months of age, while 7% of males and 9% of females were exclusively breast feeding. 17% of males and 9% of females stopped breastfeeding before the age of six months and were exclusively bottle feeding. No significant differences were observed between sex and breastfeeding (p = 0.40). Figure 1b illustrates bottle use practices, where 66% of males and 59% of females began using a bottle between the ages of birth to two months. Infants who were exclusively breastfed at six months (n = 4) were not included. There was no significant difference between sex and bottle use introduction (p = 0.42).

Complementary Feeding Practices and Number of Food Types

Figure 2a illustrates complementary feeding practices for this cohort of weaning six-month old Nicaraguan infants. The most commonly consumed foods were fruit and natural juices, as reported by 93% of males and 100% of females. Vegetables were consumed by 90% of males and 91% of females. No significant differences were found between sex and food types.

Figure 2b shows the number of food types out of the 11 food...
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<th>Males</th>
<th>Females</th>
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<tr>
<td>Number of participants</td>
<td>51</td>
<td>29</td>
<td>22</td>
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</tr>
<tr>
<td>Birth weight (kg)^2</td>
<td>3.07 ± 0.42</td>
<td>3.10 ± 0.46</td>
<td>3.03 ± 0.37</td>
<td>0.35</td>
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<tr>
<td>Premature Status^</td>
<td>3 (6)</td>
<td>2 (7)</td>
<td>1 (5)</td>
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<tr>
<td>Weight at six month of age (kg)^2</td>
<td>7.96 ± 1.12</td>
<td>8.23 ± 1.22</td>
<td>7.60 ± 0.87</td>
<td>0.53</td>
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<tr>
<td>Length at six month of age (cm)^2</td>
<td>65.94 ± 2.61</td>
<td>66.7 ± 2.94</td>
<td>64.91 ± 1.66</td>
<td>0.30</td>
</tr>
<tr>
<td>Length-for-Age Z-score^2</td>
<td>-0.04 ± 1.11</td>
<td>-0.03 ± 1.37</td>
<td>0.05 ± 0.64</td>
<td>&lt; 0.01</td>
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<td>Weight-for-Age Z-score^2</td>
<td>0.26 ± 1.05</td>
<td>0.18 ± 1.23</td>
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<td>Weight-for-Length Z-score^2</td>
<td>0.48 ± 1.17</td>
<td>0.36 ± 1.35</td>
<td>0.63 ± 0.91</td>
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**Mother's Education**

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<td>1 (2)</td>
<td>0 (0)</td>
<td>1 (5)</td>
<td>0.37</td>
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<tr>
<td>Some primary</td>
<td>11 (22)</td>
<td>6 (21)</td>
<td>5 (23)</td>
<td></td>
</tr>
<tr>
<td>Completed primary</td>
<td>6 (12)</td>
<td>3 (10)</td>
<td>3 (14)</td>
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<tr>
<td>Some secondary</td>
<td>14 (28)</td>
<td>10 (35)</td>
<td>4 (18)</td>
<td></td>
</tr>
<tr>
<td>Completed secondary</td>
<td>10 (20)</td>
<td>7 (24)</td>
<td>3 (14)</td>
<td></td>
</tr>
<tr>
<td>University/Professional</td>
<td>9 (18)</td>
<td>3 (10)</td>
<td>6 (27)</td>
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**Water Source**

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<th>Females</th>
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<tr>
<td>Indoor municipal</td>
<td>51 (100)</td>
<td>29 (100)</td>
<td>22 (100)</td>
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**Sanitation System**

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<tr>
<td>Indoor toilet</td>
<td>35 (67)</td>
<td>21 (72)</td>
<td>14 (64)</td>
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<td>Latrine</td>
<td>15 (29)</td>
<td>8 (28)</td>
<td>7 (32)</td>
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<tr>
<td>None</td>
<td>1(2)</td>
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**Household floor**

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<td>Tile</td>
<td>5 (10)</td>
<td>2 (7)</td>
<td>3 (14)</td>
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<tr>
<td>Cement</td>
<td>21 (41)</td>
<td>14 (48)</td>
<td>7 (32)</td>
<td></td>
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<tr>
<td>Brick</td>
<td>8 (16)</td>
<td>3 (10)</td>
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<tr>
<td>Dirt</td>
<td>17 (33)</td>
<td>10 (35)</td>
<td>7 (32)</td>
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**Animals present**

