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Optimal Duration of Exclusive Breastfeeding of Low Birthweight Infants in Honduras

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Executive Summary

Background and Objectives

Current evidence indicates that exclusive breastfeeding until about six months of age can be recommended for full-term, normal birthweight infants, but it is unclear whether this recommendation can also be applied to low birthweight (LBW) infants. LBW infants represent up to 50% of births in some developing countries. Because infant sucking ability is related to birthweight, mothers of these infants may have more difficulty establishing lactation. LBW infants are also more vulnerable to nutritional deficiencies because they are more likely to be born to malnourished mothers and to have lower stores of several key nutrients at birth. They may also be more vulnerable to dehydration, due to limited renal function. At present there are no reference data for growth of LBW, breastfed infants, which makes it difficult to evaluate the adequacy of breastfeeding in this group.

This study was designed to address the following specific questions with respect to term, LBW infants in Honduras:

1) What is the incidence of inadequate breastmilk intake among LBW infants whose mothers are provided with intensive lactation guidance, and what are the risk factors for this?

2) What is the pattern of growth among exclusively breastfed, LBW infants, and does this vary between those born to mothers of low versus normal body mass index?

3) Do exclusively breastfed, LBW infants need extra water?

4) What is the risk of micronutrient deficiencies among exclusively breastfed, LBW infants?

5) What are the barriers to exclusive breastfeeding in this population?

6) Do exclusively breastfed, LBW infants need complementary food prior to six months?

Study Design

The study was designed as a prospective observational study from birth to four months of age, followed by a randomized intervention trial of complementary feeding from four to six months. Mothers of full-term (> 37 week) infants weighing 1500-2500 grams at birth, who were willing to exclusively breastfeed for at least four months, were recruited from the two main maternity hospitals in San Pedro Sula, Honduras. Lactation guidance was provided to all subjects in the hospital and at home visits at three days postpartum and every week thereafter. Anthropometric and morbidity data were collected each week. Blood samples were collected at two, four, and six months of age. At

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sixteen weeks of age, infants were randomly assigned to one of two groups: 1) continued exclusive breastfeeding to six months, or 2) complementary feeding plus breastfeeding from four to six months, with mothers requested to maintain baseline nursing frequency. The complementary foods were provided in jars (Beech Nut) and included rice cereal, chicken, fruits and vegetables.

Preliminary Findings

The following are highlights of the preliminary results from this project:

Adequacy of Lactation

The adequacy of lactation was assessed by weighing all infants weekly during the first four months. When weight gain was low in a given week, the field workers assessed the situation and provided some advice to the mother. An infant was considered to have "inadequate weight gain" if there were two consecutive weeks of low gain. In these cases, the mother and infant were either brought into the central facility for further assessment, or a lactation consultant went to the home to conduct an assessment.

In total, 65 cases (40%) met the criteria for "inadequate weight gain" at some point during the first sixteen weeks postpartum, using cut-offs that approximated the tenth percentile for growth velocity. Of these, supplementary feeds were considered necessary for seven infants (in three of these, the "supplement" given was the mother's breastmilk by syringe or spoon). Two required temporary feeding by nasogastric tube. Of the seven cases, all but two were able to discontinue the supplement after one to two weeks. There are no normative data available to indicate what the expected percentage would be in a more affluent population, but given the typically large within-individual variability in infant growth, it is likely to be considerably greater than 10%. In this sample, the percentage identified with inadequate weight gain did not change with age in a consistent pattern. However, certain problems were more likely to be evident during the first few weeks, such as poor infant suck, infant sleeping too much, and poor breastfeeding technique. Inadequate weight gain was more often linked to infant factors, particularly illness, than to maternal factors. After receiving lactation guidance, the vast majority of the cases did not continue to exhibit inadequate growth. Supplementation was rarely considered necessary, even temporarily.

Infant Growth

First Month

Infant weight gain during each of several intervals (0-7 days, 0-14 days, and 0-30 days) was examined as a proxy for adequacy of breastmilk intake during the establishment of breastfeeding. More than

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30 different variables that might influence this process were examined using multiple regression. These were grouped into five categories: a) infant characteristics (anthropometric indices, gestational age, sex, Apgar score); b) maternal characteristics (age, parity, birth spacing, marital status, education, anthropometric indices, and several indicators of socioeconomic status); c) early feeding practices (use of a bottle in the hospital, use of a "chupon," timing of the first breastfeed); d) aspects of labor, delivery and the early postnatal period (vaginal versus cesarean section, complications for either mother or infant, length and difficulty of labor, breast pain, cracked nipples); and, e) variables reflecting maternal attitudes and motivation (number of visits for prenatal care, confidence in breastfeeding, anxiety level).

Of these variables, several consistent associations were observed. In the first two weeks, infant weight gain was positively associated with gestational age, Apgar score, head circumference, and number of prenatal visits and negatively associated with ponderal index (wt/length3), use of a bottle in the hospital, length of labor, parity, and use of a chupon. Infant sex became an important predictor of weight gain after the first two weeks. Several variables were not related to infant weight gain, including maternal anthropometric indices, education and marital status.

These results indicate that the risk factors for lower weight gain in the first month include the following: infant immaturity; infant health status at birth (Apgar score); high ponderal index at birth; lack of prenatal care; use of bottles or chupones; long labor; and, other children to care for.

Birth to Four Months

The LBW cohort showed considerable "catch-up" by four months, with the average z-score increasing from -2.04 to -0.45. However, absolute weight gain from birth to four months was significantly lower in the LBW infants compared to data from normal weight infants available from an earlier study. The average length-for-age z-score of the LBW cohort increased from -1.95 to -1.01 from birth to four months.

The average BMI of the mothers was 23.7 kg/m2; only fifteen had a BMI considered "low" (< 20). Weight gain of infants born to these low BMI mothers was significantly lower from zero to four months than that of infants born to normal BMI mothers. The difference in length gain zero to four months was not significant.

Hydration Status

Urine specific gravity was measured as an indicator of hydration status of male infants at two weeks (N=68) and eight weeks (N=59) of age. Subjects stayed at the central facility for eight hours, during which time two to twelve urine samples were collected per infant. The range in temperature was 72-96o F, and the range in relative humidity was 37-86%. None of these infants had an abnormal

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level (> 1.02) indicative of an attempt to conserve water. The only case of dehydration seen during the study was an infant brought in for assessment of inadequate weight gain in the first two weeks postpartum, whose mother had very low milk production.

These results indicate that even among low birthweight infants in a hot, humid climate, breastmilk alone is sufficient to assure adequate hydration status.

Anemia

Blood samples were collected at two, four, and six months. At two months, 47.5% had a hemoglobin (Hb) concentration < 10 g/dL and were given iron supplements. At four months, another eight infants had a Hb < 10, and eleven of 58 infants who had received iron supplements at two months still had a Hb < 10. Slightly less than half (49%) of the infants did not have a low Hb level at either two or four months, and 35% never had a low Hb level during the first six months.

Results from retesting of those infants who received iron supplements suggests that iron deficiency was a factor underlying low Hb levels in the majority of cases. Small infant size was the main predictor of low Hb at two months.

Plasma ferritin was measured, as this index is generally considered to be reflective of iron stores. The results indicated no correlation between ferritin concentration and either Hb or hematocrit. Thus, ferritin concentration does not appear to be a good index of iron status during the first six months of life. Data on other indicators of iron status (% transferrin saturation) are still pending.

These results confirm previous observations that low birthweight, exclusively breastfed infants are at high risk for iron deficiency within the first six months of life. Current recommendations are to provide iron drops routinely to all such infants at about two to three months.

Analyses of other indices of micronutrient status are pending.

Barriers to Exclusive Breastfeeding

In general, there was strong support for exclusive breastfeeding from husbands, but less support from the mother's parents, in-laws, friends, and neighbors. At two, four, eight, and twelve weeks postpartum, mothers were asked if anyone advised them to give the child other fluids or foods. The percentage responding "yes" was 23%, 19%, 21% and 11%, respectively. In the first month, such advice came from many sources (family, neighbors, husband, friends), but at eight and twelve weeks such advice was most likely to come from neighbors. The percentage of mothers who were confident in their ability/desire to exclusively breastfeed until six months increased from 87% at two weeks to 96-97% at eight to twelve weeks.

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These findings indicate that the whole community must be targeted in educational campaigns to increase the duration of exclusive breastfeeding. The most vulnerable period is the first few weeks postpartum. After that, mothers' confidence in their ability to exclusively breastfeed increases, although they still face pressure from others to give their children other foods or fluids.

Response to Complementary Foods from Four to Six Months

There was no significant difference in weight or length gain from four to six months between exclusively breastfed infants and those who were given complementary foods. As was found in our previous study, breastmilk intake declined between four and six months in those given complementary foods but increased slightly in those exclusively breastfed. These results suggest that with regard to infant growth, the recommendation to breastfeed exclusively to about six months can also be applied to LBW infants.

Programmatic Implications

- The recommendation to breastfeed exclusively to about six months can also be applied to LBW infants.
- Supplemental water is not needed even among low birthweight infants in a hot, humid climate.
- Low birthweight, exclusively breastfed infants are at high risk for iron deficiency within the first six months of life and should be routinely provided with iron drops at about two to three months.
- Mothers of LBW infants may require targetting for lactation guidance
- Use of bottles in the hospital was significantly associated with low weight gain in the first two weeks and should be avoided, unless absolutely medically indicated.
- The most vulnerable period for failure to exclusively breastfeed is the first few weeks postpartum.

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Optimal Duration of Exclusive Breastfeeding of Low Birthweight Infants in Honduras

Background and Objectives

Current evidence indicates that exclusive breastfeeding until about six months of age can be recommended for full-term, normal birthweight infants, but it is unclear whether this recommendation can also be applied to low birthweight (LBW) infants. LBW infants represent up to 50% of births in some developing countries. Because infant sucking ability is related to birthweight, mothers of these infants may have more difficulty establishing lactation. LBW infants are also more vulnerable to nutritional deficiencies because they are more likely to be born to malnourished mothers and to have lower stores of several key nutrients at birth. They may also be more vulnerable to dehydration, due to immature renal function. At present there are no reference data for growth of LBW, breastfed infants, which makes it difficult to evaluate the adequacy of breastfeeding in this group.

