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IFPRI

FCND DP No. **130**

FCND DISCUSSION PAPER NO. 130

CREATING A CHILD FEEDING INDEX USING THE DEMOGRAPHIC AND HEALTH SURVEYS: AN EXAMPLE FROM LATIN AMERICA

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April 2002

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ABSTRACT

Data from the Demographic and Health Surveys (DHS) for five Latin American countries (seven data sets) were used to explore the feasibility of creating a composite feeding index and to examine the association between feeding practices and child height-for-age (HAZ). Urban/rural differences were also examined.

The data sets used were Bolivia, 1994 and 1998; Colombia, 1995; Guatemala, 1995 and 1999; Nicaragua, 1998; and Peru, 1996. The variables used to create the index were: breastfeeding (whether the mother is currently breastfeeding the child); use of baby bottles in the previous 24 hours; dietary diversity (whether the child received selected food groups in the previous 24 hours); food group frequency (how many days the child received selected food groups in the past seven days); and meal (or feeding) frequency (how many times the child was offered solids or semisolid foods in the previous 24 hours (including meals and snacks). The index was made age-specific for 6–9-, 9–12-, and 12–36-month age groups, and country- and age-specific feeding terciles were created.

Bivariate analyses showed that feeding practices were strongly and statistically significantly associated with child HAZ in all seven data sets, especially after 12 months of age. Differences in HAZ between the lowest and highest feeding terciles remained significant for all countries except Bolivia, after controlling by multivariate analysis for potentially confounding influences. Multiple regression analyses also revealed that better feeding practices were more important for children from lower, compared to higher, socioeconomic status (Colombia 1995; Nicaragua 1998; Peru 1996); for children of

ladino (Spanish speaking), compared to indigenous, origin (Guatemala 1995); for older (30–36 months), compared to younger, children (12–30 months); and for children of mothers with, compared to mothers without, primary schooling, or mothers with higher than secondary levels of education (Peru 1996).

Urban mothers had consistently higher feeding practices scores than rural mothers, and their children had higher HAZ at all ages. Although breastfeeding rates and duration were lower in urban than in rural areas, as is typical of most countries in the developing world, children's diets in urban areas of Latin America were consistently better than those of rural areas from the age of 6 months. Urban mothers were more likely than rural mothers to introduce complementary foods in a timely fashion, to use a greater variety of complementary foods (animal products in particular), and to offer their children complementary foods as frequently as recommended for their age. These findings provide strong empirical evidence of the higher quality of the diet of urban weaning-age children compared to their rural counterparts. Urban/rural differences in malnutrition prevalence paralleled the differences documented for child feeding practices—prevalence of stunting was systematically lower in urban than in rural areas, and countries with highest prevalence of stunting also had the lowest average child feeding index scores (Guatemala 1995, 1999; Peru 1996).

This work shows that the data available in DHS data sets can be used for a variety of purposes, including to (1) describe and study the distribution of specific feeding practices by geographic area, or other characteristics of interest such as maternal schooling or household socioeconomic status; (2) create a child feeding index to quantify and illustrate associations between child feeding practices and child outcomes, thereby serving as an advocacy tool; and (3) identify practices and vulnerable groups that could be targeted by programs and policies to improve child feeding practices and overall child health and nutrition. In sum, greater use of the DHS data on child feeding practices should be promoted for research and analysis, as a source of guidance on program design and planning, and for advocacy.

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ACKNOWLEDGMENTS

This research was supported by the University Partnership Program of the U.S. Agency for International Development (USAID), the Department for International Development (U.K.), and the International Food Policy Research Institute (IFPRI). We thank Prem Sangraula and Roshan Hussain for research assistance, and Lisa Smith for reviewing the document.

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1. INTRODUCTION

The importance of child feeding practices for child nutrition is well recognized in the nutrition literature (WHO 1995; Brown, Dewey, and Allen 1998). However, efforts to measure and quantify child feeding practices and assess the strength of their association with child nutritional status have been hampered by methodological problems. The problems arise primarily because child feeding practices encompass a series of interrelated behaviors that are difficult to summarize into one or a few variables. For example, recommended practices for a 7-month old infant include, among other things, breastfeeding, feeding the infant nutrient-dense complementary foods two to three times per day, and actively helping and motivating the infant to eat. Child feeding practices in the first three years are also age specific within narrow age ranges, which adds to the complexity of measurement. Thus, evaluating the overall quality of mothers' feeding behaviors can be challenging, and few researchers have tried.

Most research on the relationship between child feeding practices and health outcomes has focused on single behaviors, e.g., exclusive breastfeeding (Popkin et al. 1990; Victora et al. 1989; Brown et al. 1989), timing of introduction of complementary foods (Cohen et al. 1994), and the importance of animal products in complementary feeding (Marquis et al. 1997). These approaches, while valuable for evaluating the role of individual practices, do not allow an examination of the impact of child feeding practices *as a whole* on children's health and nutrition outcomes. Qualitative approaches have also been popular for research on feeding practices and care, because their flexibility makes them suitable for capturing complex behavior patterns. The knowledge acquired through the use of observational and anthropological methods is also valuable, but it does not help *quantify* the importance of child feeding and care practices for child nutrition outcomes.

The research presented here constitutes one of the first attempts at quantifying some of the various dimensions of child feeding practices, namely, type, quality, and frequency, and at summarizing the information into a composite, age-specific index of child feeding practices. Data from the Demographic and Health Surveys (DHS) from five countries (seven data sets) were used.

The specific aims of the research were to (1) assess the feasibility of creating an age-specific child feeding index using the information available in DHS data sets; (2) examine urban and rural differences in child feeding practices and evaluate whether they parallel differences in nutritional status; (3) estimate the strength of the association between child feeding practices and child nutritional status, while controlling for potentially confounding factors through multiple regression analyses; and (4) evaluate whether good feeding practices are more important for some subgroups of children than others, depending on their age or gender, their maternal and household sociodemographic characteristics, or their area of residence (urban versus rural).

This work builds on our previous experience with creating a child feeding index using primary data from a representative survey of urban livelihoods in Accra, Ghana (Maxwell et al. 2000; Ruel et al. 1999; Armar-Klemesu et al. 2000). Our experience showed that creating a child feeding index was both feasible and useful, especially to quantify the strength of the association between child feeding practices and nutritional outcomes and to study the maternal and socioeconomic barriers to optimal feeding practices.

2. SUBJECTS AND METHODS

DATA

Seven data sets from the Demographic and Health Surveys (DHS) collected in five countries of Latin America between 1994 and 1999 were used. The DHS program is funded by the U.S. Agency for International Development (USAID) and coordinated by Macro International, Inc. Data collection is usually carried out in collaboration with country governments using population sampling frames and all data sets are nationally representative. These data sets are in the public domain and are available from the DHS website (Measure DHS+ 2000). Ethical clearance for the use of these data was obtained from the Cornell University Commission on Human Subjects.

