Child Feeding Practices Are Associated with Child Nutritional Status in Latin America: Innovative Uses of the Demographic and Health Surveys[1,2]

Marie T. Ruel[3] and Purnima Menon*

*International Food Policy Research Institute (IFPRI), Washington, DC 20006; and *Division of Nutritional Sciences, Cornell University, Ithaca, NY 14853*

ABSTRACT Data from the Demographic and Health Surveys (DHS) for 5 Latin American countries (7 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 Z-scores (HAZ). The variables used for the index were as follows: current breast-feeding, use of complementary foods and liquids in the past 24 h, frequency of use over the past week and feeding frequency. The index was made age specific for 6- to 9-, 9- to 12- and 12- to 36-mo-old age groups, and age-specific feeding terciles were created. Bivariate analyses showed that feeding practices were strongly and significantly associated with child HAZ in all 7 data sets, especially after 12 mo of age. Differences in HAZ between child feeding terciles remained significant after controlling for potentially confounding influences, for all countries except Bolivia. Multiple regression analyses also revealed that better feeding practices were more important for children of lower, compared with higher socioeconomic status (in Colombia 1995 and Nicaragua 1998); among children of Ladino (Spanish speaking) compared with indigenous origin (in Guatemala 1995); and among children whose mothers had primary schooling compared with mothers with no schooling, or mothers with higher than primary school level (Peru 1996). The data available in DHS data sets can thus be used effectively to create a composite child feeding index and to identify vulnerable groups that could be targeted by nutrition education and behavior change interventions. J. Nutr. 132: 1180–1187, 2002.

KEY WORDS: • *child feeding practices* • *Demographic and Health Surveys (DHS)* • *Latin America* • *nutritional status* • *stunting*

The importance of child feeding practices for child nutrition is well recognized in the nutrition literature (1) (2). However, efforts to measure and quantify child feeding practices and to assess the strength of their association with child nutritional status have been hampered by methodological problems. This is primarily because child feeding practices encompass a series of interrelated behaviors that must be considered simultaneously and are therefore difficult to summarize into one or a few variables that accurately reflect these practices. For example, recommended practices for a 7-mo-old infant include, among other things, breast-feeding, feeding the infant nutrient-dense complementary foods 2–3 times per day and actively helping and motivating the infant to eat. Child feeding practices in the first 3 y are also age specific within narrow age ranges, which adds to the complexity of measurement. Thus, evaluating the overall quality of child feeding behaviors can be challenging, and few researchers have ventured in this direction.

Most research on the relationship between child feeding practices and health outcomes has focused on single behaviors, e.g., exclusive breast-feeding (3–5), timing of introduction of complementary foods (6) or the importance of animal products in complementary feeding (7). These approaches, although valuable for evaluating the role of these individual practices, do not allow an examination of the effect 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 qualitative research methods is invaluable, but it does not allow *quantifying* the importance of child feeding and care practices for child nutrition outcomes.

The research presented in this manuscript constitutes one of the first attempts to combine the information on some key dimensions of child feeding practices, namely, type, quality and frequency into a composite, age-specific index of child feeding practices. Data from the Demographic and Health Surveys (DHS)[4] from 5 countries (7 data sets) were used.

[1] Preliminary findings were presented at Experimental Biology 2000, San Diego, CA [Menon, P. & Ruel, M. T. (2000) Quantifying the association between child feeding practices and nutritional status: experience with the Demographic & Health Surveys. FASEB J. 14: A504 (abs.)] and at a poster session at the International Union of Nutritional Sciences in Vienna, Austria [Menon, P. and Ruel, M. T. (2001) Towards the development of a child feeding index: using the Demographic and Health Surveys from Latin America to quantify and model child feeding practices. Ann. Nutr. Metab. 45 (suppl. 1): 440 (abs.)].

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[3] To whom correspondence should be addressed. E-mail: m.ruel@cgiar.org.

[4] Abbreviations used: DHS, Demographic and Health Surveys; HAZ, height-for-age Z-scores; OLS, ordinary least squares; SES, socioeconomic status; USAID, United States Agency for International Development.