This study was designed to address the following specific questions with respect to term, LBW (i.e., small-for-gestational age) infants in Honduras:

1) What is the incidence of inadequate breastmilk intake among LBW infants whose mothers are provided with intensive lactation guidance, and what are the risk factors for this?

2) What is the pattern of growth among exclusively breastfed, LBW infants, and does this vary between those born to mothers of low vs. normal body mass index?

3) Do exclusively breastfed, LBW infants need extra water?

4) What is the risk of micronutrient deficiencies among exclusively breastfed, LBW infants?

5) What are the barriers to exclusive breastfeeding in this population?

6) Do exclusively breastfed, LBW infants need complementary food prior to six months?

Study Design

The study was designed as a prospective observational study from birth to four months of age, followed by a randomized intervention trial of complementary feeding from four to six months. Mothers of full-term ($\geq$ 37 wk) infants weighing 1500-2500 g at birth, who were willing to exclusively breastfeed for at least four months, were recruited from the two main maternity hospitals in San Pedro Sula, Honduras. Lactation guidance was provided to all subjects in the hospital and at home visits at three days postpartum and every week thereafter. Anthropometric and morbidity data

were collected each week. Blood samples were collected at two, four, and six months of age. At sixteen weeks of age, infants were randomly assigned to one of two groups: 1) continued exclusive breastfeeding to six months, or 2) complementary feeding plus breastfeeding from four to six months, with mothers requested to maintain baseline nursing frequency. The complementary foods were provided in jars (Beech Nut) and included rice cereal, chicken, fruits, and vegetables.

Sample Size and Attrition

During the 24 weeks of recruitment there were 8218 births, of which 569 (6.9%) were low birth weight. Of these 569, 227 qualified for the study and agreed to participate. The main reasons for not participating were work (40%), residence outside of the recruitment zone (28%), prematurity (17%), infant illness, death or adoption (4%), and inability of field workers to find the subject's home (4%).

Of the 227 women who enrolled, 133 completed the study to four months postpartum. Thus, the attrition rate was 41.4%. The reasons for attrition were as follows:

n	%	Reason
32	34	Moved or could no longer be located
26	28	Did not exclusively breastfeed
22	23	Went back to work
10	11	Spouse or family refused permission to continue
4	4	Infant or mother died or was very ill

Of the 26 who did not exclusively breastfeed for the full four months, the following reasons were given for introducing other fluids or foods: a) "insufficient milk" [6]; b) baby cries too much, disturbs husband [4]; c) didn't really intend to exclusively breastfeed that long (despite saying so at recruitment) [4]; d) too busy/ had to leave house often/ family pressure [4]; e) infant suck problems [3]; f) breastfeeding problem/ baby hospitalized, and mother did not want to persevere or relactate [3]; and g) mother intended to go back to work [2].

Characteristics of Subjects

Characteristics of subjects who completed the study to four months and of those lost to attrition are shown in Table 1. There were no significant differences between participants and dropouts in infant sex, gestational age, birthweight, head circumference at birth, ponderal index, or nutritional status score (CANSCORE, Metcoff, 1994), or in maternal age, height, body mass index, income, or prenatal care. However, dropouts were significantly lower in infant birth length and there were marginally significant differences in maternal education and weight. In addition, dropouts had lower infant weight gain than participants during the first four weeks of life.

Results

Adequacy of Lactation

To identify potential cases of insufficient breastmilk intake, the following criteria were developed based on growth data for breastfed infants from Nelson et al. (1989) and from seven other studies in North America and northern Europe (WHO Working Group on Infant Growth, 1994), taking into account the accuracy of the scale used during home visits:

Age of Infant	Low Weight Gain
Week 1	Loss of > 10% of birthweight
Week 2	< 100 g/wk
Weeks 3-6	Boys: < 175 g/wk Girls: < 75 g/wk
Weeks 7-12	< 100 g/wk
Weeks 13-16	< 75 g/wk

After the first week, the above values correspond to roughly the tenth percentile of expected weight gain per week. When weight gain was low in a given week, the field workers assessed the situation and provided some advice to the mother. An infant was considered to have "inadequate weight gain" if there were *two consecutive weeks* of low gain according to the above criteria. In these cases, the mother and infant were either brought into the central facility for further assessment (including measurement of milk volume), or a lactation consultant went to the home to conduct an assessment.

In total, 65 cases met the criteria for "inadequate weight gain" at some point during the first sixteen weeks postpartum. If an infant experienced more than one two-week episode of inadequate weight gain, only the first instance was included in the tabulations below. The distribution by infant age is as follows:

Infant Age	Total # Subjects in Study	# Cases	%	# Assessed in Facility
0-2 Weeks	202	13	6.4	8
2-6 Weeks	171	20	11.7	9
6-12 Weeks	151	11	7.3	2
12-16 Weeks	133	21	15.8	2

Of the 65 cases, 21 were brought into the central facility for an eight-hour assessment of milk intake. For the remaining 44, there were several reasons why they were not brought into the facility: a) in many of these cases, the infant had been ill, but there was no indication of a problem with lactation; b) in some cases, the mother/infant pair was already scheduled to come into the facility for another reason within a week or two, so the milk intake assessment was postponed; and, c) in other cases, the mother could not come in for eight hours or it was felt that the problem could be resolved without a detailed work-up.

Test-weighing to assess milk intake was performed for the 21 cases who came into the facility. Average breastmilk intake was 159 ± 81 g/8 hr. A "low" milk intake was considered to be < 175 g/8 hr (based on the tenth percentile of milk intake at 4 mo postpartum for subjects who participated in a later phase of this study). Using this criterion, 46% of the 21 cases had low milk intake at the time of assessment. Only five infants had any clinical signs of note: one was dehydrated, two had sucking problems, and one was flaccid. On the day of assessment, two infants had upper respiratory infections and one had conjunctivitis; three of the 21 mothers were anemic, one of these also had malaria, and, two others had infected stitches from C-sections.

Table 2 shows the diagnoses made by the physician/nurse team with regard to the reasons for inadequate weight gain. The percentages add up to more than 100% because there were multiple reasons for some infants. Infant illness was the most common diagnosis. In total, 46 of the 65 infants (71%) had been ill during the period of inadequate weight gain (primarily upper respiratory tract infections and fevers), although this was not always diagnosed as the cause of the poor growth. Other reasons for poor growth included infant sleepiness; insufficient breastfeeding frequency or time; poor infant suck or problems with latch-on; poor breastfeeding technique; provision of other fluids to the infant, leading to poor breastmilk intake; maternal illness; and emotional or family problems.

Of the 65 cases, supplementary feeds were considered necessary for seven infants (in three of these, the "supplement" given was the mother's breastmilk by syringe or spoon). Two required temporary feeding by nasogastric tube. Of the seven cases, all but two were able to discontinue the supplement after one to two weeks (in the other two cases, there were medical problems requiring hospitalization of the mother or infant, which jeopardized milk production; neither mother wanted to try to relactate).

Growth during the two weeks after assessment, for the 58 infants who were not supplemented, was categorized as follows:

n	Growth
41	Had 0 weeks of inadequate growth
13	Had 1 week of inadequate growth
0	Had 2 weeks of inadequate growth
4	Dropped out of the study within 2 weeks of assessment

To summarize, these data suggest that about 40% of the low birthweight infants experienced at least one episode (two consecutive weeks) of inadequate weight gain during the first sixteen weeks of life, using cut-offs that approximated the tenth percentile for growth velocity. There are no normative data available to indicate what the expected percentage would be in a more affluent population, but given the typically large within-individual variability in infant growth (WHO Working Group on Infant Growth, 1994), it is likely to be considerably greater than 10%. In this sample, the percentage identified with inadequate weight gain did not change with age in a consistent pattern. However, certain problems were more likely to be evident during the first few weeks, such as poor infant suck, infant sleeping too much, and poor breastfeeding technique. Inadequate weight gain was more often linked to infant factors, particularly illness, than to maternal factors. After receiving lactation guidance, the vast majority of the cases did not continue to exhibit inadequate growth. Supplementation was rarely considered necessary, even temporarily.

Infant Growth

First Month

Infant weight gain during each of several intervals (0-7 days, 0-14 days, and 0-30 days) was examined as a proxy for adequacy of breastmilk intake during the establishment of breastfeeding. More than 30 different variables that might influence this process were examined using multiple regression.

These were grouped into five categories: a) infant characteristics (anthropometric indices, gestational age, sex, Apgar score), b) maternal characteristics (age, parity, birth spacing, marital status, education, anthropometric indices, and several indicators of socioeconomic status), c) early feeding practices (use of a bottle in the hospital, use of a "chupon," timing of the first breastfeed), d) aspects of labor, delivery and the early postnatal period (vaginal vs. C-section, complications for either mother or infant, length and difficulty of labor, breast pain, cracked nipples), and e) variables reflecting maternal attitudes and motivation (number of visits for prenatal care, confidence in breastfeeding, anxiety level).

Of these variables, several consistent associations were observed. In the first two weeks, infant weight gain was positively associated with gestational age, Apgar score, head circumference, and number of prenatal visits and negatively associated with ponderal index (wt/length^3), use of a bottle in the hospital (which was linked with C-section delivery), length of labor, parity (which was linked with maternal age), and use of a chupon. Infant sex became an important predictor of weight gain after the first two weeks. Several variables were not related to infant weight gain, including maternal anthropometric indices, education and marital status.

These results indicate that the risk factors for lower weight gain in the first month include the following:

- infant immaturity (note that all infants were $\geq$ 37 weeks gestation);
- infant health status at birth (Apgar score);
- high ponderal index at birth;
- lack of prenatal care;
- use of bottles or chupones;
- long labor; and,
- other children to care for.

Birth to Four Months

Weight, length and head circumference data for males and females for the LBW cohort of 133 infants are shown in Table 3.

Figure 1 shows the weight-for-age z-scores of the LBW cohort, in comparison with 113 exclusively breastfed infants in our previous study in Honduras who were of normal birthweight (NBW: > 2500 g). The LBW cohort showed considerable "catch-up" by four months, with the average z-score increasing from -2.04 to -0.45. However, absolute weight gain from birth to four months was significantly lower in the LBW infants compared to the NBW cohort: 3355 $\pm$ 620 vs. 3641 $\pm$ 599 g ($p < 0.0001$). Figure 2 shows the average length-for-age z-score of the LBW cohort, which increased from -1.95 to -1.01 from birth to four months (comparable data are not available for the NBW cohort).