Data sets collected from 1994 onward and available on the website as of August 2000 were used. These included Bolivia, 1994 and 1998; Colombia 1995; Guatemala 1995 and 1999; Nicaragua 1998; and Peru 1996. The criteria used for country selection were (1) availability of data to create the child feeding index (see subsection below); (2) availability of child anthropometric data; and (3) urban and rural samples equal or larger than 500 children 0–36 months of age. This latter criterion was important to allow an adequate sample size for the stratification of the sample by age groups within urban and rural areas.

CHILD FEEDING INDEX

A child feeding index was created based on current feeding recommendations for children 6–36 months (Brown, Dewey, and Allen 1998; The Linkages Project 1999), as summarized in Figure 1. Optimal feeding practices were defined for three age groups: 6-9 months (breastfeeding plus gradual introduction of complementary foods); 9–12 months (the same, but increasing the amount and frequency of complementary feeding); and 12-36 months (continued breastfeeding for as long as possible, gradual transition to the family diet, and focus on dietary quality). The use of baby bottles was considered an inappropriate practice at all ages.

The following variables were used in the index creation: breastfeeding (whether the mother is currently breastfeeding the child); use of baby bottles in the previous 24 hours; dietary diversity (whether the child received selected food groups in the previous 24 hours); food group frequency (how many days the child received selected food groups in the past seven days); and meal (or feeding) frequency (how many times the child was offered solids or semisolid foods in the previous 24 hours (including meals and snacks).

The list of variables and the scoring system used to create the child feeding index for the different age groups are presented in Table 1. The general scoring system was to assign a score of 0 for a potentially harmful practice and a score of 1 for a positive practice. Practices considered particularly important at a given age, such as breastfeeding between 6 and 12 months of age, or feeding the child animal products regularly between 12 and 36 months of age received a score of 2. As indicated above, practices were

Figure 1. The continuum of child feeding

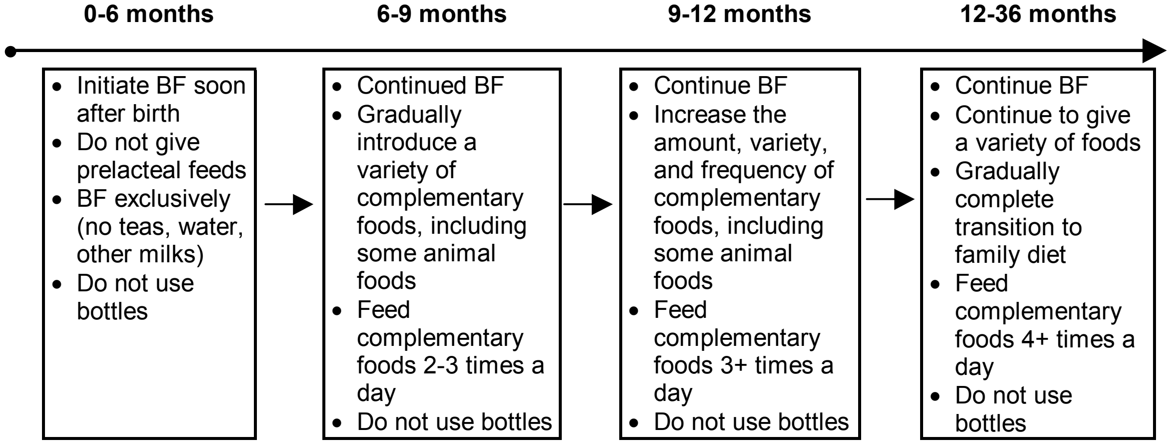


Table 1—Variables and scoring system used to create the child feeding index for children 6-36 months, by age group

Variables	6-9 mo	9-12 mo	12-36 mo
Breastfeeding	No = 0; Yes = +2	No = 0; Yes = +2	No = 0; Yes = +1
Uses bottle	No = 1; Yes = 0	No =1; Yes = 0	No = 1; Yes = 0
Dietary diversity (in past 24 hours)	**Sum of:** (grains + tubers + milk + egg/fish/poultry + meat + other): 0 = 0 1-3 = 1 4+ = 2	**Sum of:** (grains + tubers + milk + eggs/fish/poultry + meat + other): 0 = 0 1-3 = 1 4+ = 2	**Sum of:** (grains + tubers + milk + eggs/fish/poultry + meat + other): 0 = 0 1-3 = 1 4+ = 2
Food group frequency (past 7 days)	**For each of:** - **egg/fish/poultry** - **meat** 0 times in past 7 d = 0 1-3 times in past 7 d = 1 4+ times in past 7 d = 2 **For staples (grains or tubers)** 0-2 times = 0; 3+ times = 1 **Food group frequency** = sum of scores for staples + egg/fish/poultry +meat	**For each of:** - **egg/fish/poultry** - **meat** 0 times in past 7 d = 0 1-3 times in past 7 d = 1 4+ times in past 7 d = 2 **For staples (grains or tubers)** 0-3 times = 0; 4+ times = 1 **Food group frequency** = sum of scores for staples + egg/fish/poultry + meat	**For each of:** - **milk** - **eggs/fish/poultry** - **meat** 0 times in past 7 d = 0 1-3 times in past 7 d = 1 4+ times in past 7 d = 2 **Food group frequency** = sum of scores for milk + egg/fish/poultry + meat
Meal frequency (past 24 hours)	0 meals/d = 0 1 meal/d= 1 2 meals/d = 2	0 meals/d = 0 1-2 meals/d = 1 3+ meals/d = 2	0-1 meal/d = 0 2-3 meals/d = 1 4+ meals/d = 2
Total score	**12 points**	**12 points**	**12 points**

considered positive or negative based on current child feeding recommendations and on available scientific evidence about their benefits or risks (WHO 1995; Brown, Dewey, and Allen 1998). The specific scoring system used for the three age groups is summarized below.

Breastfeeding received a score of 2 for infants 6–12 months of age, a score of 1 for older children, and a score of 0 for non-breastfeeding children of any age. Avoidance of baby bottles was scored 1 (good practice), and their use received a score of 0 at any age because the practice is considered potentially harmful for all children.

A dietary diversity score was created based on the number of food groups consumed by the child in the previous 24 hours (maximum of six food groups: cereals, tubers, milk, egg/fish/poultry, meat, and other). Note that eggs, fish, and poultry are combined into a single group in the DHS data sets used. There are currently no specific recommendations regarding the optimal number of foods or food groups a child should consume each day, but there is some consensus that higher dietary diversity is desirable because it can help meet daily requirements for a variety of nutrients. In the absence of a specific recommendation, an arbitrary scoring, similar for all age groups, was used: none (meaning no semisolid or solid foods) was scored 0, one to three food groups received a score of 1, and four or more food groups received a score of 2.

