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Household Food Security Is Associated with Infant Feeding Practices in Rural Bangladesh,[1,2]

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Abstract

Although household food security (HHFS) has been shown to affect diet, nutrition, and health of adults and also learning in children, no study has examined associations with infant feeding practices (IFP). We studied 1343 infants born between May 2002 and December 2003 in the Maternal and Infant Nutrition Intervention in Matlab study to investigate the effect of HHFS on IFP in rural Bangladesh. We measured HHFS using a previously developed 11-item scale. Cumulative and current infant feeding scales were created from monthly infant feeding data for the age groups of 1–3, 1–6, 1–9, and 1–12 mo based on comparison to infant feeding recommendations. We used lagged, dynamic, and difference longitudinal regression models adjusting for various infant and maternal variables to examine the association between HHFS and changes in IFP, and Cox proportional hazards models to examine the influence of HHFS on the duration of breast-feeding and the time of introduction of complementary foods. Better HHFS status was associated with poor IFP during 3–6 mo but was associated with better IFP during 6–9 and 9–12 mo of age. Although better HHFS was not associated with the time of introduction of complementary foods, it was associated with the type of complementary foods given to the infants. Intervention programs to support proper IFP should target mothers in food-secure households when their babies are 3–6 mo old and also mothers in food-insecure households during the 2nd half of infancy. Our results provide strong evidence that HHFS influences IFP in rural Bangladesh.

Introduction

Household food insecurity (HHFI)[7] causes hunger and malnutrition in most countries in the world (1). The nutrition and health consequences of HHFI have been documented among adults and children even in rich countries such as the US (2–6), Canada (7,8), and Australia (9). HHFI was negatively associated with dietary intake (2–4,7), health, and nutritional status (4–6,8,9) of adults in those countries and in developing countries such as Trinidad (10), Tanzania (11), and South Africa (12).

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[7] Abbreviations used: ABF, any breast-feeding; EBF, exclusive breast-feeding; HHFI, household food insecurity; HHFS, household food security; MINIMat, Maternal and Infant Nutrition Intervention in Matlab; SES, socioeconomic status.

HHFI also influences health and nutritional status of children. In the US, children in food-insecure households had more frequent cough, stomachaches, headaches, iron deficiency (13), compromised psychological functioning (6), higher rate of hospitalization (14), and lower BMI (15) than their food-secure counterparts. The reported effects of HHFI on dietary intake of children in the US have been mixed. For example, children in low-income, food-insecure households had significant decreases in energy intake and meat consumption (15) and consumed fewer carbohydrates and fruits and less total energy (16) than children in food-secure households. In contrast, HHFI had no significant influence on food intake of preschool children (3,15), although it was associated with decreased household food supplies (15) and decreased mean food intake for rest of the household members (3). In Korea, HHFI was strongly and negatively associated with dietary intake and anthropometric status of children (17).

In Bangladesh, approximately one-half of the population is food insecure (18). Hunger and childhood malnutrition in Bangladesh are among the highest in the world (19). Approximately 31% of the rural population in Bangladesh suffers from “chronic poverty,” which is characterized by low consumption, lack of access to basic health services, and undernutrition (20). About 19% of rural households cannot have “3 full meals” a day and ~10% survive on 2 meals or less for a number of months every year.

The profound influence of household food security (HHFS) on dietary intake and health and nutritional status of adults and children is supported by a substantial body of research. The association between HHFS and infant feeding practices (IFP), however, has rarely been studied, either in developed or developing countries. Proper IFP are essential for growth and development during infancy, childhood, and beyond. Therefore, it is important to examine whether household food availability makes any significant change in IFP. In this study, we investigated the association between HHFS and IFP in rural Bangladesh using longitudinal data and appropriate statistical techniques for longitudinal data analysis. We proposed that households that were food secure would differ significantly in IFP from households that were not. Specifically, we proposed that mothers in food-insecure households would introduce complementary feeding later than mothers in food-secure households.

Subjects and Methods

Data

We used data from the Maternal and Infant Nutrition Intervention in Matlab (MINIMat) study, a large intervention trial in which infants were followed from birth until 12 mo of age and beyond. We selected all infants who were born between May 2002 and December 2003 and had completed their 12-mo follow-up in December 2004 (*n* = 1343). MINIMat was carried out in Matlab, a rural subdistrict in Bangladesh.