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The specific aims of the research were as follows: *1*) to assess the feasibility of creating an age-specific child feeding index using the information available in DHS data sets for 6- to 36-mo-old children; *2*) to estimate the strength of the association between child feeding practices and child nutritional status, while controlling for potential confounding factors through multivariate analyses; and *3*) to evaluate whether better 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 vs. 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 (8–10). 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.

SUBJECTS AND METHODS

Data. Seven data sets from the Demographic and Health Surveys (DHS) collected in 5 countries of Latin America between 1994 and 1999 were used. The DHS program is funded by the United States Agency for International Development (USAID) and coordinated by Macro International. 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 (11). 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 the following: *1*) availability of data to create the child feeding index (see subsection below); and *2*) availability of child anthropometric data.

Child feeding index. The index was created on the basis of current feeding recommendations for children 6–36 mo (2) (12), as summarized in **Figure 1**. Optimal feeding practices were defined for 3 different age groups: 6–9 mo (breast-feeding plus gradual introduction of complementary foods); 9–12 mo (same as 6–9, but increasing the amount and frequency of complementary feeding); and 12–36 mo (continued breast-feeding 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: breast-feeding (whether the mother is currently breast-feeding the child or not); use of baby bottles in the previous 24 h (yes/no); dietary diversity (whether or not the child received selected food groups in the previous 24 h); food frequency (how many days the child received selected food groups in the past 7 d); and feeding frequency (how many times the child was offered solid or semisolid foods in the previous 24 h (including meals and snacks). Information about the questionnaires and the code books can be found on the DHS website (11) and in the published reports for each country.

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 positive score of "1" for a positive practice. Practices considered particularly important at a given age, such as breast-feeding between 6 and 12 mo of age, or feeding the child animal products regularly between 12 and 36 mo of age received a score of "2". As indicated above, practices were considered positive or negative on the basis of current child feeding recommendations and available scientific evidence about their benefits or risks (1) (2). The specific scoring system used for the three age groups is summarized below.

Breast-feeding received a score of "2" for infants 6–12 mo of age and "1" for older children, and a score of 0 was given to nonbreast-feeding children at all ages. Avoidance of baby bottles was scored 1 (good practice) and their use received a score of 0 at all ages because the practice is considered potentially harmful for all children throughout the age range included.

A dietary diversity score was created on the basis of information on the number of food groups consumed by the child in the previous 24 h (maximum of 6 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 given a score of "0", 1–3 food groups received a score of "1" and 4 food groups or more received a score of "2."

A food-frequency score was also created on the basis of 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-frequency score, each food group was scored individually and the scores for each one were summed to derive a final food-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 two of the animal product groups, i.e., 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 1–3 d, and "2" if they were consumed on 4 or more

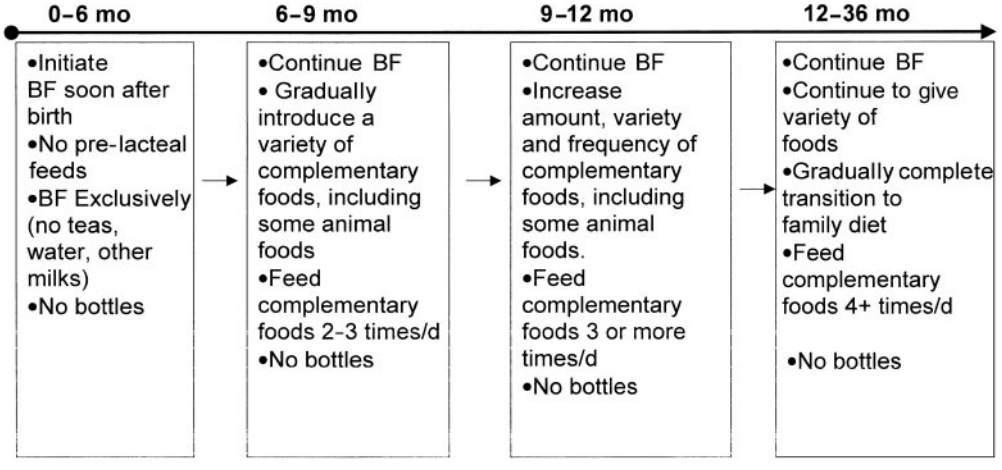

FIGURE 1 The continuum of child feeding. BF, breast-feeding.