Z-scores were also calculated using a pooled dataset of breastfed infants from affluent populations (WHO Working Group on Infant Growth, 1994) as the "reference" rather than the NCHS database. Figure 3 shows that both weight-for-age and length-for-age increased relative to the breastfed reference, with a steeper increase in the former than in the latter.

Monthly weight and length gains are shown in Table 4. Compared to weight gain of breastfed infants in affluent populations (WHO Working Group on Infant Growth, 1994; Dewey et al., 1992), weight gain of the LBW cohort was similar (0-1 and 3-4 mo) or more rapid (1-3 mo). Length gain of the LBW cohort was more rapid than that of breastfed infants in affluent populations during each of the first four months of life.

Table 5 shows weight and length gain by maternal BMI and infant ponderal index categories. Average BMI of the mothers was 23.7 kg/m^2; only 21 had a BMI considered "low" (< 20). Weight gain of infants born to these low BMI mothers tended to be lower from 0 to 4 months than that of infants born to normal BMI mothers ($p= 0.065$). The difference in length gain 0 to 4 months was not significant. Only eighteen infants were identified as having a low ponderal index. There were no significant differences in weight or length gain from 0-4 months between infants with normal vs. low ponderal index.

Results of the multiple regression analyses are shown in Table 6. Because data on income were available for only 109 of the 133 subjects, the analyses were run both with and without this variable. Income was not a significant factor in any of the analyses, so the results are shown for the models run without it. Infant weight gain from birth to four months was higher in boys than in girls, was negatively associated with parity, and was positively associated with infant birth length and number of prenatal visits. Length gain from birth to four months was also higher in boys than girls, and was positively associated with maternal height, floor type (an index of socioeconomic status), and number of prenatal visits.

Hydration Status

At 2 (n=68) and 8 (n=59) weeks of age, hydration status was assessed. To simplify urine collection procedures, only male infants were included in this assessment. Mothers and their infants spent eight hours at a central facility. During that time, each infant wore a sterile, adhesive plastic collection bag with a drainage tube. After each void, the urine was suctioned from the bag using a syringe and the amount was weighed to the nearest gram. Total urine volume was calculated as the sum of all voids. Ambient temperature and relative humidity were recorded every two hours during the assessment period. Urine specific gravity was measured for each void using a hand-held refractometer (Atago: Urincon-PN). Breastmilk intake was also measured during the eight-hour period.

Ambient air temperature ranged from 72-96° F, and relative humidity from 37-86% during the eight-hour assessment period (8:00 am - 4:00 pm). Between two and twelve urine samples were collected

per infant. Average eight-hour urine output was 71 g at two weeks, and 107 g at eight weeks. Average eight-hour breastmilk intake was 188 g at two weeks and 267 g at eight weeks. The range in maximum urine specific gravity was 1.001-1.012 at two weeks and 1.002-1.010 at eight weeks (Figure 4). None of the infants had an abnormal level (> 1.02) indicative of an attempt to conserve water.

The only case of dehydration seen during the study was an infant brought in for assessment of inadequate weight gain in the first two weeks postpartum, whose mother had very low milk production.

These results indicate that even among low birthweight infants in a hot, humid climate, breastmilk alone is sufficient to assure adequate hydration status.

Micronutrient Status

Anemia and Iron Status

Table 7 shows data for Hb, Hct, MCV, ferritin and transferrin saturation. At two months, 75 of 158 infants (47.5%) had a Hb concentration < 10 g/dL and were given iron supplements. At four months, another eight infants (who had not had a low Hb concentration at two months) had a Hb < 10, and eleven of 58 infants who had received iron supplements at two months still had a Hb < 10. There were 62 infants (48% of 129 tested) at four months who did not have a low Hb level at either two or four months, and 23 infants (20% of 113 tested) who never had a low Hb level during the first six months. Similar results were found with regard to low Hct levels: 51.9% of infants at two months had a Hct < 30%; another 12.5% fell below this cutoff at four months. There were 56 infants (43% of 129 tested) who did not have a low Hct level at either two or four months, and 26 infants (23% of 113 tested) who never had a low Hct during the first six months.

Of those who received iron supplements at two months and were retested at four months (N=58), 19% had an increase in Hb of < 0.8 g/dL whereas 81% had an increase of ≥ 1.0 g/dL. In those who did not receive iron supplements at two months, 10% had an increase in Hb of ≥ 1.0 g/dL. Of those who received iron supplements at four months and were retested at six months (N=23), 56.5% had an increase in Hb of ≥ 1.0 g/dL, compared to 6.9% of those who did not receive iron supplements at four months.

MCV values decreased from two to six months (from 89.2 to 72.7 fL) in both the iron supplemented and non-supplemented infants. At four months there was little difference in MCV between those infants who had received iron supplements at two months and those who had not. However, at six months, those who had received iron supplemention previously (at two and/or four months) had significantly higher MCV values than those who had never been supplemented. The change in MCV

from two to four months was similar between supplemented and non-supplemented infants, but change in MCV between four and six months was significantly higher in the iron-supplemented group.

Plasma ferritin concentrations were very high at two months, and declined over time even in infants given iron supplements. Despite the fact that about half of the infants at two months had a low Hb, none of them had a ferritin concentration < 12 ug/ml. At four and six months the percentage with low ferritin was 4.5% and 13.2%, respectively (5.8% and 16.9%, respectively, when excluding subjects with high or missing C-reactive protein values). At four months, this proportion did not differ significantly between the iron-supplemented and non-supplemented groups, but at six months, infants who had never received iron supplements were more likely to have low ferritin (23.1%) than those who had received iron at two and/or four months (23.1 vs. 2.7%, $X^2 = 6.9$; p=0.009).

Transferrin saturation declined from an average of 54.7% at two months to 35-37% at four to six months. There were no cases of low transferrin saturation (< 12%) at two or four months and only one case at six months. Mean values were significantly higher in the iron supplemented group at four months (p=0.04), but not at six months.

Zinc, Folate, Vitamin B_{12} and Vitamin A Status

Table 8 shows data for the indices of zinc, folate, vitamin B_{12} and vitamin A status. Mean plasma zinc concentration increased slightly with age, from 72.6 ug/dL at 2 mo to 77.1 ug/dL at six months. The percentage with values below 60 ug/dL was 18.9% at two months, but only 5-7% at four and six months.

Plasma folate concentrations averaged 10.7, 18.0 and 15.6 ng/ml at two, four, and six months, respectively. At none of these ages were any infants found to have values below the usual cut-off for adults (<3 ng/ml). However, it is unclear whether this cut-off is appropriate for infants because their average values are usually about 20 ng/ml (Fomon, 1993), which is higher than the usual average for adults (about 6 ng/ml). Mean red blood cell folate concentrations increased from 162 to about 200 ng/ml between two months and four to six months. A substantial proportion of the infants had values below the usual cut-off for adults (140 ng/ml): 43%, 15% and 27% at two, four, and six months, respectively. Again, it is unclear whether this cut-off value is appropriate for young infants, in whom hematological parameters are changing rapidly. Using a lower cut-off of 120 (or 100) ng/ml (Gibson, 1990), the proportion with low values was 30%, 11%, and 18% (19%, 8%, and 8%) at two, four, and six months, respectively.

Mean plasma vitamin B_{12} concentrations were 291, 343 and 284 pg/ml at two, four, and six months, respectively. Approximately 20-30% had a value below 200 pg/ml (considered "marginal" in adults), 6-10% had a value below 130 pg/ml (considered "low" in adults), and very few (1-5%) had a value below 100 pg/ml (considered deficient in adults).

Plasma vitamin A concentrations averaged 22-28 ug/dl at 2-6 mo, and ranged from 7 to 57 ug/dl. Infants and young children are known to have lower serum vitamin A levels than adults (Lewis et al., 1990), and thus the usual cut-off for "deficiency" of < 20 ug/dL is not appropriate. Using a cut-off of < 10 ug/dL, the percentage "low" was 3.9%, 2.2% and 0% at two, four, and six months, respectively.

Correlations Among Indices of Micronutrient Status

Only correlations with a coefficient > 0.30 ($p < 0.01$) will be discussed. At all ages, Hb was closely correlated with Hct ($r = 0.88$-0.94), and the folate values (serum and red blood cell indices) were positively correlated with each other ($r = 0.39$-0.54). At two months, plasma vitamin A was positively correlated with transferrin saturation ($r = 0.32$). At both four and six months, MCV was positively correlated with both Hb and Hct ($r = 0.30$-0.31), and transferrin saturation was negatively associated with both MCV ($r = -0.35$ and -0.50, respectively) and ferritin ($r = -0.41$ and -0.51, respectively). In addition, plasma folate was positively correlated with vitamin B_{12} concentration at four months ($r = 0.39$) and with transferrin saturation at six months ($r = 0.33$). At no age was ferritin significantly correlated with Hb or Hct.

Summary

- The response of Hb and Hct to iron supplementation at two and four months, together with results from randomized trials with low birthweight infants (Lundstrom et al., 1977), suggests that iron deficiency was a factor underlying low Hb levels in the majority of cases. These results confirm previous observations that low birthweight, exclusively breastfed infants are at high risk for iron deficiency within the first six months of life. Current recommendations are to provide iron drops routinely to all such infants at about two to three months.

- Despite the high prevalence of low Hb and Hct levels, very few infants had low ferritin concentrations and only one had a low transferrin saturation. Ferritin concentration is normally very high at birth and declines dramatically during the first six months of life. It was not correlated with Hb or Hct values at any age, and was negatively correlated with transferrin saturation at four and six months. Because of the rapid hematological changes that occur during early infancy, it is unclear what cut-off values to use for both ferritin and transferrin saturation. Further research on appropriate indices of iron status during infancy is needed.