The mothers of these infants were followed during pregnancy when data on HHFS and socioeconomic status (SES) were collected. Feeding history and morbidity of infants were collected every month during the first 12 mo of life. Data on early feeding practices were collected at 7–10 d postpartum. The mothers of these infants had been randomly assigned to receive a food supplement starting at ~17 wk of gestation and also received health education messages either with or without random assignment to intensive breast-feeding counseling during pregnancy and after delivery. In addition, mothers of these infants were randomly assigned to receive a daily pill that contained 1 of 3 different combinations of micronutrients starting at ~14 wk of gestation.

Data collection and quality control of data

All data were collected at women's homes by trained interviewers and paramedics. Structured questionnaires with precoded and open-ended questions were used for data collection. All questionnaires were pre-tested and revised accordingly. The questionnaires were first prepared in English and then translated into Bangla. All birth weights were measured by electronic or beam scales, which were precise to 10 g (UNICEF Uniscale, SECA). Maternal weights were measured by electronic scales (Uniscale), which were precise to 100 g. All measuring scales were standardized daily.

Written consent was obtained from women about participation in the study. The study was approved by the Research Review Committee and Ethical Review Committee of ICDDR,B and the University Committee on Human Subjects at Cornell University.

Measurements

Household food security—We created a HHFS scale from an 11-item food securitymeasure (21). The items covered frequency of food purchased (rice and perishable food, e.g. vegetables, fish, and meat), frequency of cooking, borrowing or lending (food and money), and whether there was ready access to adequate meals and snacks. This information was collected during the household visits at 8 and 30 wk of pregnancy.

We assigned scores to each item according to the classification of households and their experiences as previously described (21). Higher scores were assigned to those experiences that indicated better food security status. For example, for frequency of purchasing rice, a score of 1 was assigned to those who purchased rice 4–5 times a week, which indicated that the household had a little or no store of rice and had to buy rice almost every day to meet their need. A score of 5 was assigned to those who had not purchased rice in the last 30 d, which indicated the household had an adequate store of rice and did not need to buy rice for a long time.

We computed food security scales at 8 and 30 wk by adding all scores that were allocated to different items, weighting for the number of categories of responses. The mean food security scale at 30 wk was greater by 0.96 than the mean food security scale at 8 wk. Therefore, we further computed the food security scale at 30 wk with an offset by subtracting this value from the food security scale at 30 wk. This was done to minimize any systematic effect that might increase mean food security from 8 to 30 wk. We used the mean of food security scales at 8 and 30 wk as the food security measure.

The mean of food security scales at 8 and 30 wk was 38.6 ± 3.6 (Table 1). A higher score indicated better HHFS. The reliability (e.g. Cronbach's α) of the sum of the food security scales at 8 and 30 wk was 0.78. We used this scale both as a continuous variable and categorical variable. For categorical variable, households were divided into quartiles: quartile 1 (extremely food insecure), 2 (moderately food insecure), 3 (occasionally food insecure), and 4 (food secure).

Infant feeding—We created infant feeding scales using data collected monthly until 12 mo of age. Mothers were asked to recall the general feeding pattern in last month, i.e. whether the baby was still breast-fed, feeding of plain water, water containing sugar/glucose/jaggery (unrefined brown sugar made from the sap of the date palm or sugar), fruit juice, cow milk, and semisolid (mostly soft rice, occasionally with lentils and oil) and solid foods. We used feeding data that were collected at 7–10 d postpartum to create the early feeding scale. These data included the first food given to the baby, timing of breast-feeding initiation, anything given to the baby before giving breast milk, colostrum rejection, number of times the baby was breast-fed during the day and night, and use of bottle with a nipple to feed the baby.

The response for most items was “yes” or “no.” We scored each item depending on whether or not a practice was good based on the current infant feeding recommendations of the WHO/UNICEF (22,23). For example, a practice that was appropriate for a specific age group received a score of 1 and a practice that was potentially detrimental to infant health received a 0. Practices that were considered particularly beneficial for a given age received a score of 2. For example, breast-feeding received a score of 2 for infants from 0–12 mo. A score of 0 was given to non-breast-fed infants. We assigned 0 to semisolid food if given before 6 mo but assigned 2 if given at and after 6 mo of age.

We created cumulative infant feeding scales, which were specific for different age groups, e.g. 3, 6, 9, and 12 mo, because the nature of the practices required for different age groups are different. We created the feeding scale for early as well as current feeding practices. The early feeding scale included the practices that were followed immediately and during the first few days after birth (data collected at 7–10 d postpartum). For the current feeding scale, we considered the practices that were followed subsequently and information that was collected every month. First, we created an early feeding scale and a feeding scale for each month from 1–12 mo. We then computed cumulative feeding scales for different age groups by adding all the monthly feeding scales of those particular age groups with the feeding scales of the preceding months. For example, we computed a cumulative feeding scale at 3 mo by adding individual feeding scales from 1–3 mo (feeding scale at 3 mo = feeding scale at mo 1 + … + feeding scale at mo 3). We followed the same strategy to create cumulative feeding scales at 6, 9, and 12 mo. We excluded the early feeding scale from computations of feeding scales at 3, 6, 9, and 12 mo for 2 reasons. First, the number of missing values for the variables on early feeding practices was very high (~40%). Second, the distribution of the early feeding scale lacked variability; > 90% of the subjects had the highest 2 scores of the scale.