A food group frequency score was also created, based on the information on the number of days the child consumed different food groups in the previous week. For this score, the grains and tubers groups were combined into one single group, referred to as "staples," and the "others" food group was not used, leaving a total of four food groups (staples, milk, egg/fish/poultry, and meat). For the food group frequency score, each food group was scored individually and the scores to each one were summed to derive a final food group frequency score. Different combinations of food groups were included in the score, depending on the age group. For the two younger age groups, the staple group was included, as well as the two animal product groups (egg/fish/poultry and meat). The animal products were scored 0 if they were not consumed during the past week, 1 if they were consumed on one to three days, and 2 if they were consumed on four days or more. The staple foods received a score of 1 if consumed three days in the previous week at 6–9 months of age, and four days at 9–12 months of age; otherwise, they were scored 0. A higher score was given for regular consumption of animal products than for staple foods. The reason for this emphasis on animal products is that, although there is no specific recommendation at this time about the optimal frequency of intake of animal products, the current recommendation is that children 6 months of age and older consume animal products as often as possible, ideally every day (The Linkages Project 1999). The milk group was not included in the food group frequency score for infants up to 12 months of age because it is thought to displace breast milk and is associated with greater use of baby bottles. For children 12 months and older, all three animal food groups (milk, meat, fish/egg/poultry) were included and a score of 2 was given for each when consumed four days per week or more. For these older children, the "staple" group was not included because little variability was found—most children consumed cereals or tubers regularly.

The scoring of meal frequency was based on current feeding recommendations, according to which 6–9-months-old infants should receive complementary foods at least twice a day, 9–12-months old infants three times a day, and 12–36-months-old children four times a day (The Linkages Project 1999).

The final child feeding index was the sum of the scores obtained for each variable described above. The index ranged from 0 to 12 for all three age groups. Within each age group (and country), the child feeding index scores were grouped into terciles of child feeding practices: low, average, and high.

SOCIOECONOMIC INDEX

A socioeconomic index was created using data available at the household level from the DHS data sets. The main purpose of creating the index was to categorize households into socioeconomic status (SES) terciles and to control for socioeconomic status in the multiple regression analyses of the determinants of child nutritional status (see analytical methodology). The index was constructed separately for each country and for urban and rural areas within each country, because the characteristics that define wealth were expected to be different from one country to the other, as well as between urban and rural areas within countries.

Principal components analysis was used to derive one factor from the selected wealth variables. All candidate variables were categorical and ranked by ascending order (from worst to best). Variables included water source, sanitary facility, housing material (floor, wall, roof), and ownership of a list of assets. The selection criteria for inclusion of individual variables into the final factor was that factor loadings (defined as the correlation between the variable and the factor) had a value greater than 0.5. For each country and area, the newly created variable reflecting the factor scores was then ranked into terciles to create three socioeconomic (SES) status groups: low, average, and high. More details about the methodology are available in Menon, Ruel, and Morris (2000).

OTHER VARIABLES

The child nutritional status outcome used was height-for-age because stunting (defined as height-for-age Z-score less than –2 standard deviations of the WHO/NCHS/CDC reference standards (WHO 1979) is the main nutritional problem in Latin America (Ruel 2001). Wasting (low weight-for-height) prevalence is very low throughout the region.

Maternal education was available as highest level of formal schooling, and four categories were created: no schooling, primary, secondary, and higher than secondary.

Maternal height (in centimeters), parity (number of pregnancies), child gender (coded 1 for male and 2 for female), number of children under age 5 in the household, and urban/rural residence (coded 1 for urban and 2 for rural) were also used in the analyses. Ethnic group (coded 1 for indigenous and 2 for ladino) was used when available (only in the two data sets from Guatemala).

ANALYTICAL METHODOLOGY

T-tests and analysis of variance (ANOVA) were used to test the statistical significance of differences in bivariate analyses. Ordinary least squares (OLS) regression was used to test whether the magnitude and statistical significance of the association between the feeding index terciles and HAZ remained after controlling for other determinants of child nutritional status such as child age and gender, maternal education, height, parity, number of children under 5, ethnic group (when available), household socioeconomic status, and area of residence. Interaction models were also used to test the statistical significance of all two-way interactions between the child feeding terciles on the one hand and the individual variables included in the model on the other. The objective of testing for two-way interaction terms was to determine whether the magnitude of the association between child feeding practices and child nutritional status differed according to specific characteristics of the child, mother, or household. For example, we hypothesized, based on findings from our previous work in Ghana, that children from poorer households and those whose mothers were less educated may benefit more from better feeding practices than wealthier children or children with more educated mothers (Ruel et al. 1999).

One potential limitation of our multiple regression analyses is that the child feeding practices variable may be endogenous to the model, i.e., it may be determined by a set of factors that also determine the outcome. For example, maternal education and household socioeconomic factors may influence both feeding practices and children's nutritional status. Failure to control for endogeneity leads to biased coefficient estimates (Judge et al. 1985). One common approach to address the issue of endogeneity is the use of instrumental variables (using predicted as opposed to observed values of a variable) and two-stages, least squares methods. In order to use this approach, it is necessary to identify at least one variable (determinant) that is associated with the endogenous variable being predicted in the first stage of the equation (the instrumental variable—in this case feeding practices), but that is not associated with the outcome (HAZ). None of the variables available in the DHS data sets met this criterion. For this reason, the potential problem of endogeneity was not addressed in this analysis. Additional research is required to identify potential instruments that could be used to predict child feeding practices and to address the problem of endogeneity of this variable in modeling the determinants of nutritional status.

Probability values less than 0.05 for main effects and less than 0.20 for two-way interactions were considered statistically significant. Least squares means (adjusted for other covariates by OLS) were reported only for statistically significant interactions. All analyses were done using Stata (Stata Corporation), versions 6 and 7.

3. RESULTS

URBAN/RURAL DIFFERENCES IN CHILD FEEDING PRACTICES AND IN NUTRITIONAL STATUS (HEIGHT-FOR-AGE Z-SCORES)

Table 2 presents mean child feeding scores by age group, area of residence, and country. Results show that urban mothers have consistently higher child feeding practices scores than rural mothers, with most of the differences in favor of urban mothers being statistically significant. Mean index scores range from a low 5.9 points in Guatemala 1999 among children aged 6–9 months old to a high of 9 points among urban 12–36-month-old children in Bolivia 1998 and Colombia 1995.