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<td>None</td>
<td>15 (29)</td>
<td>11 (38)</td>
<td>4 (18)</td>
<td>0.23</td>
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<tr>
<td>Dogs</td>
<td>25 (51)</td>
<td>15 (56)</td>
<td>10 (46)</td>
<td></td>
</tr>
<tr>
<td>Cats</td>
<td>11 (22)</td>
<td>5 (19)</td>
<td>6 (27)</td>
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<tr>
<td>Chickens</td>
<td>11 (22)</td>
<td>5 (19)</td>
<td>6 (27)</td>
<td></td>
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<tr>
<td>Pigs</td>
<td>4 (8)</td>
<td>2 (7)</td>
<td>2 (9)</td>
<td></td>
</tr>
<tr>
<td>Parrot/Parakeet/Pet bird</td>
<td>10 (20)</td>
<td>5 (19)</td>
<td>5 (23)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (2)</td>
<td>1 (4)</td>
<td>0 (0)</td>
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**Table 1: Infant participant characteristics**

1Pearson’s chi-square was used to complete the statistical analysis.

2Values are means ± SD

3Values are number of participants (percent rounded to the nearest integer)

4Multiple responses were included and response totals are > 100%

5Data collected on n = 50 participants (n = 29 males, n = 21 females)

Bold indicates significance (p ≤ 0.05).

n/a = not applicable

**Figure 1:** Breastfeeding and bottle feeding practices in male and female Nicaraguan infants at six months of age. (a) Percent of infants and breastfeeding practices, (b) Percent of infants and bottle use initiation.
types assessed that were consumed in this Nicaraguan infant cohort. A majority of infants consumed between four and seven different food types (totaling 83% of males and 82% of females). The most common number of food groups consumed by males was 4 (28%), while 32% of females consumed 5 different food types. A multiple linear regression analysis was performed to evaluate number of food types consumed and nutritional status among males and female infant participants.

Differences in Complementary Feeding Practices among Infants

Multiple linear regression analysis was performed to assess the effects of complementary feeding practices, breastfeeding and bottle use on nutritional status, independent of sex (Table 3). The model with LAZ as the dependent variable and cow’s milk and sex as the independent variables was statistically significant (p = 0.04), where 8.4% of LAZ was predicted by cow’s milk consumption. The unstandardized coefficient reveals that there is a positive association between cow milk consumption and LAZ, when controlling for sex.

Discussion

This study described the breastfeeding and weaning practices of a six-month-old Nicaraguan infant cohort, and also examined associations between breastfeeding, bottle use, and complementary feeding on nutritional status, as measured by LAZ, WAZ, and WLZ. While no relationships were detected with regards to nutrition status or household environment factors, this study did identify a significant difference between sex and LAZ. This may have been influenced by the LAZ range of healthy male infants (-2.31 to 2.83) compared to females (-1.35 to 0.86). For breastfeeding and bottle use practices, 76% of males and 82% of females were partially breastfed, and 7% of males and 9% of females were exclusively breastfed. While this study shows the introduction to bottle feeding was common for infants that were younger than two months of age, there were no differences between breastfeeding or bottle use...
practices on nutritional status. Infant participants were also being weaned on several food types, with the most common foods being fruit and natural juices, and vegetables. Cow milk consumption was the only food type that had a positive association with nutritional status (LAZ).

The breastfeeding and bottle behavior results from this cohort were similar to that previously reported in the literature [4,8,9,18]. Ruel and Menon analyzed child feeding practices that included five Latin American countries and found that approximately 70% of Nicaraguan infants between the ages of 6–9 months were breastfeeding and 81% were using baby bottles [4]. According to Espinoza, approximately 30% of infants three months of age or less were exclusively breastfed, 61% were partially breast fed and 9% were not receiving breast milk [9]. While this analysis was performed during infant ages where exclusive breastfeeding is preferred and recommended, it still confirms our finding that Nicaraguan infants are being weaned off breast milk earlier than six months of age. Additionally, women living in the urbanized Pacific regions had a lower prevalence of exclusively breastfeeding compared to mothers living in rural and central areas of the country [9]. Other Latin American countries, such as Mexico, have only 8% of infants reported to be exclusively breastfed at six months of age [20].