TABLE 1

Variables and scoring system used to create the child feeding index for children 6–36 mo old 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 (past 24 h)	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-frequency (past 7 d)	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 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 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 frequency = sum of scores for milk + egg/fish/poultry + meat
Meal frequency (past 24 h)	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

days. The staple foods received a score of "1" if consumed 3 d in the previous wk at 6–9 mo of age, and 4 d at 9–12 mo of age. They were scored "0" otherwise. 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 mo of age should consume animal products as often as possible, ideally every day (2,12). The milk group was not included in the food-frequency score for infants up to 12 mo of age because it is thought to displace breast milk and it is associated with greater use of baby bottles.

For children ≥12 mo old, all three animal food groups (milk, meat, fish/egg/poultry) were included and a score of "2" was given for each when consumed 4 d/wk or more. For these older children, the "staple" group was not included because little variability was found, i.e., most children consumed cereals or tubers regularly.

The scoring of meal frequency was based on current feeding recommendations, according to which 6- to 9-mo-old infants should receive complementary foods at least twice a day, 9- to 12-mo-old infants three times a day, and 12- to 36-mo-old children four times a day (2,12).

The final child feeding index was a summation 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 to form three categories of child feeding practices: low, average and high.

Socioeconomic status (SES) index. A socioeconomic index was created using data available at the household level. The main purpose of creating the index was to categorize households into SES terciles, and to control for SES 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 country.

Principal components analysis was used to derive one factor from the selected wealth variables. All variables were categorical and ranked by ascending order (from worst to best). The selection criterion 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 > 0.5. For each country and area, the newly created variable reflecting the factor scores was then ranked into terciles to create three SES groups, i.e., low, average and higher. More details about the methodology are available in Menon and collaborators (13).

Other variables. The child nutritional status outcome used was height-for-age Z-scores (HAZ) because stunting (defined as HAZ less than −2 SD of the WHO/NCHS/CDC reference standards) (14) is the main nutritional problem in Latin America (15). Wasting (low weight-for-height) prevalence is very low throughout the region.

Maternal education, or highest level of formal schooling achieved, was used as a categorical variable, i.e., no schooling, primary, secondary, and higher than secondary schooling. Maternal height (in cm), parity (number of pregnancies), child gender (coded "1" for male and "2" for female), number of children <5 y old 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, i.e., mixed origin, Spanish-speaking) was used when available (only in the two data sets from Guatemala).

Analytical methodology. ANOVA was used to test the association between child feeding index terciles and child nutritional status (HAZ) 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 <5 y old, ethnic group (when available), household SES, 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, it was hypothesized on the basis of findings from our previous work in Ghana that children from poorer households and/or those whose mothers were less educated may benefit more from better feeding practices than wealthier children or children with more educated mothers (9).

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 (16). 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-stage least-squares methods. To use this method, 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 is not associated with the outcome (HAZ). None of the variables available in the DHS data sets met this criterion. For these reasons, 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 < 0.05 were considered significant. Least-squares means (adjusted for other covariates by OLS) were reported only for selected significant interactions. All analyses were done using Stata (Stata Corporation, College Station, TX), versions 6 and 7.

RESULTS

Child feeding practices in Latin American countries. The percentage of mothers who reported selected child feeding practices is presented in **Table 2**, by country and by age group. Only data for the two extreme age groups are presented. Breast-feeding rates among 6- to 9-mo-old children were high, with percentages close to 90% in 5 of the data sets. In Colombia and Nicaragua, however, only ~70% of mothers still breast-fed at this age, and by the time children were 12–36 mo old, less than one quarter of Colombian mothers were still breast-feeding, compared with 40–50% in the other Latin American countries studied. As expected, countries with lower rates of breast-feeding showed significantly higher use of baby bottles, with > 75% of mothers in Colombia and Nicaragua giving bottles to their 6- to 9-mo-old child.