We examined whether the infants who were missing data for early feeding practices differed from those who were not missing these data. We compared these 2 groups for their birth weight, HHFS, and other key baseline SES variables. For the continuous variables, we used a *t* test for equality of means and, for the categorical variables, we used Pearson chi-square tests.

We standardized the feeding scales by converting the original scores into percentages of the maximum total scores of the theoretical scales (descriptive statistics of the standardized feeding scales are presented in Table 1). A higher score in the feeding scales indicated better IFP. The feeding scales were used as continuous variables in the analyses. The reliability (Cronbach’s α) of these feeding scales was 0.6–0.8.

Morbidity—We created morbidity scales based on the presence or absence of the illnesses in the last 7 d, signs and symptoms of the illnesses and their severity, and healthcare seeking. The variables included in the morbidity scales were fever, cough/difficult breathing, diarrhea, any other illness, and treatment received in last 1 mo. Absence of any of these illnesses received a score of 1 and presence of this received 2. We used available information that was collected along with diarrhea (blood in stool, associated vomiting, etc.) and cough (difficult breathing and rapid breathing/chest indrawing) to indicate severity of the illnesses. We also included information on whether or not any healthcare was sought for the infant in the last month that reflects the severity of illness.

We created monthly morbidity scales of 1–12 mo by adding the scores assigned on 12 items of the morbidity scale. We used the mean of the morbidity scales of preceding periods for the morbidity scale of that particular age. For example, we used the mean of morbidity scales at

1, 2, and 3 mo for the morbidity scale at 3 mo. We followed the same strategy for computing morbidity scales at 6, 9, and 12 mo (descriptive statistics of the morbidity scales are presented in Table 1). A higher score in the morbidity scale indicated a worse state of illness of the infant. The reliability of each morbidity scale was high (Cronbach's α was 0.7).

SES—We used wealth index as a measure of SES that was created by the MINIMat team using information on household assets. Variables included were land (homestead, land under cultivation, fallow land, pond/ditch, and family land), construction materials of the walls of the house, ownership of household assets (clock/watch, chair/table, cupboard, bicycle, radio, television, electric fan, cows, goats, and chicken/ducks), "sarees" (a traditional garment worn by women in Bangladesh or from the Indian subcontinent), or "shalwar-kameez" (a pair of loose-fitting pleated trousers tapering to the ankle, worn by women, usually under a long tunic owned for ceremonial use), and pair of shoes or sandals owned.

Total land was computed by adding homestead land, land under cultivation, and fallow land. Total land was categorized into groups of 0, > 0–5, > 5–25, > 25–90, and > 90 decimals [approximately equal to 1/100 acre (0.00004 km^2)]. The categories for pond/ditch and family land were either "yes" or "no." The categories for construction materials of the walls of the house were brick/cement, tin, bamboo, and other. For household assets, categories for each item were "owned" or "not owned" by the household. Total number of clothes was obtained by adding sarees and shalwar-kameez, which were categorized into 0–3, 4–9, 10–17, and >18. The categories for shoes or sandals were 0, 1, 2, and >2.

Principal component analysis was used to create the wealth index. A weight was attached to each item from the first principal component. The households were classified into SES quintiles based on the wealth index: quintile 1 (poor), 2 (lower middle), 3 (middle), 4 (upper middle), and 5 (rich).

Statistical models—Changes in IFP over time were assessed by using lagged, dynamic, and difference models for longitudinal data analysis (24–26). The lagged model was used to assess whether lagged independent variables (M_t) and lagged outcome (IFP_t) related to subsequent change of outcomes:

$$\Delta IFP=\beta_0+\beta_1 HHFS+\beta_2 M_t+\beta_3 IFP_t+\ldots+\varepsilon,$$

where IFP_t = IFP at time t, Δ IFP = $IFP_{t+3} - IFP_t$, M_t = morbidity of infant at time t, t = 3, 6, 9 mo, β_0 and β_1 = regression coefficients, and ε = error term.