- Average plasma zinc values were higher than those of breastfed infants in Finland (Salmenpera et al., 1994) and Denmark (Michaelsen et al., 1994). In comparison with values for SGA infants in Chile who were randomly assigned to Zn-supplemented or placebo groups (Castillo-Duran et al, 1995), mean values in this study were higher than those for the placebo

group and lower than those for the Zn-supplemented group at two and four months, but higher than those of both Chilean groups at six months. Using a cut-off of 60 ug/dL for plasma zinc, 19% of infants in this study had low values at two months; this proportion declined to 5-7% at four to six months. However, it is uncertain whether the cut-off of 60 ug/dL is appropriate, given that the *mean* values in Denmark and Finland were close to this level and the tenth percentiles in those two populations were approximately 39-53 at two months and 42-45 at four to six months. By contrast, the *lowest* plasma zinc concentration among the infants in Honduras was 39 at two months, 58 at four months, and 56 at six months. There are many limitations to using plasma zinc as an index of zinc status. Nonetheless, these results suggest that zinc deficiency is no more common among LBW, exclusively breastfed infants in Honduras than it is among healthy, exclusively breastfed infants in affluent populations.

- Plasma folate is considered an indicator of short-term folate status (i.e., dietary intake), whereas red blood cell folate is thought to reflect long-term status. No infant had a low plasma folate concentration (using the typical cut-off for adults), but a substantial proportion (8-43%, depending on age and the cut-off used) had low red blood cell folate. Again, the appropriate cut-off for infants is unclear.

- The appropriate cut-off value for plasma vitamin B_{12} in infants is also not well understood. Very few infants had a value below 100 pg/ml, which is considered deficient among adults (Gibson, 1990), but approximately 6-10% of the infants at each age had a value below 130 pg/ml, and 20-30% had a value below 200 pg/ml. Vitamin B_{12} values were not significantly correlated with MCV (a marker of macrocytic anemia) at any age, so the significance of the "low" plasma concentrations is unclear.

- Less than 5% of infants had plasma vitamin A concentrations < 10 ug/dL.

Barriers to Exclusive Breastfeeding

Several approaches were used to investigate the barriers to exclusive breastfeeding in this population. Prior to recruitment of subjects for the prospective study, focus group discussions were conducted with women who participated in our previous study in the same location. Women who lived close to the study offices or in easily accessible communities were recontacted and asked to take part in a discussion about their breastfeeding experiences. All of the women had exclusively breastfed their infants to four or six months of age (depending on their group assignment in the previous randomized trial). Five focus group discussions were conducted with six to eight woman per group in several communities surrounding San Pedro Sula. Two of the most experienced staff members from the previous study led the discussions and recorded the mothers' exchange. The objectives of the focus group discussions were to evaluate the mothers' reactions to exclusive breastfeeding for four to six months, and to identify pressures or constraints that made it difficult for them to comply with their

group assignment. The guide used for the focus group discussions appears in Appendix 1. Information obtained from the focus groups and from our previous studies was used to design educational materials to be used in the prospective study of LBW infants (Appendix 2).

At the first home interview with mothers in the LBW study, information was obtained on their infant feeding practices with previous children. During the first six months, data were gathered at regular intervals on: a) the mother's confidence in her ability to exclusively breastfeed and her use of any other foods and fluids; b) support of family and friends for exclusive breastfeeding; and, c) pressures to introduce other foods and fluids. At the end of the intervention phase (six months postpartum), the field workers who had had the most contact with each mother reviewed the file and filled out a questionnaire that dealt with the mother's compliance with exclusive breastfeeding and the negative and positive influences that might have affected her compliance. Finally, at ten months postpartum, an "exit interview" was conducted with each mother to ask her what she did or did not like about exclusive breastfeeding (Appendix 3).

The results below are presented in order of the approaches outlined above; whenever appropriate, the responses are described following each of the specific questions asked.

Focus Group Discussions

- *Describe your experience exclusively breastfeeding. What did you like about it (advantages)? What did you dislike about it (disadvantages)?*

With regard to advantages of exclusive breastfeeding, the women commented that it was easier (especially when travelling by bus) and more comfortable (particularly at night), and that their children got sick less often, had a finer quality to their skin, were less often constipated, and were more intelligent. With regard to disadvantages, some felt that they (the mothers) lost too much weight (or at least their relatives thought they did), they didn't have enough time to attend to all their chores (because exclusive breastfeeding "required more time"), and they received negative feedback from family, friends or neighbors about their decision to exclusively breastfeed.

- *Did you have any breastfeeding problems? How were you helped to resolve them? Could something more/better have been done?*

Few women mentioned having problems breastfeeding, but those who did were pleased with the help they received from the study's lactation counselors and were able to successfully resolve the problems. The problems they experienced generally occurred early postpartum, and some commented that they wouldn't have continued to exclusively breastfeed had it not been for the amount of attention they received from the study staff.

- *Describe how your family and neighbors reacted when you told them you were only going to feed your child breastmilk and nothing else for the first four to six months.*

Almost everyone had relatives or neighbors who did not believe in exclusive breastfeeding. They thought children must be given other foods or liquids to fatten them up or quench their thirst, or because they believed that breastmilk alone wasn't sufficient to satisfy the child's nutritional needs. One woman's neighbor warned her that her boy would have nose bleeds if she continued to nurse him too long (an old belief).

- *What did you do when you had to leave the house?*

None of the mothers reported any problems when they had to leave the house because most took their babies with them. They commented that it was more difficult to take an infant along if you were bottle feeding. Almost no one expressed breastmilk and left it so that someone else could feed the infant while the mother was away. The one woman who tried this said that her baby wouldn't drink from the bottle.

- *What suggestions would you give another mother to help her exclusively breastfeed her infant?*

To encourage other mothers to breastfeed exclusively, the mothers said that they would explain that their children would be healthier and more intelligent, that breastfeeding is easier than bottle-feeding at night, and that their children *will* accept food at six months even if they have not received it prior to then. One concrete suggestion was to show photographs of the babies who had participated in the study to demonstrate how well they grew and how healthy they looked.

- *Did you always think you produced enough breastmilk for your infant to be well-fed and grow adequately?*

A number of women felt that they didn't have adequate breastmilk production at some time during their participation in the study, but once they followed the suggestions of the lactation counsellors their production improved. One woman commented that without the staff's help she wouldn't have breastfed her baby.

- *What motivated you most to [participate in the study and/or to] exclusively breastfeed your infant?*

Motivating factors for exclusive breastfeeding were: a) it was more economical and hygienic; b) the babies were healthier; c) many breastfeeding problems were avoided or resolved easily by breastfeeding on demand; and, d) the help, support and advice they received from the study staff.

Previous Infant Feeding Practices of Study Participants

About 29% of the multiparous mothers reported that they had "exclusively" breastfed a previous child until six months. The most common reasons given for feeding other foods or fluids to previous children were: a) custom (18%); b) work (16%); c) breastmilk alone did not fill them up (14%); d) the child did not "want" the breast (13%); and, e) low breastmilk production (7%). When asked who advised the mother to give other fluids or foods to the child, neighbors and friends were cited most often (35%), followed by the mother's mother (26%), other family members (16%), the husband (10%), the mother-in-law (6%) and health center personnel (4%). The main reasons given for this advice were: a) they fed their children that way (20%); b) to fatten the baby (16%); c) to be able to work (14%); d) breastmilk alone doesn't satisfy the baby (12%); and, e) custom (8%).

Infant Feeding Decisions with the Study Infant

With regard to the study infant, Table 9 shows the perceived feeding mode preferences of family members, friends, and neighbors (asked of the mother at three days postpartum). There was strong support from husbands for exclusive breastfeeding (73%), but less of a preference for exclusive breastfeeding among the mother's parents, in-laws, friends, and neighbors (22-47%) (many of these individuals were reported to have "no opinion"). When asked to whom the mother would turn for help with breastfeeding, the most common choice was a sister (31%), followed by a friend (10%), mother (9%), sister-in-law (9%), neighbor (8%), the study personnel (6%), mother-in-law (6%), no one (5%) or grandmother (5%).

At two, four, eight, and twelve weeks postpartum, mothers were asked if anyone advised them to give the child other fluids or foods. The percentage responding "yes" was 23%, 19%, 21% and 11%, respectively. In the first month, such advice came from many sources (family, neighbors, husband, friends), but at eight and twelve weeks such advice was most likely to come from neighbors. The reasons given for such advice were: a) "they fed that way"; b) to "fatten" the baby; c) breastmilk alone wouldn't satisfy the baby; d) work; e) to reduce disturbance to the family from the baby's crying; and, f) to prevent too much weight loss by the mother.

The percentage of mothers who were confident in their ability/desire to exclusively breastfeed until six months increased from 87% at two weeks to 96-97% at eight to twelve weeks. When asked why

they were confident, the most common responses were: a) the baby would be healthier; b) "breastmilk is best"; c) the mother doesn't have to work outside the home; and, d) the mother produces plenty of milk. Very few mothers were unsure of their ability to breastfeed exclusively for six months; the main reasons given were: a) need to work; and, b) baby isn't or won't be satisfied by breastmilk alone/ low milk production.

Field Workers' Assessment of Compliance with Exclusive Breastfeeding

In making the determination as to whether each mother had really exclusively breastfed her infant, evidence gathered during the weekly visits was utilized. The most common evidence of non-compliance was the report of the mother giving non-milk liquids. The presence of baby bottles in the homes or reports of giving other milks or food were also typical reasons to suspect non-compliance. In very few cases was the infant actually observed being fed something other than breastmilk.

- *Do you think this mother really exclusively breastfed her infant to four or six months? Why?*

The field workers felt that the majority (almost 76%) of the women did indeed exclusively breastfeed for the period to which their infants had been assigned (four months for the SF group and six months for the EBF group). Of the women in the EBF group, 71% were judged to have exclusively breastfed their infants to six months, and another 10% to at least four months. In the SF group, 80% were categorized as having exclusively breastfed to four months. Of the women who were suspected of not exclusively breastfeeding (in both groups), in the vast majority of cases (93%) the women gave other foods (or food tastes) and fluids for the first time before four months postpartum, rather than after four months.

- *What were the influences on the mother to exclusively breastfeed or not?*

The field workers judged that 52% of mothers received negative comments about exclusive breastfeeding, principally from neighbors, friends, husbands, in-laws, and sisters. Sixty-two percent received positive comments, mainly from their husbands.

- *What did the mother complain about?*

Sixty-five percent of the mothers had no complaints. Of those who did, the greatest number complained about low breastmilk production (the child not being "satisfied") (21%) followed by losing weight (10%), feeling weak (10%), and the baby crying too much (10%).

"Exit" Interviews

[To date more than 75% of the subjects have completed the interview conducted at ten months postpartum (Appendix 3).]