Table 2—Child feeding practices scores in Latin America, by age group, country, area of residence and year (DHS data sets)[a]

	6-9 months				9-12 months				12-36 months			
	Urban		**Rural**		**Urban**		**Rural**		**Urban**		**Rural**	
Country	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Bolivia 1994	**8.09**	2.14	**7.79**	2.32	**8.96***	1.86	**8.40**	1.91	**8.80***	1.60	**7.78**	1.91
	[n=137]		[n=120]		[n=141]		[n=111]		[n=759]		[n=678]	
Bolivia 1998	**7.88***	2.42	**7.32**	2.61	**9.00***	1.89	**8.10**	2.36	**9.07***	1.60	**7.79**	1.98
	[n=170]		[n=171]		[n=178]		[n=171]		[n=1,022]		[n=836]	
Colombia 1995	**8.19**	1.86	**8.11**	1.78	**8.53**	186	**8.20**	1.85	**9.02***	1.47	**8.64**	1.61
	[n=143]		[n=91]		[n=165]		[n=66]		[n=987]		[n=500]	
Guatemala 1995	**6.44***	2.13	**5.98**	2.10	**7.46***	1.97	**6.86**	1.95	**7.26***	1.79	**6.23**	1.70
	[n=113]		[n=346]		[n=99]		[n=356]		[n=591]		[n=1,931]	
Guatemala 1999	**5.95**	2.19	**5.92**	1.95	**7.72***	2.07	**6.87**	1.92	**7.41***	1.92	**6.34**	1.77
	[n=43]		[n=160]		[n=54]		[n=154]		[n=304]		[n=874]	
Nicaragua 1998	**6.98***	2.14	**6.52**	1.84	**6.83***	1.67	**6.36**	1.91	**7.32***	1.75	**6.51**	1.86
	[n=139]		[n=164]		[n=124]		[n=150]		[n=984]		[n=1,123]	
Peru 1996	**7.29***	2.30	**6.85**	2.55	**8.53***	1.90	**8.13**	1.97	**8.38***	1.65	**7.24**	2.00
	[n=324]		[n=385]		[n=423]		[n=381]		[n=2,628]		[n=2,206]	

[a] An asterisk (*) indicates that the t-test of the comparison between urban and rural areas is statistically significant ($p < 0.05$).

Table 3 highlights urban/rural differences in specific feeding practices. It shows that urban mothers generally use a greater variety of complementary foods than rural mothers and, more importantly, that they are more likely to feed their children animal products and to offer them complementary foods as frequently as recommended for their age. This is true for all age groups between 6 and 36 months (although only findings for the 12–36 month age group are presented).

Table 3—Urban/rural differences in maternal feeding practices for children 12-36 months of age (percent of mothers who report the following practices)[a]

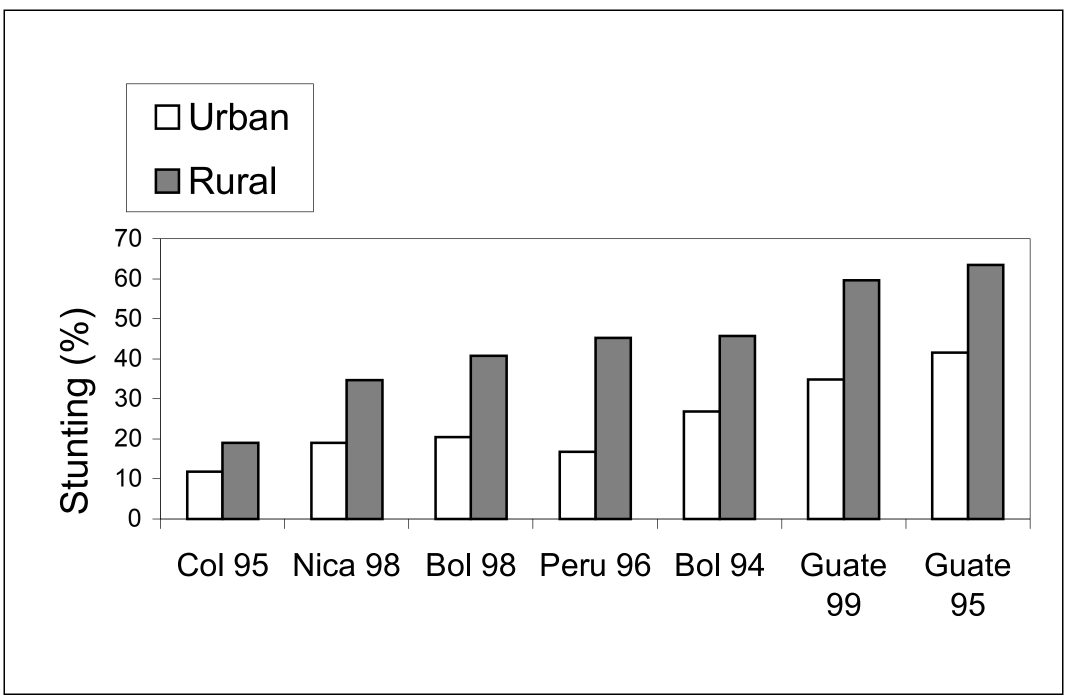
	Bolivia 1994		Bolivia 1998		Colombia 1995		Guatemala 1995		Guatemala 1999		Nicaragua 1998		Peru 1996	
Practices	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Currently breastfeeding	33.3*	49.1	33.6*	47.4	21.7*	28.8	44.0	57.0*	42.1*	57.0	29.3*	36.9	40.4	52.5*
Uses baby bottles	46.9*	20.5	53.4*	24.8	70.0*	56.6	57.1	32.7*	3.8*	2.3	77.6*	71.6	41.4	70.8*
In past 24 hours gave:														
- Grains	48.3	51.3	68.8	70.8	90.1	92.4	40.1	32.4*	47.9*	55.4	29.8*	24.1	86.6	89.0*
- Eggs, fish, poultry	65.5*	48.3	67.1	54.4	74.6*	65.0	69.0	57.5*	71.9*	65.7	65.8	62.8	74.2	52.3*
- Meat	84.4*	66.0	76.7*	62.8	65.0	62.0	48.5	29.3*	37.6*	32.0	56.4*	36.6	39.7	35.5*
In past 7 days gave (>1 time):														
- Grains	74.6*	76.4	90.2	89.2	97.7	99.2	66.2	57.0*	68.8*	71.1	42.7	37.9	98.2	96.5*
- Eggs, fish, poultry	93.5*	86.6	93.7*	85.9	97.2*	93.5	93.1	88.9*	90.3	90.3	88.9*	86.2	96.9	83.6*
- Meat	97.2*	87.1	94.8*	86.4	93.6*	90.8	82.9	72.3*	74.1*	64.0	83.1*	59.9	83.0	69.5*
In past 24 hours gave $\geq$ 4 meals	70.5*	55.5	76.9*	59.8	91.2*	84.6	41.3	28.9*	63.4*	2.5	56.0*	47.7	57.8	37.4*

[a] An asterisk (*) indicates that the t-test of urban-rural difference is statistically significant at $p < 0.05$.

On the negative side, urban mothers in Latin America, as in other regions of the developing world, are likely to stop breastfeeding earlier than rural mothers and to use baby bottles and breast-milk substitutes. These nonoptimal practices are widespread in urban areas, often as a result of women's extensive involvement in income-generating activities (Ruel 2000).