The dynamic model was used to assess whether the change in outcome related to lagged independent variables (M_t) and lagged outcome (IFP_t) as well as changes of the independent variables in 2 time points (ΔM):

$$\Delta IFP=\beta_0+\beta_1 HHFS+\beta_2 M_t+\beta_3 IFP_t+\beta_4 \Delta M\ldots+\varepsilon.$$

The difference model was used to assess whether changes in independent variables in 2 points in time (Δ M) related to subsequent change of outcomes:

$$\Delta IFP=\beta_0+\beta_1 HHFS+\beta_2 \Delta M\ldots+\varepsilon.$$

Each of these models has advantages and disadvantages. The lagged model establishes the direction of effect and distinguishes it from reverse causality by using lagged independent variables to examine the effects of earlier status of independent variables (24). This model cannot control the unobserved heterogeneity that may affect the outcomes and that are also correlated with independent variables. Therefore, the estimated effect of independent variables on the outcomes may be biased. The dynamic model includes the changes in independent variables but cannot deal with the problem of unobserved heterogeneity that may affect the outcomes and that are correlated with independent variables. The difference model eliminates the effects of unobserved heterogeneity by using differences within the same person (25). This model cannot account for the problem of reverse causality and does not capture the possible dependence of the change in the outcome on the baseline status of outcome.

Statistical analysis—All statistical analyses were conducted with SPSS 14.0 for Windows. Our outcome variables were the changes in IFP (ΔIFP) from 3–6, 6–9, and 9–12 mo of age. The independent variables were HHFS, sex, birth weight, and morbidity of infants, and maternal age, weight, education, and wealth index. We used general linear models to test the association between HHFS and ΔIFP from 3–6, 6–9, and 9–12 mo of age. These models were also used to test whether the magnitude and significance of the association between HHFS and ΔIFP remained after adjusting for other infant (sex, birth weight, and morbidity) and maternal (age, weight, and education) variables and wealth index.

We used Cox proportional hazards regression models to predict the duration of breast-feeding and the time of introducing complementary feeding at different ages of infants. We used the Kaplan-Meier method and the log-rank test to assess whether the duration of breast-feeding or the time of introduction of complementary feeding differed among the 4 quartiles of HHFS. We used Pearson chi-square tests to examine whether the proportions of infants in 4 groups of households, who were given different types of food at different ages, were statistically different from one another. An α of 0.05 was considered significant.

Results

Approximately 570 of 1343 infants were missing data on early feeding practices. Infants who were missing data on early feeding practices did not differ from infants who were not missing these data for some baseline variables, such as birth weight; HHFS status; maternal age, weight, and education; father's education; and other key SES variables, including wealth index (data not shown).

Infant feeding patterns

Colostrum and prelacteal feeding—Approximately 92% of mothers gave colostrum to their babies and only 8% of them gave some food or drink to their babies before giving breast milk. For the prelacteal foods, 3.2% of mothers gave honey, 1.3% gave mustard oil, 2.8% gave sugar/glucose/jaggery water, and ~1% gave either plain water or other milk.

Breast-feeding: types and duration—Almost all infants in this sample (99.4%) were breast-fed at 1 mo and 92% of them continued up to 12 mo. The proportion of infants who were exclusively breast-fed decreased from 78.3% at 1 mo to 10.7% at 6 mo. At 4 mo, 56% of infants were exclusively breast-fed. The median duration of exclusive breast-feeding (EBF) was ~121 d and did not differ among the 4 HHFS groups. The median duration of any breast-feeding (ABF) was 365 d in y 1 of life in all 4 groups of households. The mean duration of ABF, however, differed ($P < 0.05$) among the 4 groups of households. In the Cox regression model, HHFS was not significantly associated with the duration of EBF or ABF (data not shown).

Introduction of complementary foods

The median age at introduction of complementary foods was 124, 122, 121, and 119 d for extremely food-insecure, moderately food-insecure, occasional food-insecure, and food-secure households, respectively.

Plain water, fruit juice, and other liquids—Overall, 3.7% of infants were given plain water at 1 mo. Proportions of infants given plain water were 15.9% until 4 mo of age. At 6 mo, about three-fourths (76.0%) of infants were given plain water that increased to 97.2% at 9 mo. The proportions of infants who were given plain water during infancy did not differ significantly among the infants in 4 groups of HHFS status.