- *At any time during the four or six months of "exclusive" breastfeeding did you give your infant other liquids or foods? What did you give, how often, how much, and at what age?*

About 44% of the SF women and 63% of the EBF women admitted ever giving anything other than breastmilk during the first four or six months, respectively. In 36% of all such cases the foods or fluids were given only once, and in another 25% they were given only a few times. Water was most often given, followed by tastes of food, other milks, juice, soda, sugar water, and soup. It is customary for parents to dip a finger into the food they are eating and touch it to the lips of their infants to get them "accustomed to new flavors". It is thought that this will prevent stomach problems when the infants begin to eat solid foods. Many of the "tastes" of food are attributable to this practice.

- *Why did you give something other than breastmilk?*

The most common reasons for giving other foods or fluids were: a) someone else fed the baby, usually when the mother was out of the house or not looking; b) to get the baby used to it; c) because they felt the baby wanted it (usually when they or other family members were eating it); d) out of curiosity; e) they were advised to do so by a family member; and, f) because the mother had to leave the baby at home when she went out (Table 10).

- *What did you like most (and least) about your exclusive breastfeeding experience?*

When asked what they liked about exclusive breastfeeding, women mentioned: a) the healthier outcome in their infants (31%); b) good growth of their infants (11%); c) that exclusive breastfeeding was easier (11%); d) the contact with the baby while breastfeeding (8%); d) that exclusive breastfeeding was more practical (6%); e) "everything about exclusive breastfeeding" (6%); and, f) that it was more economical (4%). The majority of women (65%) could find nothing they disliked about exclusive breastfeeding. Among the women who disliked some aspects, the reasons mentioned were: 1) they felt exclusive breastfeeding required a lot of time and caused them to get behind on household chores; 2) the baby would not accept a bottle if it was introduced after six months; 3) they could not be employed outside the home (a study prerequisite); 4) they disliked the breast or nipple pain in the early stages of lactation; 5) they disliked having to take the baby with them when they left the house; and, 6) they disliked feeling insecure about whether the baby was getting enough milk (Table 11).

- If you could participate in the study again, to which group would you like to be assigned? Why?

Approximately 62% of the mothers said that they would like to exclusively breastfeed their infants to six months (76% of the EBF group and 49% of the SF group; p=0.008). The most common reasons they would choose the EBF group were: 1) the baby is healthier; 2) exclusive breastfeeding is easier, it entails less work; 3) exclusive breastfeeding is the best way to feed; 4) the baby grows better; 5) to experience exclusive breastfeeding (for those in the SF group); 6) breastmilk is more nourishing; and, 7) the baby is older when he starts eating solids (and therefore more developmentally ready). Of those who would choose the solid food group, 22% thought that the baby learns to eat faster if given foods earlier, 14% said the mother could rest more, 11% thought the baby would be more satisfied and also would eat better at 6 months, 8% said it was more nourishing to give solids early, and 5.6% said giving solids fattens the baby faster (Table 12).

- If you had a friend who was pregnant, what advice would you give her to convince her to exclusively breastfeed to six months?

The advice these mothers would give a friend to convince her to exclusively breastfeed was very similar to their responses about what they liked most about their own experience. They would highlight the health benefits to the baby, using their own infants as examples, and recount their personal experience with exclusive breastfeeding. Mothers said that they would relay the information they learned through their participation in the study, including the advantages of breastfeeding, and would stress that breastfeeding was easier than bottlefeeding.

Summary

These and other findings indicate that the whole community must be targeted in educational campaigns to increase the duration of exclusive breastfeeding. The most vulnerable period is the first few weeks postpartum. After that, mothers' confidence in their ability to exclusively breastfeed increases, although they still face pressure from others to give their children other foods or fluids.

Response to Complementary Foods from Four to Six Months

There was no significant difference in weight or length gain from four to six months between exclusively breastfed infants and those who were given complementary foods. As was found in our previous study, breastmilk intake declined between four and six months in those given complementary foods, but increased slightly in those exclusively breastfed.

Conclusions and Programmatic Implications

- The recommendation to breastfeed exclusively to about six months can also be applied to LBW infants. However, these infants are at high risk for iron deficiency because of low iron stores at birth. Therefore, supplemental iron drops are recommended beginning at about two to three months. With regard to other micronutrients, very few infants in this population had low plasma vitamin A or folate concentrations, although about 8-43% had low red blood cell folate levels (depending on the cut-off used) and 6-10% had "low" vitamin B_{12} levels. These results are difficult to interpret because of uncertainty regarding appropriate cut-off values in early infancy. Provision of vitamin supplements to the breastfeeding mother is the safest and probably most effective means by which to assure adequate folate and vitamin B_{12} status. The plasma zinc data suggest that zinc deficiency is no more common among LBW, exclusively breastfed infants in Honduras than it is among healthy, exclusively breastfed infants in affluent populations.

- Supplemental water is not needed even among low birthweight infants in a hot, humid climate.

- Mothers of LBW infants may require targeting for lactation guidance, especially those whose infants are of lower gestational age, have a poor Apgar score, or have a high ponderal index at birth. Mothers who did not receive adequate prenatal care, had a long labor, or have several other children to care for should also be specially targeted. Adequate lactation guidance can prevent or resolve nearly all cases of poor infant weight gain during the first four months postpartum.

- Use of bottles in the hospital was significantly associated with low weight gain in the first two weeks and should be avoided, unless absolutely medically indicated.

- Exclusively breastfed LBW infants show considerable "catch-up" in weight and length by 4 months. Nonetheless, their absolute weight gain from birth to 4 mo is significantly lower than that of their normal birthweight peers in the same environment. It is unclear whether this is an inevitable consequence of intrauterine growth retardation, or could be altered postnatally. Until the latter question is answered, the data presented herein may be useful as a yardstick by which to compare growth of exclusively breastfed LBW, term infants in other populations.

- The most vulnerable period for failure to exclusively breastfeed is the first few weeks postpartum. Although there are many barriers to exclusive breastfeeding in the community (especially pressures from family, friends and neighbors), mothers who persevere become quite enthusiastic about their experience. Finding ways to provide mother-to-mother support beginning as soon as possible after delivery should be a high priority. Messages should focus on the advantages of exclusive breastfeeding with regard to infant health, convenience, and cost. In addition, educational campaigns need to address: a) common misconceptions regarding the need for infants to "taste" foods at an early age to prevent "feeding and stomach

problems" later on; and, b) ways that mothers can exclusively breastfeed while still having flexibility in completing other tasks (household chores, leaving the house to shop, etc.). Because very few women in this study expressed their breastmilk for others to feed to the infant, the latter was a common impediment.

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TABLE 1

Characteristics of participants and dropouts

Variable	Participants (n=133)	Dropouts (n=93)	P
Maternal age (y)	23.7 (5.9)*	23.0 (5.8)	0.37
Maternal education (y)	6.0 (2.9)	5.3 (2.7)	0.054
Maternal height (cm)	150.3 (6.5)	149.1 (5.5)	0.16
Maternal weight pp (kg)	53.6 (8.9)	51.2 (10.0)	0.07
Maternal BMI (kg/m^2)	23.7 (3.5)	22.9 (3.9)	0.13
Income (L/mo)	1210 (683) n=109	1204 (1041) n=66	0.97
Prenatal care (% yes)	74%	68%	0.86
Infant sex (% boys)	43.6%	44.1%	0.30
Gestational age (wk)	38.8 (1.04)	38.7 (1.14)	0.27
Birth weight (g)	2334 (165)	2300 (167)	0.13
Birth length (cm)	45.9 (1.4)	45.4 (1.5)	0.02
Head circumference (cm)	31.7 (0.9)	31.6 (1.0)	0.49
Ponderal index (g/cm^3 x 100)	2.42 (0.18)	2.45 (0.20)	0.21
Canscore	22.9 (1.9) n=92	23.0 (2.5) n=63	0.61
Infant wt. gain (g)			
0-2 wk	367 (250)	275 (264) n=73	0.02
0-4 wk	921 (342)	783 (411) n=57	0.02
0-8 wk	1925 (415)	1771 (358) n=31	0.06

* Mean (SD)

Table 2

Diagnosis	Cases at Facility (n=21)	Cases at Home (n=44)	Total (n=65)
Infant illness/vomiting/congenital problem	6	24	30 (46%)
Infant sleeps too much/need to wake to feed	8	3	11 (17%)
Insufficient breastfeeding frequency or time	6	5	11 (17%)
Poor suck/problem with latch-on/flat nipples	7	3	10 (15%)
No apparent problem	0	9	9 (14%)
Poor breastfeeding technique	4	2	6 (9%)
Infant given other fluids	2	3	5 (8%)
Infant hospitalized and given other fluids	3	2	5 (8%)
Mother ill	0	3	3 (5%)
Emotional/family problems	2	1	3 (5%)

Table 3 Weight, length and head circumference of 133 (58 male, 75 female) exclusively breast fed, low birthweight term infants 0 - 16 wk.

Age (wk)	Weight (kg)		Length (cm)		Head Circumference (cm)	
	Males	Females	Males	Females	Males	Females
0	2.31 (0.19)[a]	2.35 (0.14)	45.9 (1.5)	45.9 (1.4)	31.7 (1.0)	31.6 (0.8)
1	2.42 (0.25)	2.46 (0.25)				
2	2.67 (0.29)	2.72 (0.32)				
3	2.99 (0.35)	2.99 (0.39)				
4	3.29 (0.39)	3.24 (0.39)	50.7 (1.8)	50.5 (1.7)	35.1 (1.2)	34.9 (0.9)
5	3.62 (0.45)	3.51 (0.38)				
6	3.91 (0.44)	3.77 (0.41)				
7	4.16 (0.45)	4.02 (0.44)				
8	4.39 (0.47)	4.20 (0.44)*	54.8 (2.1)	54.1 (1.7)*	37.3 (1.0)	36.8 (0.9)*
9	4.65 (0.47)	4.46 (0.46)*				
10	4.85 (0.51)	4.66 (0.47)*				
11	5.08 (0.52)	4.86 (0.50)*				
12	5.26 (0.51)	5.04 (0.54)*	57.8 (2.1)	56.9 (2.0)*	38.7 (1.0)	38.2 (0.9)*
13	5.44 (0.56)	5.20 (0.57)*				
14	5.60 (0.58)	5.33 (0.62)*				
15	5.74 (0.61)	5.48 (0.66)*				
16	5.82 (0.60)	5.57 (0.66)*	60.8 (2.3)	59.6 (2.2)*	40.0 (1.1)	39.4 (1.0)*

[a]Mean (SD)
*Significant difference between males and females, $p < 0.05$

Table 4 Monthly weight and length gain of exclusively breastfed, low birthweight term infants.