Large differences in the use of animal products were found between countries, especially among the younger age group. It seems that Colombian mothers (and Nicaraguan mothers to some extent) were much more likely to feed their infant animal products (either in the past 24 h or the past 7 d) than mothers from poorer and more rural countries such as Guatemala and Peru. Meat, for example, was offered to 75% of all 6- to 9-mo-old infants in the previous week in Nicaragua, compared with only 18% in Guatemala and 35% in Peru. Although differences in the intake of animal products were still found among children in y 2 and 3 of life, the magnitude of these differences was smaller. It seems that the main differences between countries was in the timing of introduction of animal products, which was delayed in poorer and more rural countries.

Meal frequency varied markedly between countries among the 12- to 36-mo-old group, with as few as 32% of Guatemalan children (in 1995) having consumed the recommended 4 meals or more in the previous 24 h, compared with 89% in Colombia.

The mean, SD and range of values of the feeding index scores are presented in **Table 3**, by country, year and age group. Mean index scores ranged from a low 5.93 in Guatemala 1999 for the 6- to 9-mo-old age group to a high of 8.89 in Colombia 1995 among the oldest age group. Not surprisingly, the lowest scores were found in the two Guatemala data sets, and the highest scores were found in Colombia, following the patterns observed with the raw variables presented in Table 2. Note that these trends are also exactly the reverse of the trends seen in the prevalence of stunting, with the highest prevalences of stunting found in the two Guatemala data sets (42 and 39% in 1995 and 1999, respectively), and the lowest prevalence found in Colombia (12% stunting) (Table 3).

The index scores were generally normally distributed, with a coefficient of *skewness* < 0.5 except for the Bolivia 1998 and the Colombia 1995 scales for 12- to 36-mo-old children, which had a *skewness* of -0.7. The coefficient of *kurtosis*, which measures the peakedness of a distribution, was close to 3 for most data sets, the value found in a normal distribution. The coefficients ranged from 2.1 to 3.9.

Association between child feeding practices and HAZ. Findings from the bivariate analyses of the association between child feeding practices and HAZ are presented in **Figure 2** for children 12–36 mo of age. The analysis shows that better child feeding practices were associated with higher HAZ among 12- to 36-mo-old children in all 7 data sets. All differences were significant (ANOVA $P < 0.05$), and the magnitude of differences between the low and the high feeding terciles was > 0.5 Z-scores in 5 of the 7 data sets. Differences between feeding

TABLE 2

Feeding practices in Latin American countries: percentage of mothers reporting selected practices, by child age group

Age of children	6–9 mo							12–36 mo						
Country	Bol[1]	Bol	Col	Guate	Guate	Nica	Peru	Bol	Bol	Col	Guate	Guate	Nica	Peru
y	1994	1998	1995	1995	1999	1998	1996	1994	1998	1995	1995	1999	1998	1996
Feeding practices								%						
Breast-feeding	87.1	91.9	69.9	93.0	88.5	69.6	92.3	40.5	39.1	24.1	52.7	48.9	32.8	45.0
Uses baby bottles	41.3	39.8	75.0	34.9	47.8	81.4	39.4	34.7	42.0	65.5	40.8	50.9	74.9	47.5
In past 24 h gave														
Cereals	42.0	52.8	72.4	19.8	34.8	21.3	54.4	49.7	69.6	90.9	35.0	52.4	27.2	87.5
Eggs/fish/poultry	36.3	31.9	53.3	25.0	27.4	40.7	38.6	57.6	62.0	71.3	61.3	68.2	64.4	65.9
Meat	46.4	39.6	44.6	6.0	5.8	26.5	17.9	76.0	71.2	63.9	35.7	34.3	47.3	38.1
In past 7 d gave (at least once)														
Milk	54.8	59.4	77.9	33.4	39.8	77.4	58.4	69.1	73.2	86.2	44.7	49.3	75.9	81.0
Egg/fish/poultry	59.8	55.3	84.5	41.9	46.5	61.8	58.5	90.3	90.6	96.0	90.3	90.4	87.6	91.8
Meat	63.6	51.2	75.0	19.1	17.7	43.3	34.7	92.6	91.5	92.6	75.8	68.0	72.5	78.9
In past 24 h gave														
≥2 meals	89.0	85.5	97.8	75.4	73.8	93.2	70.8	—	—	—	—	—	—	—
≥4 meals	—	—	—	—	—	—	—	63.5	70.2	89.0	31.6	51.8	52.2	50.0

[1] Abbreviations: Bol, Bolivia; Col, Colombia; Guate, Guatemala; Nica, Nicaragua.