This descriptive analysis showed high levels of partial breastfeeding in both males and females at six months of age, and was an important update to another recent report highlighting Nicaragua as the least common of several Latin American countries to continue breastfeeding between six months and two years [18]. Cultural preferences that drift from current recommendations may be attributed to less understood beliefs of Nicaraguan mothers. For instance, exclusive breastfeeding in infants less than one year old may not be perceived to be helpful to growth, and rather viewed as being an inconvenience to mothers, particularly working mothers [9,21].

A large majority of infants in this cohort were consuming fruits and natural juices, followed by vegetables. Other food types such as cow’s milk, rice cereal, gallo pinto, cheese, and yogurt were consumed by fewer numbers of infants. It was expected that brown rice was not consumed by infants at all. Early introduction of fruits and vegetables has been previously reported, indicating that these are popular weaning food types in Latin American countries [20]. Formula was another common food type consumed, indicating that the partially breastfed participants were likely receiving formula in addition to breast milk. The majority (83% of males and 82% of females) in this cohort consumed between four and seven different food types at six months of age. Future investigations may consider evaluating when these infants begin eating these food types and whether dietary weaning patterns emerge prior to this six-month assessment. Prior results from the literature have indicated that over 90% of Latin American mothers start weaning their baby to solid foods before the age of six months [12].

In this study, the introduction to consuming common Nicaraguan food types had limited effects on the nutrition status of these infants at 6 months of age. The finding that consumption of cow’s milk was positively associated with LAZ was consistent with previous reports [22,23]. There have been several studies from different geographical locations, including China, Jamaica, Mexico, and Brazil, that have shown consumption of cow’s milk favorably affects length growth in infants and young children [22]. The recommendation to introduce complementary foods when children are six months old was based on the increased nutritional needs for healthy growth and development that breast milk alone cannot provide [6,7], yet in this study, we did not find that dietary intake with a greater number of food types correlated with nutritional status in males and females at six months of age.

Study limitations herein included the lack of information regarding mother’s occupation to contribute to family economic status. Prior data supported that Nicaraguan housewives were more likely to exclusively breastfeed compared to working mothers [18]. Additionally, data was not collected in a manner whereby the amounts of each food type and specific combinations of foods could be calculated as a percent of total dietary intake. Furthermore, our data could not be interpreted to specify how many times mothers were including formula, breast milk, cow’s milk, fruit juices, water, or other liquids into the baby bottles. Bottle-feeding behaviors which can include non-nutritive liquids, such as fresca (a common fruit juice drink with added sugar and water) and carbonated sugar-sweetened beverages is a global child obesity concern [8,24]. Recall bias was another possible limitation of the study dietary records.

Although the Nicaraguan Ministry of Health promotes the WHO’s exclusive breastfeeding recommendations for the first six months of life [3] and provides child health nutrition education to mothers [10], there were very few infants that were exclusively breastfed and many infants were already receiving a variety of complementary food types. Further postnatal breastfeeding education is necessary in this region since we and others have shown that Latin American mothers are more likely to practice nonexclusive breastfeeding behaviors as they introduce solid foods before the six-month mark [4,9,18,25]. Improving breastfeeding rates for working Nicaraguan mothers was identified in a recent report by the United Nations Children's Emergency Fund (UNICEF). This effort would aid to develop breast milk extraction rooms and a breastfeeding counseling program as part of an alliance between the Better Work/International Labor Organization, UNICEF, and SoyNica. The program increased exclusive breastfeeding rates among female workers from 12% in 2013 to 60% in 2015 [26].

**Conclusion**

Breastfeeding infant feeding recommendations are not being closely adhered to for six-month old infants, and family structure and cultural perceptions are influential factors. While this analysis did not reveal any negative consequences on nutritional status from diets of healthy Nicaraguan 6-month old infants, continued investigation on growth and development outcomes from weaning patterns is necessary to bolster culturally-appropriate and relevant trainings on infant nutrition in Nicaragua.

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**Disclaimers and Conflict of Interest Declaration**

The authors declare no conflict of interest and no disclaimers to report.

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