The infants who were given fruit juice were between 6.7% at 1 mo and 22.9% at 5 mo. At 6 mo, 37% of infants were given fruit juice and 48.5% received it at mo 9. Higher proportions of infants in the more food-secure (food-secure and occasional food-insecure) households were given fruit juice than their counterparts in the more food-insecure (extremely food-insecure and moderately food-insecure) households (Fig. 1*A*). The proportions of infants who were given fruit juice did not differ significantly among the 4 groups of households during the first 3 mo of age. At 4 mo and thereafter until 12 mo of age, the proportions of infants who were given fruit juice were higher ($P < 0.05$) among the more food-secure households than among the food-insecure households.

The feeding of other liquids (such as sugar/glucose/jaggery water) was low and increased with age of infants (Fig. 1*B*). Overall, a maximum of 12% of infants was given other liquids at 12 mo of age. The proportions of infants who were given other liquids were higher ($P < 0.05$) among the food-secure households than those among the food-insecure households at 3 mo, from 5 to 9 mo, and at 11 mo.

Cow milk—The median age of introducing complementary foods in this sample was 4 mo. Overall, 8.7 and 13.3% of infants were given cow milk at 1 and 2 mo, respectively. At 3 mo, approximately one-fifth (19.7%) of infants were given cow milk; at 6 mo, 41.0% received cow milk. At 10 mo, a maximum of 48.1% of infants was given cow milk.

Higher proportions of infants in more food-secure households were given cow milk throughout their first year of life than their counterparts in the food-insecure households (Fig. 1*C*). The proportions of infants who were given cow milk differed ($P < 0.05$) among the 4 groups of households when the infants were 3–12 mo of age.

Semisolid and solid foods—Only 2.2% of infants were given semisolid foods at 1 mo. The proportions of infants who were given semisolid foods increased as the infants got older: 5.3% at 2 mo, 10.1% at 3 mo, 18.1% at 4 mo, and 30% at 5 mo. At 6 mo, about half (49.6%) of the infants were given semisolid foods that reached to 66.4% at 9 mo. The proportions of infants who were given semisolid foods differed ($P < 0.05$) among the 4 groups of households at 6 mo and thereafter until 12 mo of age (Fig. 1*D*). Higher proportions of infants in more food-secure households were given semisolid foods than their counterparts in food-insecure households during the 2nd half of infancy.

Only 4 infants (0.4%) were given solid foods during first 2 mo of age. The proportions of infants who were given solid foods were 1.4% at 3 mo, 4% at 4 mo, and 13.2% at 5 mo. At 6 mo, 43.9% of infants were given solid foods; this figure increased to 94.1% at 10 mo of age. At the end of the first year of life, ~92% of the infants were being given solid food in addition to breast milk. The proportion of infants who were given solid foods was higher ($P < 0.05$) among the food-secure households than the proportions among the food-insecure households at 3, 6, and 7 mo (data not shown).

Lagged model effect of HHFS on IFP—HHFS was associated ($P < 0.001$) with worse feeding practices of infants during 3–6 mo of life (Table 2). In contrast, HHFS was associated ($P < 0.001$) with better IFP during 6–9 and 9–12 mo. These associations between HHFS and change in IFP at their various ages sustained when the models were adjusted for other infant variables, such as sex, lagged morbidity, lagged IFP, and birth weight. Moreover, we observed similar associations between HHFS and change in IFP when we adjusted the models for other infant variables as well as maternal variables, such as age, weight, education, and wealth index. The dynamic and difference models provided similar results of the associations between HHFS and IFP (Table 3).

Among the other infant, maternal, and household factors, better prior feeding practices, infant's male sex, mother's higher education, and higher wealth index were associated ($P < 0.005$) with change in IFP from 3–6 mo, 6–9 mo, and 9–12 mo in all 3 models (Table 3).

Discussion

To our knowledge, this study is one of the first in which the relationship between HHFS and IFP in a low-income country has been investigated. Despite the strong association between HHFS and dietary intake and nutritional status of children and adults in several countries, the association between HHFS and IFP has not been studied either in developed or developing countries to our knowledge. We used longitudinal data on IFP and appropriate statistical techniques for longitudinal data analysis to investigate the effects of HHFS on IFP in a low-income country. Our results provide strong evidence of the association between HHFS and IFP in rural Bangladesh.

Association between HHFS and IFP

Our aim in this study was to investigate the effects of HHFS on IFP in the first 12 mo of life. Greater HHFS was associated with better IFP during 6–12 mo but poorer IFP during 3–6 mo. These periods are important nutrition transitions in an infant's life, because infants continue to grow rapidly and improper feeding practices during infancy can cause poor health, growth, and development. HHFS, thus, is essential for better feeding practices, particularly during the 2nd half of infancy. However, our finding of a negative association between HHFS and IFP during the first half of infancy should be treated with caution.