TABLE 3

Child feeding practices scores and prevalence of stunting in Latin American countries, by age group, country and year[1]

	Stunting prevalence (0–36 mo)	Feeding index scores					
		6–9 mo		9–12 mo		12–36 mo	
	%	*n*		*n*		*n*	
Bolivia 1994	26.07	257	7.95 ± 2.23 (2–12)	252	8.72 ± 1.90 (3–12)	1437	8.32 ± 1.82 (2–12)
Bolivia 1998	22.06	341	7.60 ± 2.53 (2–12)	349	8.56 ± 2.18 (3–12)	1858	8.50 ± 1.89 (2–12)
Colombia 1995	12.34	234	8.16 ± 1.83 (3–12)	231	8.43 ± 1.86 (3–12)	1487	8.89 ± 1.53 (1–12)
Guatemala 1995	42.08	459	6.09 ± 2.12 (2–12)	455	6.99 ± 1.97 (3–12)	2522	6.47 ± 1.78 (1–12)
Guatemala 1999	39.09	203	5.93 ± 2.00 (3–11)	208	7.09 ± 1.99 (2–12)	1178	6.62 ± 1.87 (2–12)
Nicaragua 1998	20.90	303	6.73 ± 1.99 (1–12)	274	6.57 ± 1.82 (2–12)	2107	6.89 ± 1.85 (2–12)
Peru 1996	21.62	709	7.05 ± 2.45 (2–12)	804	8.34 ± 1.94 (3–12)	4834	7.86 ± 1.91 (1–12)

[1] Values are means ± SD (range).

terciles among younger age groups were less consistent. Although patterns of association in the expected direction are observable among 9- to 12-mo-old children, differences in HAZ between feeding terciles were significant only among three data sets (Guatemala 1995, Nicaragua 1998 and Peru 1996). For the younger age group (6–9 mo old), only Peru shows a significant association between HAZ and feeding terciles (not shown).

Results of multiple regression analyses confirm that child feeding practices were associated with better nutritional status, i.e., after controlling for potentially confounding sociodemographic factors, feeding practices were significant either as a main effect or in two-way interactions, except in the two Bolivia data sets (1994 and 1998). In Guatemala 1995, the adjusted difference in HAZ amounted to 0.37 Z-scores ($P = 0.001$). The analysis also reveals the existence of two-way interactions in 4 of the data sets (**Table 4**). In Guatemala 1999, feeding practices interacted with maternal ethnicity, showing a stronger association with HAZ among children of Ladino, compared with indigenous mothers (**Fig. 3**). In Colombia and Nicaragua, the interaction with SES shows that better feeding practices in these samples were more strongly associated with HAZ among poorer than wealthier households (see **Fig. 4**, for example, from Nicaragua). In the Peru data set, child feeding practices interacted with maternal schooling, although the interaction term was of borderline significance ($P = 0.06$). The adjusted means of this interaction (**Fig. 5**) suggest that child feeding practices in this sample were associated with better nutritional status only among mothers who had some primary school education.

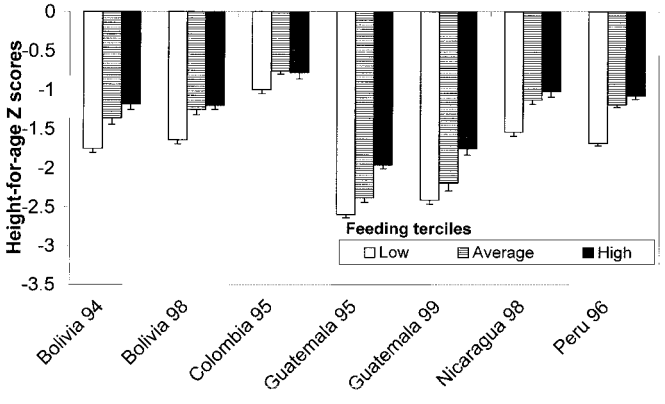

FIGURE 2 Association between child feeding practices and height-for-age Z-scores (HAZ) in 5 Latin American countries. Unadjusted mean HAZ ± SEM, (n = 1178 to 4834) are presented for children 12–36 mo old. Differences in HAZ by child feeding terciles were significant in all 7 data sets (ANOVA, $P < 0.05$).