Interval	Weight gain (g/mo)		Length gain (cm/mo)	
	Males (N=58)	Females (N=75)	Males (N=58)	Females (N=75)
0 - 4 wk	976 (340)[a]	878 (339)	4.86 (1.0)	4.70 (1.1)
4 - 8 wk	1096 (210)	984 (227)*	4.39 (1.0)	3.68 (0.9)*
8 - 12 wk	959 (231)	928 (262)	3.09 (1.0)	2.96 (1.2)
12 - 16 wk	600 (232)	571 (226)	2.95 (1.1)	2.62 (1.1)

[a]Mean (SD)
*Significant difference between males and females, $p < 0.01$

Table 5

		Weight gain (g)	Length gain (cm)
Maternal BMI			
< 20 kg/m^2	(N = 21)	3126 ± 593	13.1 ± 2.0
≥ 20 kg/m^2	(N = 112)	3388 ± 612[a]	13.4 ± 1.6
Infant ponderal index			
Low[b] (N = 8)		3425 ± 498	13.2 ± 1.5
Normal (N = 115)		3334 ± 631	13.3 ± 1.6

[a]Difference between groups marginally significant ($p = 0.065$)

[b]Defined by Lubchenco et al. (1966)

TABLE 6: FACTORS ASSOCIATED WITH GROWTH 0-4 MONTHS

Weight gain, 0-4 mo (g) (n=133) $R^2 = 0.23$

	Regression Coefficient	P-value
Parity	-85.5	0.013
Birth length (cm)	82.1	0.022
Sex (males = 0; females = 1)	-244.8	0.016
Prenatal care (number of visits)	59.7	0.001

Length gain, 0-4 mo (cm) (n=133) $R^2 = 0.30$

	Regression Coefficient	P-value
Maternal height (cm)	0.06	0.0009
Floor type (1-3)	0.81	0.0015
Sex (males = 0; females = 1)	-1.00	0.0001
Prenatal care (number of visits)	0.10	0.0145

TABLE 7: HEMOGLOBIN, HEMATOCRIT, MCV AND INDICES OF IRON STATUS

	All Subjects	Not Previously Supplemented With Iron before 6 mo	Ever Previously Supplemented With Iron at 2 and/or 4mo
<u>Hemoglobin</u> (g/dL)			
2 months (N)	158	-	-
Mean ± SD	10.0 ± 1.1		
Range	4.8 - 12.2		
% < 10g/dl	47.5		
4 months (N)	129	71	58
Mean ± SD	10.9 ± 0.9	10.8 ± 0.7	10.9 ± 1.0
Range	8.0 - 13.2	8.9 - 12.3	8.0 - 13.2
% < 10g/dl	15.5	12.7	19.0
Change 2-4 mo		-0.07 ± 0.87	+1.85 ± 1.42*
6 months (N)	113	49	63
Mean ± SD	11.0 ± 0.8	10.9 ± 0.9	11.0 ± 0.8
Range	8.3 - 13.7	8.3 - 12.7	9.2 - 12.6
% < 10g/dl	14.2	14.3	14.3
Change 4-6 mo		-0.24 ± 0.69	+0.31 ± 1.01*
<u>Hematocrit</u> (%)			
2 months (N)	158	-	-
Mean ± SD	29.8 ± 3.5		
Range	14.1 - 36.7		
% < 30	51.9		
4 months (N)	129	71	58
Mean ± SD	32.5 ± 2.5	32.5 ± 2.3	32.6 ± 2.8
Range	26.1 - 39.0	27.6 - 37.3	26.1 - 39.0
% < 30	16.3	14.1	19.0
Change 2-4 mo		+0.14 ± 2.69	+5.48 ± 4.22*
6 months (N)	113	49	63
Mean ± SD	33.5 ± 2.5	33.2 ± 2.7	33.7 ± 2.3
Range	26.0 - 42.5	26.0 - 42.5	28.0 - 39.6
% < 30	6.2	8.2	4.8
Change 4-6 mo		+0.15 ± 2.6	+1.66 ± 3.09*

TABLE 7: (cont)

	All Subjects	Not Previously Supplemented With Iron before 6 mo	Ever Previously Supplemented With Iron at 2 and/or 4mo
Ferritin (ug/L)			
2 months (N)	154	-	-
Mean ± SD	182 ± 114		
Range	17 - 682		
% < 12 ng/ml	0		
4 months (N)	89	48	41
Mean ± SD	82 ± 67	57 ± 34	112 ± 83
Range	0 - 357	4 - 172	0 - 357
% < 12 ng/ml	4.5	4.2	4.9
Change 2-4 mo		-115.6 ± 89.6	-84.3 ± 130.8
6 months (N)	77	39	38
Mean ± SD	39 ± 32	22 ± 14	57 ± 37
Range	1 - 223	1- 61	10 - 223
% < 12 ng/ml	13.2	23.1	2.7*
Change 4-6 mo		-34.6 ± 22.9	-48.4 ± 65.0

(similar results were found when excluding subjects with high or missing C-reactive protein values)

Transferrin Saturation (%)			
2 months (N)	148	-	-
Mean ± SD	54.7 ± 21.1		
Range	16.7 - 161.5		
% < 12%	0		
4 months (N)	87	48	39
Mean ± SD	35.0 ± 17.0	31.6 ± 12.5	39.1 ± 20.7*
Range	13.5 - 120.1	72.3 - 31.6	13.5 - 120.1
% < 12%	0	0	0
Change 2-4 mo		+3.1 ± 17.7	+4.6 ± 18.3
6 months (N)	78	40	38
Mean ± SD	37.4 ± 21.7	35.1 ± 26.6	39.9 ± 15.0
Range	11.2 - 169.0	11.2 - 169.0	19.7 - 84.9
% < 12%	1.3	2.6	0
Change 4-6 mo		+0.5 ± 17.2	+7.0 ± 18.1

TABLE 7: (cont)

	All Subjects	Not Previously Supplemented With Iron before 6 mo	Ever Previously Supplemented With Iron at 2 and/or 4mo
MCV (fL)			
2 months (N)	158	-	-
Mean ± SD	89.2 ± 4.4		
Range	78.5 - 104.0		
4 months (N)	127	70	57
Mean ± SD	79.6 ± 4.5	79.3 ± 4.3	79.9 ± 4.7
Range	65.0 - 89.5	65.0 - 87.0	72.0 - 89.5
Change 2-4 mo		-10.1 ± 3.4	-9.8 ± 4.5
6 months (N)	112	50	62
Mean ± SD	72.7 ± 6.3	70.9 ± 6.0	74.2 ± 6.2*
Range	56.0 - 86.5	56.0 - 82.0	56.5 - 86.5
Change 4-6 mo		-9.0 ± 6.3	-5.2 ± 6.0*

* difference between iron-supplemented and non-supplemented groups statistically significant, $p < 0.05$

TABLE 8: INDICES OF ZINC, FOLATE, VITAMIN B12 AND VITAMIN A STATUS

	PLASMA FOLATE (ng/ml)	RBC FOLATE (ng/ml)	PLASMA VIT B_{12} (pg/ml)	PLASMA Zn (µg/dL)	PLASMA VIT A (µg/dL)
2 mo					
N	145	145	151	148	153
Mean	10.7	162	291	72.6	22.0
SD	4.3	69	152	15.5	8.0
Range	4.1 - 36.7	60 - 400	94 - 1125	39.0 - 132.6	7.0 - 45.0
%"low"	<3.0: 0%	<100: 18.6%	<100: 4.6%	<60: 18.9%	<10: 3.9%
		<120: 29.7%	<130: 9.9%		
		<140: 43.4%	<200: 27.8%		
4 mo					
N	89	93	89	87	93
Mean	18.0	202	343	74.2	22.0
SD	7.1	70	199	11.3	6.2
Range	6.1 - 50.0	62 - 460	86 - 1557	58.0 - 118.3	7.0 - 38.0
% "low"	<3.0: 0%	<100: 7.5%	<100: 2.2%	<60: 6.9%	<10: 2.2%
		<120: 10.8%	<130: 5.6%		
		<140: 15.1%	<200: 21.3%		
6 mo					
N	80	78	80	78	80
Mean	15.6	194	284	77.1	28.2
SD	5.6	78	128	16.3	7.1
Range	5.6-32.2	71 - 431	96-745	55.5 - 182.4	14.0 - 57.0
% "low"	<3.0: 0%	<100: 7.7%	<100: 1.3%	<60: 5.1%	<10: 0%
		<120: 17.9%	<130: 8.8%		
		<140: 26.9%	<200: 28.8%		

TABLE 9

Feeding mode preference of family and friends (at 3 days pp) (N=230)

	Husband	Mother	Father	In-laws	Friends	Neighbors
No pref	6.4 %	11.8	19.3	14.7	11.6	12.2
EBF	73.2	47.2	21.5	29.8	36.2	37.4
Bottle	1.3	1.3	0.9	1.3	3.0	0.9
Mixed	7.7	2.6	0.4	3.1	4.3	2.6
BF/food	0	1.7	1.3	1.3	1.3	1.7
Bottle/food	0	0	0	0	0	0
Mixed/food	0	0	0	0	0	0
No opinion	11.5	35.4	56.5	49.8	43.5	45.2

TABLE 10: Principal reasons for giving other foods or fluids (study infants, N = 91)

Reason	%
Someone else gave it while the mother was out or not looking	27%
So the baby would get used to it	11%
The baby wanted it	9%
Out of curiosity	9%
Advised by a family member	9%
Mother had to leave the baby at home while she went out	7%
Other	29%

TABLE 11a: What women liked most about their breastfeeding experience

	%
Baby was healthier	31%
Baby grew well	15%
Exclusive breastfeeding was easier	11%
Enjoyed the close contact with the baby	8%
Exclusive breastfeeding was more practical	6%
Liked everything about the experience	6%
Exclusive breastfeeding was more economical	4%
Other	19%