The negative association between HHFS and IFP at 3–6 mo can be explained in the following way. First, contrary to the recommendations, more infants in food-secure households were given cow milk, fruit juice, and other liquids in early months than the infants in food-insecure households. Therefore, the infants in food-secure households had lower scores in the feeding scales than the infants in food-insecure households. Second, the infants in food-insecure households had a higher rate of morbidity than the infants in food-secure households. Morbidity during infancy was associated ($P < 0.05$) with the duration of EBF. As a result, the feeding scores of infants in food-insecure households were higher than those of infants in food-secure households during the first half of infancy.

The duration of EBF in this cohort did not differ from the results of earlier studies in Bangladesh (27,28). In this study, HHFS was not associated with the duration of EBF and ABF, but the mean duration of ABF during the first year of life differed ($P < 0.05$) among the 4 groups of households. One of the caveats of this study was that we measured the duration of ABF (median 365 d) only during the first year of life. Therefore, this was an underestimate of the actual duration of ABF. As a result, it was not possible to determine whether the duration of ABF in the first 2 y of life differed among the children in 4 categories of HHFS.

In this study, more infants were given cow milk than the infants in an earlier study in Bangladesh (27). Cow milk (or any nonhuman animal milk) is not recommended during the first year of life for 3 main reasons: cow milk is low in iron, it can cause occult blood loss from the gastrointestinal tract, and it has a high renal solute load (29). In Bangladesh, however, giving cow milk to infants beginning in early months is a widespread practice, particularly in the 2nd half of infancy. In the MINIMat cohort, infants in more food-secure households were given cow milk earlier and in higher proportions than the infants in food-insecure households. This practice has been reported by others (30) as more common among the better-off families. Providing cow milk in the early months of life may be significant if the beneficial effects of cow milk (a good source of protein, calcium, and other nutrients) outweigh its adverse effects. This trade-off is equally applicable to the early introduction of fruit juice and other liquids and semisolid foods if these foods cause higher morbidity from contamination with pathogens (30,31). In the future, it will be important to examine the growth and morbidity of the infants in the first 2 y of life who were given cow milk, fruit juice, and other liquids and semisolid foods in early months of infancy.

In this study, fewer infants were fed semisolid foods in their first 3 mo and more infants were given semisolid foods when they were 4–6 mo old than in a previous study in Bangladesh (27). Giving more semisolid foods to infants when they were 6 mo of age and older was observed particularly among the food-secure households. Thus, HHFS seems to play a key role for better feeding practices of infants as far as semisolid food is concerned.

Mothers of these infants received micronutrient supplements and health education messages either with or without randomly assigned intensive breast-feeding counseling during pregnancy and after delivery. Therefore, we adjusted our models with these interventions. The effect of HHFS on IFP, however, remained significant in the adjusted models.

Measurement scales

The food security scale that we used in this study was developed from a qualitative study that provided an in-depth understanding of the experience of food security in rural Bangladesh (21). Locally developed food security measures based on the experience of household members on their practices have been demonstrated to be valid (32,33). In Burkina Faso, an experience-based measure of HHFS was valid within and across seasons (34). The 9 themes of the food security scale of the present study were similar to those suggested from another study conducted in Bangladesh (35) in which there was a high degree of agreement between the items of food security measure identified by qualitative and quantitative methods. This agreement between methods lends validity in their assessment of HHFS and technical quality and similarity of items across the population in Bangladesh. In the food security scales developed from both studies in Bangladesh (21,35), all items were related to 1 of 4 domains: uncertainty and worry, inadequate quantity, insufficient quality, and social unacceptability, which are the basis of HHFS measures in most countries of the world (36).

One limitation of this study was that HHFS was measured only when the mothers of these infants were pregnant. We assumed that HHFS in this population was relatively static and that HHFS measured during pregnancy was a valid proxy of HHFS during the postpartum period. February to March and October to November are the 2 lean seasons, the latter being the preharvest period with low employment opportunities in agriculture (37). However, our analysis of HHFS during the 2 y of the study demonstrated that there was no seasonal pattern (data not shown). This finding is consistent with informal knowledge that HHFS in the study area does not differ during the calendar year. It is also consistent with the lack of seasonal patterns in other indicators of well-being in this population. Furthermore, although we do not have a measure of food security postpartum, our understanding of food security in the study area is that it is not likely to change substantially within households over a period as short as a year.