DISCUSSION

Key findings. Feeding practices were strongly and significantly associated with child HAZ in most of the Latin American countries studied, especially after 12 mo of age. The advantage in height experienced by 12- to 36-mo-old children who were in the high compared with the low feeding practices tertile was ~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 to successful nutrition interventions (17) (18) (19).

The association between feeding practices and child HAZ was generally weaker and less consistent among children in y 1 of life, but it increased gradually with age. Similar findings were described by P. Menon and collaborators Cornell University, Ithaca, NY (personal communication,), in their analysis of the importance of maternal schooling for child nutrition in rural Bangladesh. They found that the association between maternal schooling and child HAZ increases with increasing age throughout the second year of life. The authors interpreted 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 larger magnitude of association between feeding practices and 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 (20); mothers who engage in early positive practices for instance, may also engage in better practices in the subsequent years, and their positive practices are likely to extend over more than one dimension of caregiving behaviors. Thus, the cumulative effect of these improved practices may become apparent only after a certain age, possibly starting during y 2, and is likely to increase over time.

TABLE 4

Summary findings of multivariate analysis of the determinants of children's height-for-age Z-scores (children 12–36 mo old) in 5 countries (7 data sets) of Latin America[1]

	Bolivia 1994	Bolivia 1998	Colombia 1995	Guatemala 1995	Guatemala 1999	Nicaragua 1998	Peru 1996
Feeding index[2]	($P = 0.07$)	($P = 0.29$)	(interaction)	($P = 0.001$)	(interaction)	(interaction)	(interaction)
Child characteristics							
Age	−	+	+	−			
Gender (female)			+	+			+
Maternal characteristics							
Education		+	+	+	+	+	(interaction)
Height	+	+	+	+	+	+	+
Ethnicity (nonindigenous)	NA	NA	NA	+	(interaction)	NA	NA
Parity	−						−
Household characteristics							
Socioeconomic status (SES)	+	+	(interaction)	+		(interaction)	+
Number of children < 5 y	−	−	−	−	−	−	−
Rural residence	−	−		−	−	−	−
Two way interaction between feeding index and[3]:			SES ($P = 0.02$)		Maternal ethnicity ($P = 0.001$)	SES ($P = 0.01$)	Maternal schooling ($P = 0.06$)

[1] Entries in the table indicate the sign of the regression coefficient (positive/negative), for those coefficients that are significant ($P < 0.05$). An empty cell indicates that the coefficient was not significant. NA = not available.

[2] Feeding index: numbers in parenthesis are the *P*-values of the regression coefficients in main effect models (models in which no interaction with the feeding index were significant. For models in which two-way interactions were significant, the *P*-value of the interaction term is reported in the last row of the table. The interactions in the Guatemala 1999, Nicaragua 1998 and Peru 1996 data sets are displayed in Figures 3–5, respectively.

[3] Entries in this row report which characteristics were significant ($P < 0.05$) in two-way interaction with the feeding index; the *P*-value of the interaction term is also reported. Note that the interaction with maternal schooling was of borderline significance ($P = 0.06$).

The association between feeding practices and HAZ was also conditioned by other characteristics, such as household SES in Colombia and Nicaragua, maternal ethnicity in Guatemala (1999) and maternal schooling in Peru. In Colombia and Nicaragua, better caregiving practices were a stronger determinant of child HAZ among children from the two lower income terciles, compared with 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, Ghana (9). The Accra study also showed a stronger association between caregiving practices and HAZ among children whose mothers had less than secondary schooling compared with 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 greater 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 higher 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 (Spanish-speaking). 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