Urban/rural differences in malnutrition prevalence parallel the differences documented here for child feeding practices—the prevalence of stunting is systematically lower in urban compared to rural areas (Figure 2). Urban/rural differences as large or larger than twofold are found in the prevalence of stunting among 12–36-month-old children in four of the seven data sets (Bolivia 1998, Peru 1996, Guatemala 1995 and

Figure 2. Urban/rural differences in the prevalence of stunting among 12-36-month-old children (Latin America, DHS data)

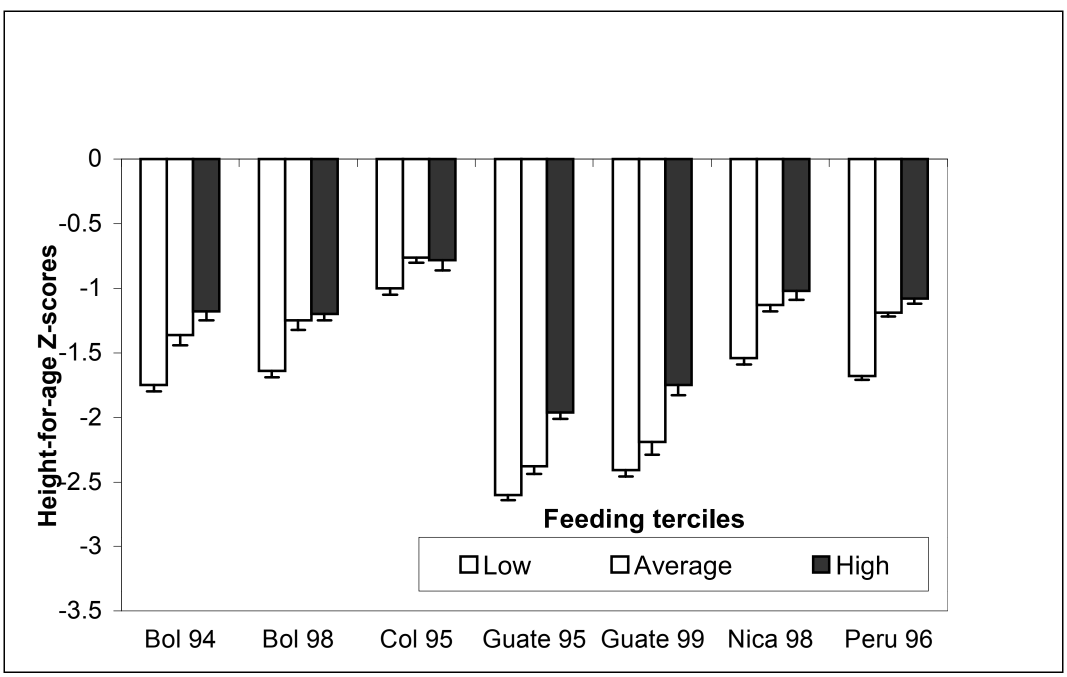


1999). Lower child feeding index scores are also found in countries with higher stunting prevalences (Guatemala 1995 and 1999, and Peru). The opposite is also true, as countries such as Colombia have the highest mean child feeding practices scores and the lowest prevalence of stunting.

ASSOCIATION BETWEEN CHILD FEEDING PRACTICES AND HEIGHT-FOR-HEIGHT Z-SCORES

Findings from the bivariate analyses of the association between child feeding practices and height-for-age Z-scores are presented in Figure 3 for children aged 12–36 months. Because there were no differences in the nature of this association between urban and rural areas, data are presented for both areas combined.

Figure 3. Association between child feeding practices and height-for-age Z-scores (HAZ) in five Latin American countries



Note: All differences are statistically significant; ANOVA, $p<0.05$.

The analysis shows that better child feeding practices are associated with higher height-for-age Z-scores among 12–36 month old children in all seven data sets. All differences are statistically significant (ANOVA $p < 0.05$), and the magnitude of differences between the low and the high feeding terciles is greater than 0.5 Z-scores in five of the data sets. Differences between feeding terciles among younger age groups are less consistent, especially among the 6–9 month age group, and are statistically significant only in a few data sets (not shown).

Results of multiple regression analyses confirm findings from bivariate analyses showing that child feeding practices are associated with better nutritional status. After controlling for potentially confounding sociodemographic factors, feeding practices are statistically significant either as a main effect or in two-way interactions in all but the two Bolivia data sets (1994 and 1998). The analysis also reveals the existence of two-way interactions in four of the data sets (Table 4). In Guatemala 1995, feeding practices interact with maternal ethnicity, showing a stronger association with HAZ among children of ladino, compared to indigenous, mothers (Figure 4). In Colombia, Nicaragua, and Peru, the interaction with socioeconomic status shows that better feeding practices in these samples are more strongly associated with HAZ among poorer than wealthier households (for an example from Nicaragua, see Figure 5). In the Peru data set, child feeding practices interact with a series of factors: socioeconomic status, child age, and maternal schooling. The socioeconomic status interaction is in the same direction as for Nicaragua and Colombia, i.e., a larger magnitude of association between feeding

Table 4—Results of ordinary least squares regression analyses of the determinants of children's height-for-age *Z*-scores in five countries (seven data sets) of Latin America[a]

Independent variables[b]	Bolivia 1994		Bolivia 1998		Colombia 1995		Guatemala 1995		Guatemala 1999		Nicaragua 1998		Peru 1996	
Main effects	*Coeff*	t-test	*Coeff*	t-test	*Coeff*	t-test	*Coeff*	t-test	*Coeff*	t-test	*Coeff*	t-test	*Coeff*	t-test
Child age (18 months)	-0.40	-4.43[c]	-0.35	-4.37[c]	-0.19	-2.80[c]	-0.35	-6.02[c]	-0.28	-3.06[c]	-0.31	-3.77[c]	-0.30	-4.08
Child age (24 months)	-0.02	-0.20	0.03	0.40	0.09	1.20	-0.11	-1.75	-0.05	-0.51	0.10	1.20	0.09	1.17
Child age (30 months)	-0.24	-2.17	0.12	1.37	0.18	2.32	-0.24	-3.40	-0.10	-0.84	-0.12	-1.34	-0.19	-2.26
Child gender	0.06	0.92	0.10	1.59	0.13	2.46	0.12	2.66	0.11	1.52	0.05	0.84	0.09	2.44
Maternal education (1)	-0.20	-1.80	0.14	1.34[c]	0.06	0.45[c]	0.00	-0.02[c]	0.10	1.16[c]	0.08	1.00[c]	-0.10	-1.18
Maternal education (2)	-0.03	-0.20	0.37	2.90	0.25	1.69	0.34	3.13	0.51	3.18	0.36	3.42	0.12	1.18
Maternal education (3)	0.11	0.50	0.41	2.54	0.29	1.66	0.38	1.46	1.20	3.15	0.71	3.08	0.46	3.09
Maternal height (centimeters)	0.06	10.54	0.04	8.88	0.06	15.03	0.07	15.37	0.03	7.46	0.03	8.12	0.05	16.59
Maternal ethnicity	-	-	-	-	-	-	0.27	5.29	0.08	0.71	-	-	-	-
Maternal parity	-0.04	-2.40	-0.02	-1.50	0.15	0.90	-0.01	-1.10	0.00	0.11	-0.00	-0.33	-0.03	-3.56
Feeding index tercile (2)	0.11	1.25	0.09	1.06	0.34	3.65	0.08	1.40[c]	-0.30	-1.97	0.15	1.40	-0.23	-1.53
Feeding index tercile (3)	0.16	1.80	0.07	0.94	0.47	3.20	0.19	3.21	-0.19	-1.42	0.52	3.34	0.30	-1.30
SES tercile (2)	0.18	2.08[c]	0.11	1.50[c]	0.44	4.53	0.12	2.23[c]	-0.07	-0.81[c]	0.12	1.11	0.16	2.38
SES tercile (3)	0.47	4.96	0.49	5.84	0.62	4.19	0.30	4.73	0.25	2.40	0.59	4.48	0.25	3.14
No. children < 5 years	-0.21	-4.55	-0.22	-5.23	-0.19	-5.83	-0.17	-6.25	-0.16	-3.99	-0.08	-2.52	-0.21	-8.64
Residence (urban/rural)	-0.35	-4.23	-0.30	-4.18	-0.11	-1.66	-0.37	-6.13	-0.19	-2.04	-0.23	-3.27	-0.52	-11.88
Two-way interactions														
Feeding . SES (2_2)					-0.21	-1.66[d]					0.24	1.49[d]	0.06	0.67[d]
Feeding . SES (2_3)					-0.44	-2.27					-0.27	-1.29	0.12	0.99
Feeding . SES (3_2)					-0.44	-2.45					-0.12	-0.69	0.23	2.14
Feeding . SES (3_3)					-0.72	-2.75					-0.62	-2.79	0.30	2.36
Feeding . age (2_18)													0.04	0.37[d]
Feeding . age (3_18)													0.04	0.31
Feeding . age (2_24)													0.06	0.54
Feeding . age (3_24)													-0.06	-0.46
Feeding . age (2_30)													0.34	2.90
Feeding . age (3_30)													0.20	1.39
Feeding . ethnicity (3_2)									0.63	3.14[d]				
Feeding . ethnicity (3_3)									0.63	3.64				
Feeding . education (1_2)													0.34[d]	2.29
Feeding . education (1_3)													0.34	1.49
Feeding . education (2_2)													0.15	0.95
Feeding . education (2_3)													0.23	1.01
Feeding . education (3_2)													0.12	0.62
Feeding . education (3_3)													-0.01	-0.04
N	1,288		1,747		1,451		2,388		1,078		1,883		4,613	
F	21.5		26.1		25.16		54.54		19.76		15.21		48.58	
Adjusted R-Square	0.19		0.18		0.24		0.26		0.24		0.13		0.24	
Root Mean Square Error	1.26		1.29		1.00		1.11		1.18		1.34		1.21	