TABLE 11b: What women liked least about their breastfeeding experience

	%
Didn't dislike anything	65%
exclusive breastfeeding required a lot of time and caused her to get behind on household chores	4%
Baby wouldn't accept a bottle at 6 months of age	3%
Couldn't be employed outside the home (study requirement)	3%
Had painful breasts or nipples in early stage of lactation	3%
Had to take the baby along when left home	3%
Insecurity about not producing enough breast milk	3%
Other	14%

TABLE 12: Reasons subjects would choose the EBF or SF group

Reasons for choosing the EBF group	%
Baby is healthier	19%
exclusive breastfeeding is easier, less work involved	19%
It's the best way to feed your baby	11%
The baby grows better	11%
To experience exclusive breastfeeding to 6 months (mothers from SF group)	9%
Breast milk is more nourishing	8%
Baby is older when starts solids (developmentally ready)	6%
Other	18%

Reasons for choosing the SF group	% *
Baby learns to eat more quickly	24%
The mother rests more	14%
Baby is more satisfied (breast milk not sufficient)	11%
Baby eats better after 6 months	11%
To experience exclusive breastfeeding to 6 months (mothers from SF group)+	9%
Feeding other foods earlier is more nourishing	8%
Baby gets fatter faster	6%
Other	22%

* Percent of responses

Figure 1

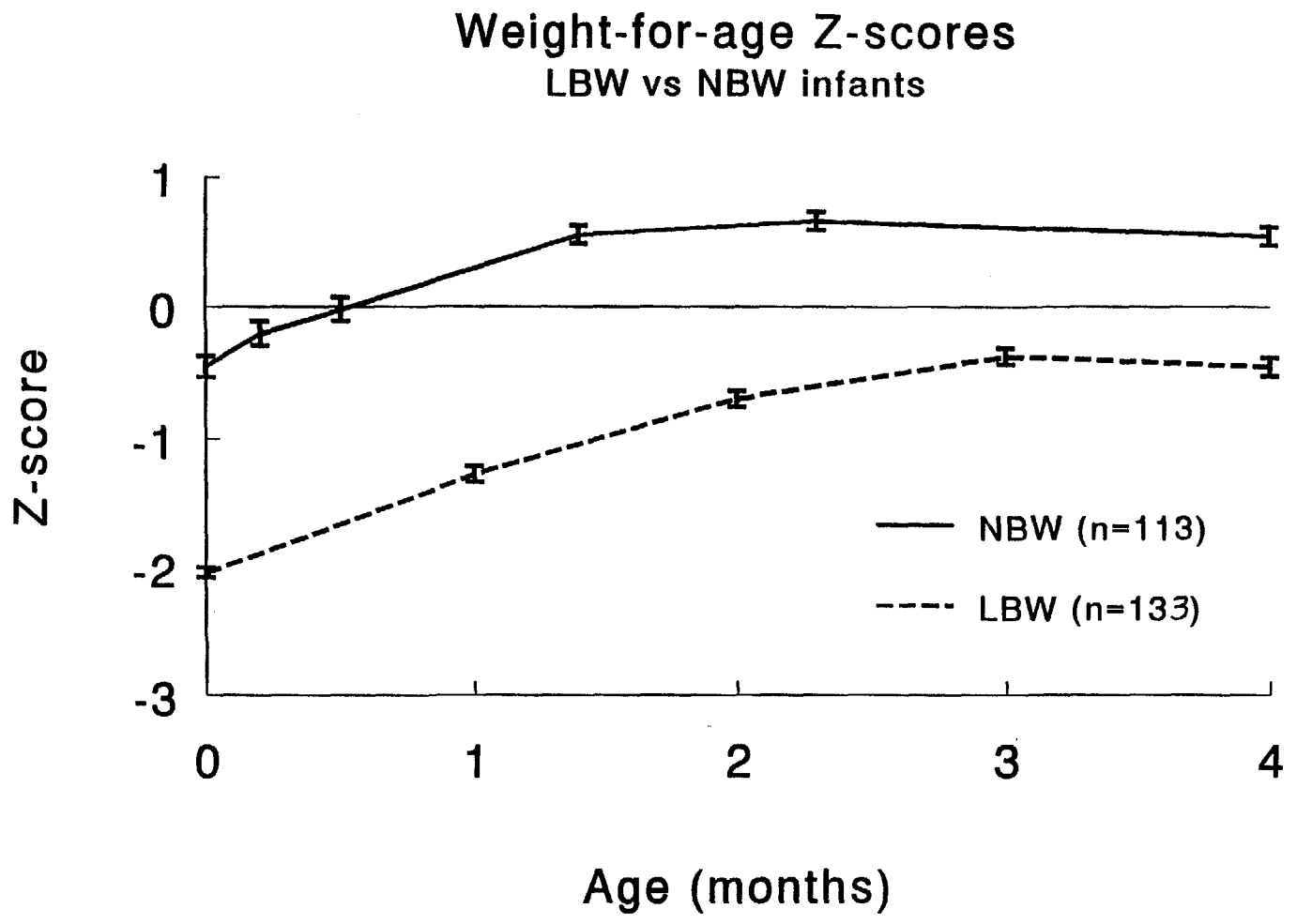

Weight-for-age Z-scores
LBW vs NBW infants
Z-score
1
0
-1
-2
-3
0
1
2
3
4
Age (months)
NBW (n=113)
LBW (n=133)

Figure 2

Length-for-age Z-scores

low birthweight infants

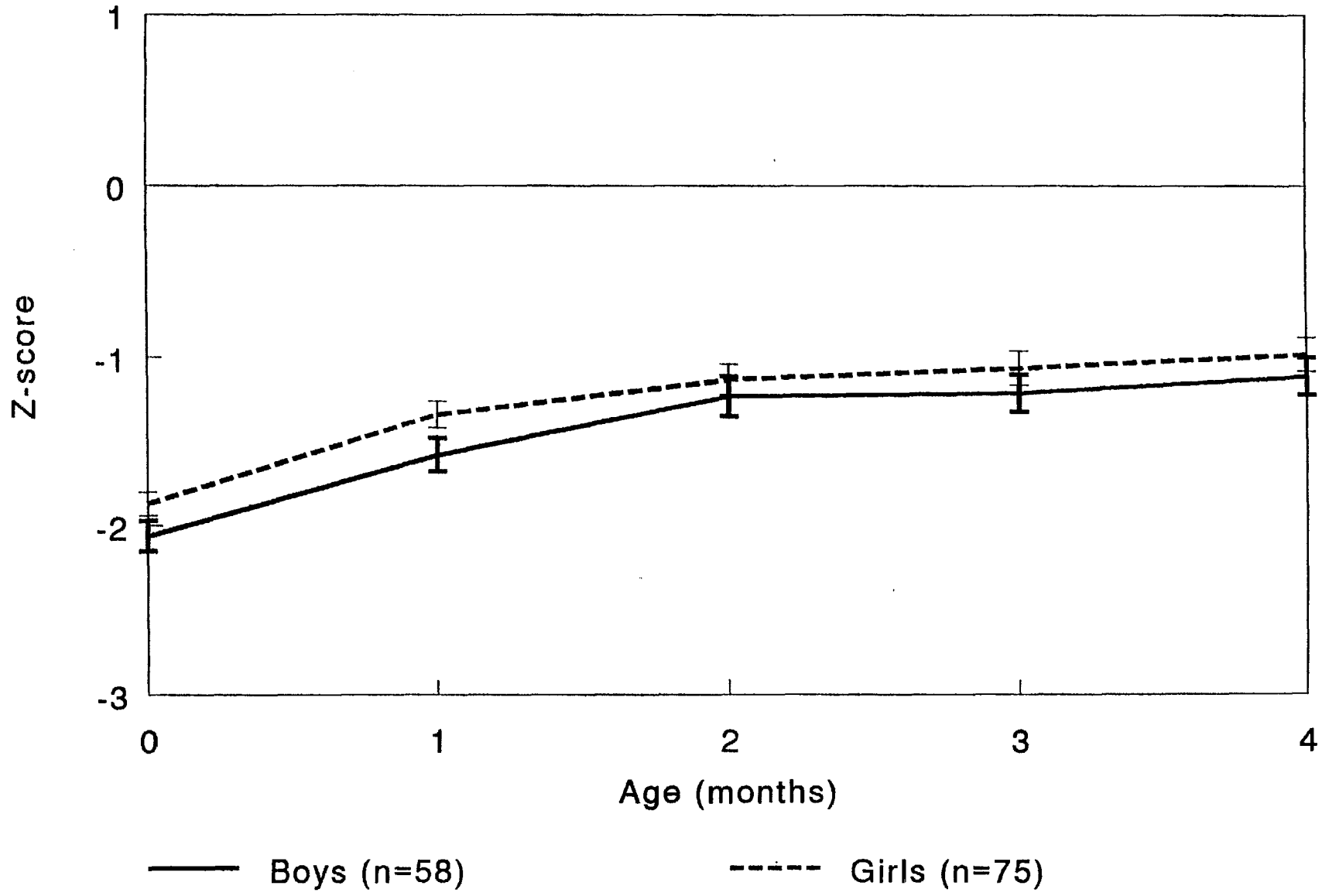


Figure 3

Weight and Length Z-scores

Relative to breastfed infants (WHO,1994)