We employed a novel approach to construct cumulative infant feeding scales using longitudinal data on IFP to capture the monthly feeding dynamics during infancy and to obtain a better measure of IFP than the conventional infant feeding scales developed from cross-sectional data

(38,39). Our infant feeding scales were based on the observed IFP and relative to the current infant feeding recommendations. These infant feeding scales were not measures of actual food consumption but rather were measures of maternal behaviors relative to the recommended behaviors. Therefore, our results suggest the importance of HHFS for following recommended IFP, particularly during the 2nd half of infancy. This is a significant test of translation of the infant feeding policy into maternal practices regarding infant feeding and the importance of HHFS in this translation of policy into practice.

Statistical approach

The statistical models for longitudinal data analysis that we used in this study were used previously to examine the effects of HHFS on academic performance, social skills, and weight gain of school children (25). These models were also used to examine the impact of obesity on wages in which more consistent estimates were generated than previous studies on the same topic (26). In this study, similar results from all 3 types of adjusted models indicated robustness of the association between HHFS and IFP.

HHFS is a determinant of IFP even in a place where breast-feeding is practiced universally and for a long duration. Mothers living in food-secure households did not meet the current feeding recommendations when their babies were 3–6 mo old. In contrast, mothers living in food-insecure households did not meet these recommendations when their babies were 6–12 mo old. Therefore, efforts should be made by all mothers in food-secure and food-insecure households to support recommended IFP in this population.

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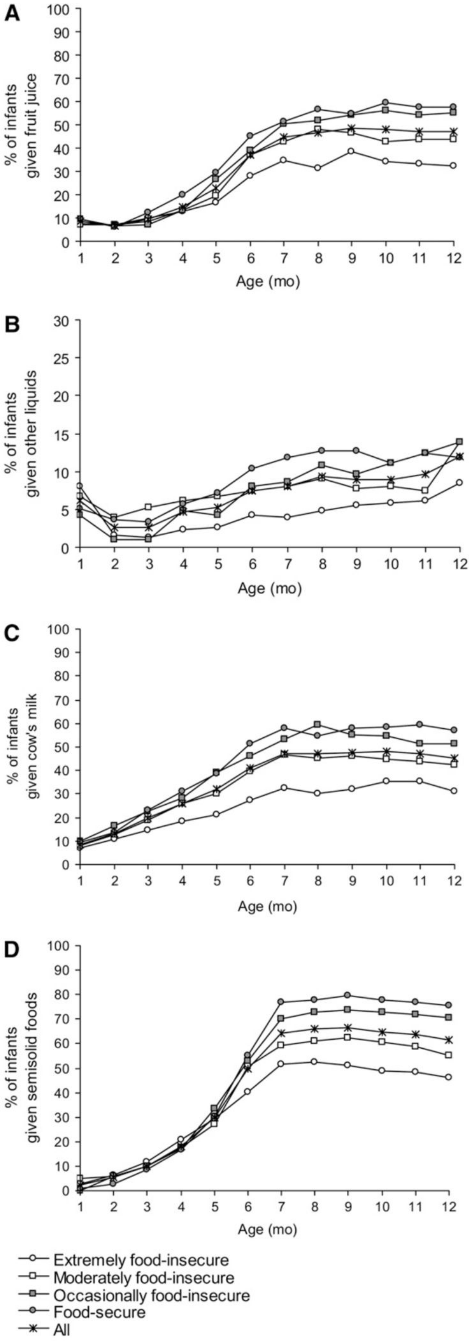

FIGURE 1.

Proportions of infants, *n* = 1242, who were given fruit juice (*A*), other liquids (jaggery/sugar/glucose water) (*B*), cow milk (*C*), or semisolid foods (*D*) at various ages by HHFS status.

TABLE 1

Descriptive statistics of HHFS, morbidity, and feeding practices of infants at different ages

	n	Theoretical range of scales	Mean ± SD (min.–max.)	Standardized[1] mean ± SD (min–max.)
Food security scale	1201	10–44	38.7 ± 3.5 (22.5–46.9)	—
Feeding scale at 3 mo	1327	0–27	24.1 ± 2.3 (12–27)	89.4 ± 8.4 (44.4–100.0)
Feeding scale at 6 mo	1322	0–54	44.3 ± 5.4 (20–54)	82.1 ± 10.0 (37.0–100.0)
Feeding scale at 9 mo	1308	0–84	62.8 ± 5.8 (36–78)	74.8 ± 6.9 (42.9–92.9)
Feeding scale at 12 mo	1242	0–114	83.9 ± 7.8 (50–105)	73.6 ± 6.9 (43.9–92.1)
Morbidity scale at 3 mo	1326	12–24	14.0 ± 1.3 (12.0–21.0)	—
Morbidity scale at 6 mo	1340	12–24	14.2 ± 1.1 (12.0–19.0)	—
Morbidity scale at 9 mo	1341	12–24	14.2 ± 1.0 (12.0–17.9)	—
Morbidity scale at 12 mo	1341	12–24	14.1 ± 1.0 (12.0–18.5)	—

[1] Only infant feeding scales were standardized and expressed as a percentage of the value of the upper range of theoretical scales.