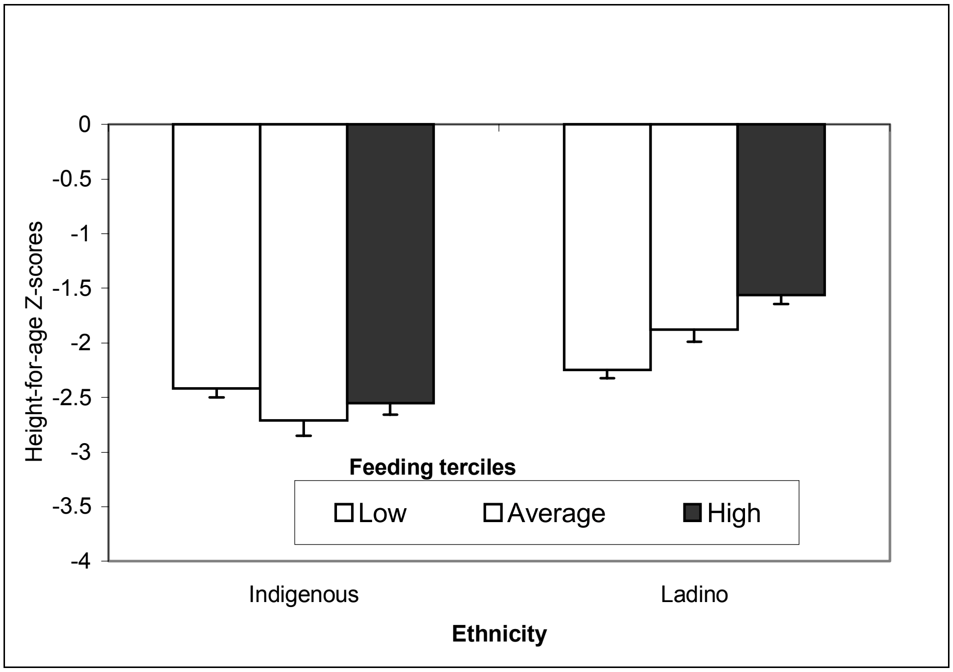
[a] Table entries are regression coefficients and t-tests.

[b] Coding of variables: Child age group: (12 = 12-17.9 mo.; 18 = 18-23.9 mo.; 24 = 24-29.9 mo.; 30 = 30-35.9mo.); 3 dummies, reference = 12; Child gender: 1 = male; 2 = female; Maternal education: (0 = no education; 1 = primary; 2 = secondary; 3 = higher); 3 dummies, reference = 0; Maternal ethnicity: (1 = Indigenous; 2 = ladino); Feeding terciles: (1 = poor; 2 = average; 3 = good); 2 dummies, reference = 1; SES = socioeconomic index score: (terciles: 1 = poor; 2 = average; 3 = higher); 2 dummies, reference = 1; Residence: Urban/rural: (urban = 1; rural = 2) *two-way interactions*: *For each interaction term, the numbers in parentheses after the variables represent the categories for the two variables in the interaction term. For example, the feeding x SES interaction term "f*eeding . SES (2_3)" represents the interaction of the second category of the feeding index with the third category of SES (i.e., average feeding tercile. high SES).

[c] Joint test for main effect is significant ($p < 0.05$).

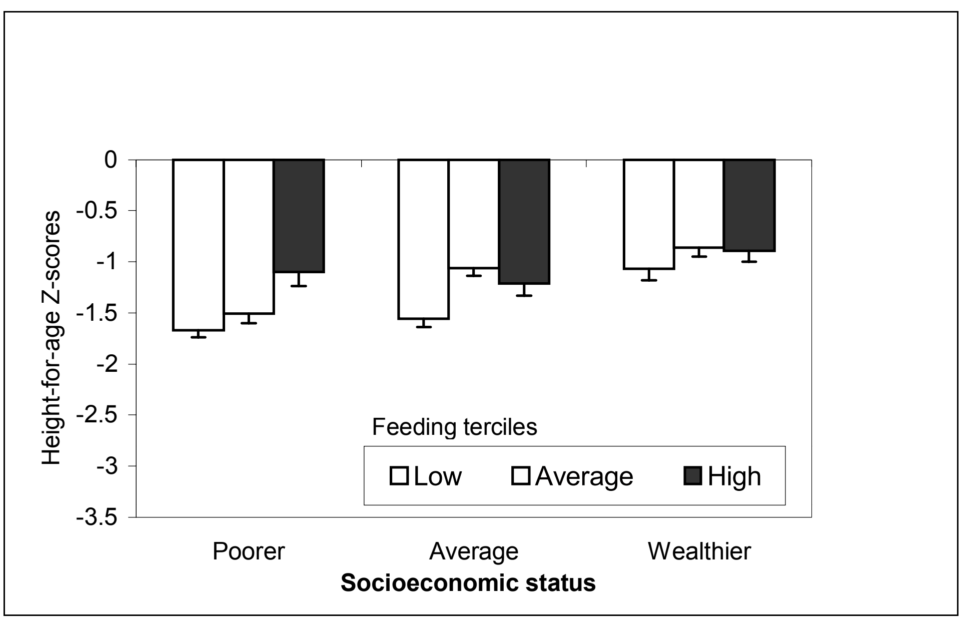
[d] Joint test for two-way interaction is significant ($p < .20$).