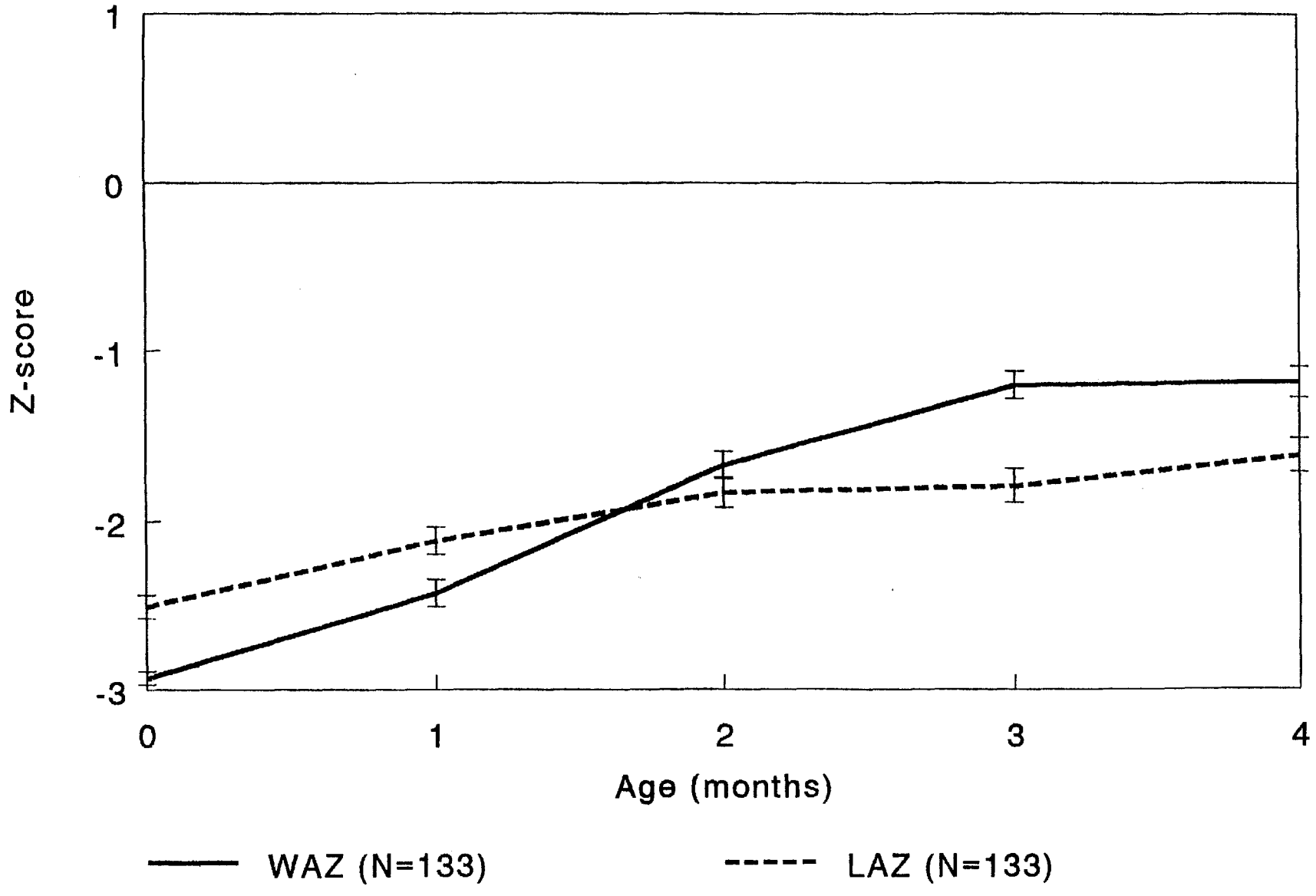
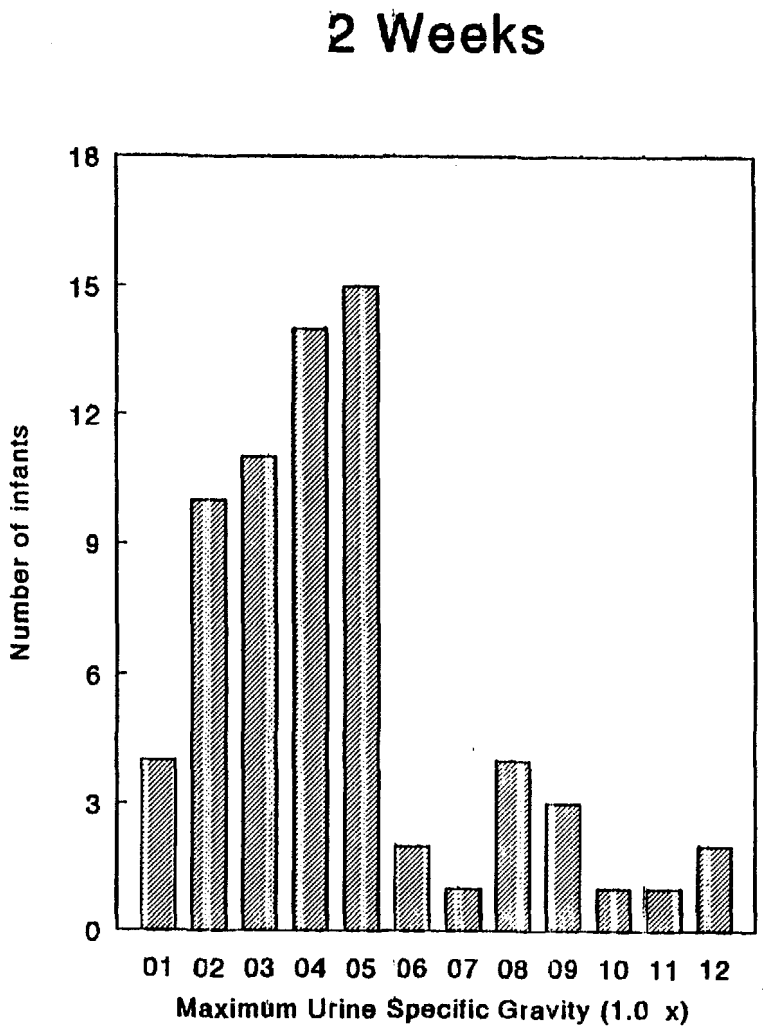
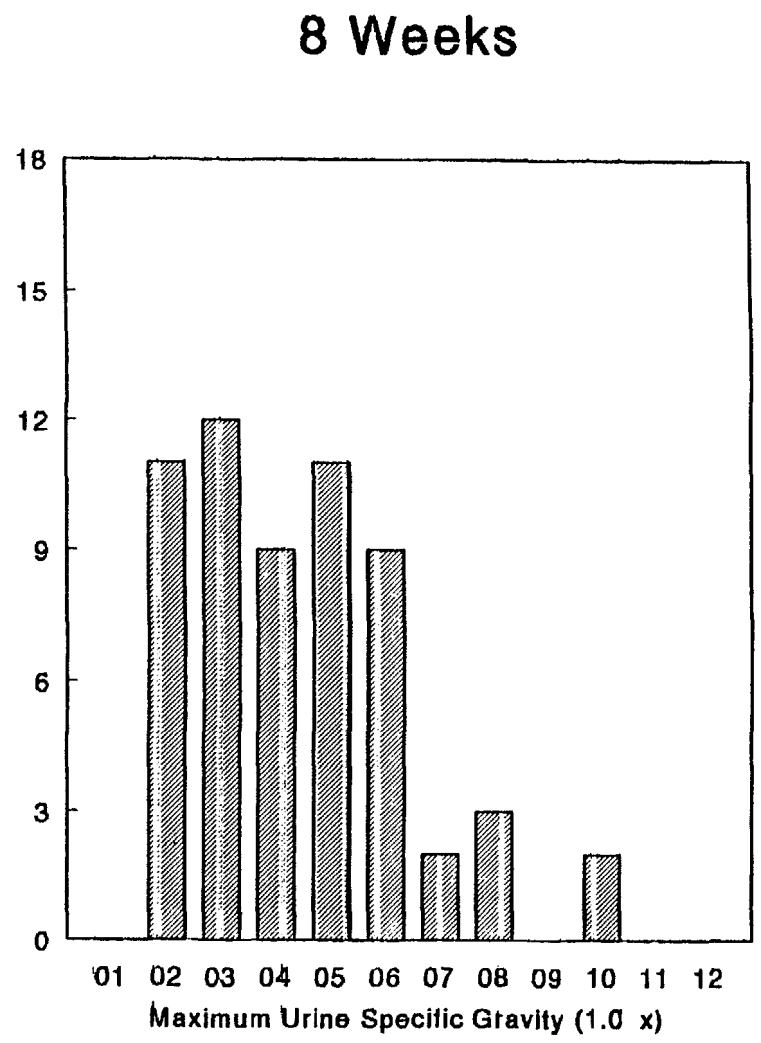


Figure 4


2 Weeks
Number of infants
0
3
6
9
12
15
18
01 02 03 04 05 06 07 08 09 10 11 12
Maximum Urine Specific Gravity (1.0 x)


8 Weeks
0
3
6
9
12
15
18
01 02 03 04 05 06 07 08 09 10 11 12
Maximum Urine Specific Gravity (1.0 x)

WELLSTART INTERNATIONAL

Wellstart International is a private, nonprofit organization dedicated to the promotion of healthy families through the global promotion of breastfeeding. With a tradition of building on existing resources, Wellstart works cooperatively with individuals, institutions, and governments to expand and support the expertise necessary for establishing and sustaining optimal infant feeding practices worldwide.

Wellstart has been involved in numerous global breastfeeding initiatives including the Innocenti Declaration, the World Summit for Children, and the Baby-Friendly Hospital Initiative. Programs are carried out both internationally and within the United States.

International Programs

Wellstart's *Lactation Management Education (LME) Program*, funded through USAID/Office of Nutrition, provides comprehensive education, with ongoing material and field support services, to multidisciplinary teams of leading health professionals. With Wellstart's assistance, an extensive network of Associates from more than 40 countries is in turn providing training and support within their own institutions and regions, as well as developing appropriate in-country model teaching, service, and resource centers.

Wellstart's *Expanded Promotion of Breastfeeding (EPB) Program*, funded through USAID/Office of Health, broadens the scope of global breastfeeding promotion by working to overcome barriers to breastfeeding at all levels (policy, institutional, community, and individual). Efforts include assistance with national assessments, policy development, social marketing including the development and testing of communication strategies and materials, and community outreach including primary care training and support group development. Additionally, program-supported research expands biomedical, social, and programmatic knowledge about breastfeeding.

National Programs

Nineteen multidisciplinary teams from across the U.S. have participated in Wellstart's lactation management education programs designed specifically for the needs of domestic participants. In collaboration with universities across the country, Wellstart has developed and field-tested a comprehensive guide for the integration of lactation management education into schools of medicine, nursing and nutrition. With funding through the MCH Bureau of the U.S. Department of Health and Human Services, the NIH, and other agencies, Wellstart also provides workshops, conferences and consultation on programmatic, policy and clinical issues for healthcare professionals from a variety of settings, e.g. Public Health, WIC, Native American. At the San Diego facility, activities also include clinical and educational services for local families.

Wellstart International is a designated World Health Organization Collaborating Center on Breastfeeding Promotion and Protection, with Particular Emphasis on Lactation Management Education.

For information on corporate matters, the LME or National Programs, contact:

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