TABLE 2

Lagged model effects of HHFS and other infant, maternal, and household factors on the changes in IFP from 3–6, 6–9, and 9–12 mo of age

Outcomes	**Effect of HHFS**	**Effect of HHFS after controlling for other infant variables**[1]	**Effect of HHFS after controlling for other infant and maternal variables**[1,2]
	β (*P*-value)	*β* (*P*-value)	*β* (*P*-value)
Δ IFP 3–6 mo	− 0.288 (<0.001) *n* = 1182	− 0.302 (<0.001) *n* = 1086	− 0.091 (0.141) *n* = 919
Δ IFP 6–9 mo	0.372 (<0.001) *n* = 1170	0.245 (<0.001) *n* = 1085	0.146 (<0.001) *n* = 911
Δ IFP 9–12 mo	0.166 (<0.001) *n* = 1107	0.171 (<0.001) *n* = 1031	0.067 (0.045) *n* = 866

[1] Lagged morbidity, lagged feeding, birth weight, and sex of infants.

[2] Lagged morbidity, lagged IFP, birth weight, and sex of infants, and maternal age, weight, education, and wealth index.

TABLE 3

Summary of lagged, dynamic, and difference model effects of HHFS and other infant and maternal factors on the changes in IFP from 3–6, 6–9, and 9–12 mo of age

	Models					
Δ IFP	Lagged	Dynamic	Difference			
3–6 mo, $n = 919$	*β*	*P*-value	*β*	*P*-value	*β*	*P*-value
HHFS	−0.091	0.141	−0.101	0.101	−0.091	0.139
Morbidity at 3 mo	−0.058	0.737	−0.458	0.020	—	—
IFP at 3 mo	−0.050	0.044	−0.052	0.033	—	—
Δ Morbidity from 3–6 mo	—[1]	—	−1.229	<0.001	−0.939	<0.001
Female sex of infant	0.697	0.063	0.646	0.083	0.656	0.078
Birth weight of infant, *kg*	−0.740	0.140	−0.794	0.111	−0.810	0.105
Mother's age, *y*	−0.004	0.904	−0.011	0.733	−0.005	0.877
Mother's weight, *kg*	0.053	0.098	0.053	0.095	0.051	0.108
Mother's education, *y*	−0.101	0.103	−0.098	0.112	−0.093	0.132
Wealth index	−0.763	<0.001	−0.755	<0.001	−0.734	<0.001
6–9 mo, $n = 911$						
HHFS	0.146	<0.001	0.156	<0.001	0.132	0.017
Morbidity at 6 mo	−0.356	0.003	−0.197	0.136	—	—
IFP at 6 mo	−0.391	<0.001	−0.389	<0.001	—	—
Δ Morbidity from 6–9 mo	—	—	0.846	0.003	0.499	0.182
Sex of infant	−0.789	0.001	−0.758	0.001	−1.350	<0.001
Birth weight of infant, *kg*	−0.096	0.761	−0.071	0.820	0.335	0.457
Mother's age, *y*	0.020	0.346	0.023	0.263	0.056	0.061
Mother's weight, *kg*	−0.007	0.745	−0.007	0.721	−0.041	0.157
Mother's education, *y*	0.081	0.037	0.079	0.042	0.116	0.037
Wealth index	0.222	0.048	0.227	0.042	0.745	<0.001
9–12 mo, $n = 866$						
HHFS	0.067	0.045	0.062	0.062	0.038	0.257
Morbidity at 9 mo	0.218	0.054	0.081	0.503	—	—
Feeding at 9 mo	−0.087	<0.001	−0.093	<0.001	—	—
Δ Morbidity from 9–12 mo	—	—	−0.634	0.002	−0.643	0.001
Sex of infant	−0.623	0.002	−0.608	0.002	−0.633	0.002
Birth weight of infant, *kg*	0.466	0.080	0.497	0.060	0.562	0.038
Mother's age, *y*	0.026	0.142	0.028	0.108	0.030	0.103
Mother's weight, *kg*	−0.033	0.055	−0.033	0.053	− 0.037	0.034
Mother's education, *y*	0.072	0.028	0.070	0.033	0.066	0.048
Wealth index	0.319	0.001	0.331	<0.001	0.392	<0.001

[1] –, Variables were not included in the models.