Figure 4. Mean adjusted height-for-age Z-scores (HAZ), by feeding terciles and ethnicity (DHS, Guatemala 1999)



Note: Means are adjusted for child age, maternal height, parity, number of children < 5 years, and socioeconomic status.

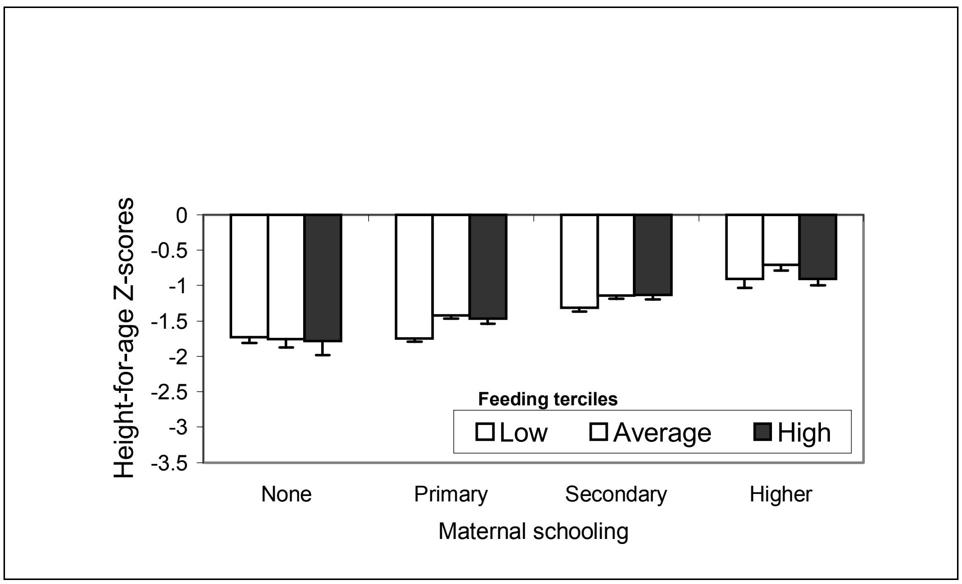
Figure 5. Mean adjusted height-for-age Z-scores (HAZ), by feeding terciles and socioeconomic status (DHS, Nicaragua 1998)



Note: Means are adjusted for child age, maternal height, parity, number of children < 5 years.

practices and HAZ is observed among households of lower socioeconomic status. The interaction with maternal schooling (Figure 6) indicates that child feeding practices in this sample are associated with better nutritional status only among mothers who have some primary school education. Finally, the interaction with child age shows a stronger association between feeding practices and HAZ among older children (30–36 months), compared to the younger age groups (12–30 months) (results not shown).

Figure 6. Mean adjusted height-for-age Z-scores (HAZ), by feeding terciles and maternal schooling (DHS, Peru 1996)



Note: Means are adjusted for child age, maternal height, parity, number of children < 5 years, and socioeconomic status.

4. DISCUSSION

KEY FINDINGS

Feeding practices were strongly and statistically significantly associated with child HAZ in most of the Latin American countries studied, especially after 12 months of age. The advantage in height experienced by 12–36-month-old children who were in the high compared to the low feeding practices tercile was approximately 0.5 Z-score. This magnitude of difference is usually considered a large effect size and is similar to the magnitude of differences commonly attributed to maternal education, socioeconomic differentials, or successful nutrition interventions (Rutstein 1996; Ruel et al. 1995; Brown, Peerson, and Allen 1998).

The association between feeding practices and child HAZ was generally weaker and less consistent among children in their first year of life, but it increased gradually with age. Similar findings were obtained in an analysis of the importance of maternal schooling for child nutrition in rural Bangladesh (Menon, personal communication). They found that the association between maternal schooling and child HAZ increased with age throughout the second year of life. The authors interpret this finding as an indication that maternal schooling might operate in a cumulative fashion and thus may manifest itself in terms of better nutrition and health for older, rather than younger, children.

An additional factor that may explain the greater effect of feeding practices on HAZ among older children is the clustering of positive practices. Our recent review of the literature on hygiene and child feeding practices provides evidence that positive (or negative) behaviors tend to cluster, both at one point in time and over time (Arimond and Ruel 2001); mothers who engage in early positive practices, for instance, may also engage in better practices in subsequent years, and their positive practices are likely to extend over more than one dimension of caregiving. Thus, the cumulative effect of these improved practices may become apparent only after a certain age, possibly starting during the second year, and is likely to increase over time. This seemed to be the case in the Peru data set, where the magnitude of the association between feeding practices and HAZ increased with age between 12 and 36 months of age and was greater among 30-36-month-old children.

The association between feeding practices and HAZ was also conditioned by other characteristics, such as household socioeconomic status in Colombia, Nicaragua, and Peru, maternal ethnicity in Guatemala (1999), and maternal schooling in Peru. In the Colombia, Nicaragua, and Peru data sets, better caregiving practices were more strongly associated with child HAZ among children from the two lower income terciles, compared to children from wealthier households. The larger magnitude of association between feeding practices and HAZ among poorer households in Latin American countries is consistent with findings from our urban livelihood study in Accra (Ruel et al. 1999). In addition, the Accra study also showed a stronger association between caregiving practices and HAZ among children whose mothers had less than secondary schooling compared to those who had secondary schooling or higher. The interaction between feeding practices and maternal schooling found in Peru, however, was more complex. In Peru, better child feeding practices were associated with better HAZ only among children whose mothers had some primary schooling. Children whose mothers had no schooling had the lowest mean HAZ, but better child feeding practices were not associated with higher HAZ. At the other extreme, mothers with secondary schooling and higher had significantly better-nourished children (HAZ was close to 1 Z-score higher), but better child feeding practices did not provide any additional benefit.

The interaction between maternal ethnicity and feeding practices in Guatemala 1999 revealed that better feeding practices were associated with higher HAZ only among children of ladino mothers. Children of indigenous mothers were, on average, 0.8 Z-scores shorter than children of ladino origin, and better feeding practices among the indigenous group were not associated with improved nutritional status. This finding is disconcerting, because indigenous children generally live in more precarious conditions than ladino children and are at increased risk of malnutrition, poor health, and mortality. It is likely that the lack of association between feeding practices and HAZ among this group was, in fact, due to their severe socioeconomic deprivation. There is evidence from the literature that the effect of maternal schooling on children's nutritional status is conditioned by resource availability at the household level (Doan 1988; Ruel et al. 1992; Reed, Habicht, and Niameogo 1996). These studies show that maternal schooling is associated with improved child nutrition only among households that have access to at least a minimum level of resources. Although to our knowledge there is no similar evidence from studies examining the association between child feeding practices and nutritional status, it is likely that the lack of beneficial effect of good feeding practices among indigenous children in Guatemala was at least in part due to their severe deprivation. At this low level of resources, improved feeding and care behaviors (or greater maternal education) may not be sufficient to improve children's well-being.

Maternal education, as a main effect, was strongly and consistently associated with child HAZ in all data sets, except Bolivia 1994. Maternal height and area of residence were also consistently associated with HAZ. As expected, taller mothers had taller children, and living in urban areas was associated with greater HAZ, even when other determinants of child nutrition were controlled for. Maternal parity and the number of children under 5 years of age in the household showed inconsistent patterns.

URBAN/RURAL DIFFERENCES IN CHILD FEEDING AND NUTRITION

Urban-rural differences in child nutrition are well documented, and there is unequivocal evidence that, on average, children from urban areas are better nourished than their rural counterparts (Ruel et al. 1998). Differences are usually attributed to the lower levels of food insecurity and poverty in urban areas and to the greater access to services. It is also believed that with greater availability of a wide variety of food in urban markets, urban dwellers have a more diverse diet than rural populations (Ruel, Haddad, and Garrett 1999). Little is known, however, about urban-rural differences in child feeding practices and in children's dietary patterns, with the exception of a recognized pattern of lower rates of initiation and shorter duration of breastfeeding in urban areas (Ruel et al. 1998; Population Health and Nutrition Information Project 2000).

Our analysis of the DHS data sets from Latin America confirms previous assumptions and provides empirical evidence that children's diets in urban areas are better than in rural areas from the age of 6 months. Although breastfeeding rates and duration were typically lower in urban than in rural areas in the countries studied, the more timely introduction of complementary foods, the greater dietary diversity, and the higher feeding frequency adopted by urban mothers provide strong evidence of the higher quality of the diet of urban weaning-age children. Our analysis also indicates that better feeding practices are probably, at least partially, responsible for the better nutritional status of children in urban areas. The fact that area of residence remained statistically significant in the models that included other determinants of child nutritional status, however, suggests that area of residence had an independent effect above and beyond the effects of child feeding, maternal schooling, and household socioeconomic status. The absence of an interaction between area of residence and feeding practices, on the other hand, suggests that the importance of good feeding practices was consistent across urban and rural areas.

METHODOLOGICAL CONSIDERATIONS

As noted in the section on methodology, a more appropriate approach to examining the specific nature of the determinants of nutritional status, while addressing the potential problem of endogeneity of the child feeding index, would have been to use an instrumental variable approach and two-stage, least squares modeling. This would require the availability of variables that affect child nutritional status but not child feeding practices. Unfortunately, we were unable to identify appropriate variables in the DHS data sets that meet this requirement. Additional research on other data sets is needed to develop appropriate instruments to predict child feeding and care so that problems of endogeneity can be addressed in future analyses of this type. Consideration should be given in future modifications of the DHS questionnaires to the inclusion of variables that would make potentially suitable instruments.

In modeling the determinants of height-for-age Z-scores, it is important to remember that stunting, or cumulative linear growth retardation leading to stunting, is a long-term process, which results from a series of insults often starting as early as the prenatal period and continuing throughout the first three years of life. The variables used to create the child feeding index in this analysis, on the other hand, covered a period of one day to one week. There are reasons to believe that measuring practices in the short term can be a good proxy for practices over longer periods, as suggested by some of the literature on the “clustering” of practices within and across dimensions (Arimond and Ruel 2001). It is important to recognize, however, that as is true for any cross-sectional analysis of the type reported here, inferences of causality cannot be made, and findings should be interpreted purely as indications of associations between feeding practices and child nutritional status.

With regard to the construction of a child feeding index, our research showed that the information available in the DHS data sets could be used effectively to create a composite, age-specific child feeding index. The indices had sufficient variability and were generally normally distributed, and were associated with nutritional status.

The main advantages of creating indices are that they can be made age-specific, and they can capture multiple dimensions of child feeding practices in a single summary variable that can be used in bivariate or multiple regression analyses. These analyses, in turn, can be used to identify subgroups of children who may benefit more from better feeding practices, thus providing potentially useful targeting information for nutrition education and behavior change interventions. The use of feeding practices terciles also provides a meaningful way of illustrating the association between child feeding and child nutrition graphically, thereby making it a useful advocacy tool.

Finally, because indices allow the inclusion of a variety of practices, they help take into account the possible cumulative effect of multiple practices on child outcomes. Research in the area of hygiene practices has shown consistently that associations with child diarrhea are weaker when single practices are tested individually rather than when the practices are combined into an index. Researchers interpret this finding as an indication that some cluster of good practices—rather than any single practice—is necessary to decrease the risk of diarrhea (Arimond and Ruel 2001). A similar finding was obtained in our analysis of the association between individual child feeding, hygiene, and preventive heath care practices, and child nutrition and morbidity outcomes in the Accra study (Ruel, Armar-Klemesu, and Arimond 2001). While only a few individual practices were statistically associated with child outcomes, a much stronger and more consistent association was found when individual practices from these three dimensions were combined into a composite feeding, preventive health seeking, and care during feeding index. Conversely, a disadvantage of indices is that they conceal the specific practices that they include, and thus they may mask the existence of important associations between specific practices and the outcomes of interest. While this does not constitute a problem for some applications, it does limit interpretation for others. Thus, indices should be used judiciously and should not replace analysis of individual practices. In fact, the two approaches should be used in conjunction to maximize their usefulness for research, program design, and targeting.

5. CONCLUSIONS

Although it is generally agreed that child feeding is a crucial proximal determinant of child growth and morbidity, surprisingly little has been done to quantify the strength of the association between overall feeding behaviors and child outcomes. Child feeding is one of various dimensions of child caregiving (Engle, Menon, and Haddad 1997), which is now increasingly recognized as a key determinant of child nutrition along with food security and availability of health services (ICN 1992).

The method developed in this study to explore child feeding practices using the DHS data sets constitutes an invaluable program and policy tool. It can be used to identify vulnerable groups that are more likely to benefit from interventions to promote improved child feeding practices, as well as to identify the specific feeding practices that are deficient and that should be targeted through nutrition education and behavior change programs. Given that the DHS data sets are widely available and contain useful information on child feeding, efforts should be made to use them more extensively to help design and target nutrition interventions and possibly to evaluate their impact. The information contained in the DHS data sets should be complemented by in-depth qualitative studies to further refine the messages and the delivery of specific interventions, and to help understand cultural taboos and potential constraints to the adoption of recommended practices. These steps are essential to maximize the impact of nutrition education and behavior change interventions and to improve child feeding practices globally.

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