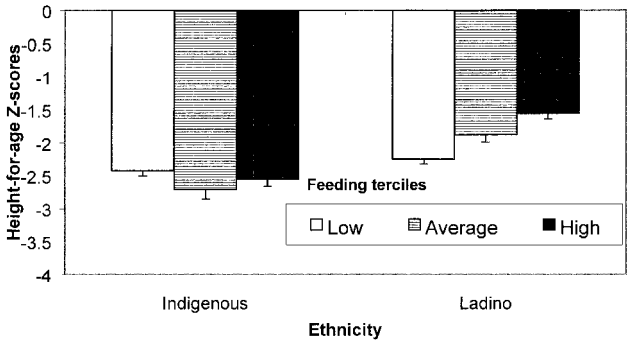

FIGURE 3 Mean adjusted height-for-age Z-scores (HAZ), by feeding tertile and ethnicity (Demographic and Health Survey, Guatemala 1999). Adjusted mean HAZ ± SEM ($n = 1078$) are presented for children 12–36 mo old. Mean HAZ are adjusted by ordinary least-squares analysis for child age, maternal height, parity, number of children < 5 y and household socioeconomic status.

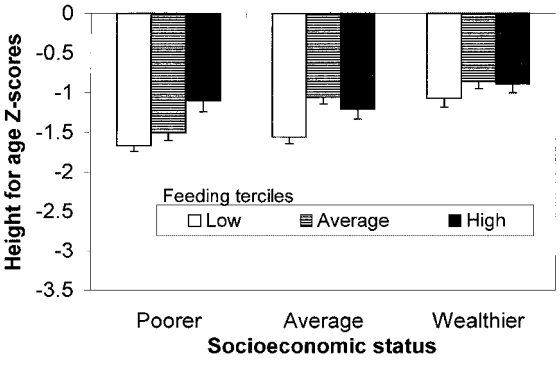

FIGURE 4 Mean adjusted height-for-age Z-scores (HAZ) by feeding tertile and by socioeconomic status (Demographic and Health Survey, Nicaragua 1998). Adjusted mean HAZ ± SEM ($n = 1883$) are presented for children 12–36 mo old. Mean HAZ are adjusted by ordinary least-squares analysis for child age, maternal height, parity and number of children < 5 y.

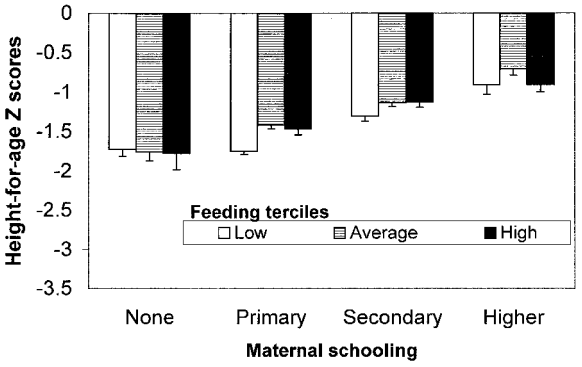

FIGURE 5 Mean adjusted height-for-age Z-scores (HAZ) by child feeding tertile and maternal schooling (Demographic and Health Survey, Peru 1996). Adjusted mean HAZ ± SEM (n = 4613) are presented for children 12–36 mo old. Mean HAZ are adjusted by ordinary least-squares analysis for child age, maternal height, parity, number of children < 5 y and socioeconomic status.

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 (21,22) (23). 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 due at least in part to their severe deprivation. At this low level of resources, improved feeding and care behaviors (and/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 number of children < 5 y old were also consistently associated with HAZ. As expected, taller mothers had taller children, and children from households with a larger number of preschoolers had poorer nutritional status, even when other determinants of child nutrition were controlled for. Living in rural areas was significantly associated with lower HAZ in all data sets, except Colombia. Maternal parity showed inconsistent patterns.

Methodological considerations. As noted in the 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. Unfortunately, we were unable to identify appropriate variables in the DHS data sets to use in the prediction of feeding practices, which would not also affect the outcome, HAZ. Additional research is required to develop appropriate instruments to predict child feeding and care so that problems of endogeneity can be addressed in future analyses of this type.

In modeling the determinants of HAZ, it is important to remember that stunting, or cumulative linear growth retardation leading to stunting, is a long-term process that results from a series of insults often starting as early as the prenatal period and continuing throughout the first 3 y of life. The variables used to create the child feeding index in this analysis, on the other hand, covered a period of 1 d to 1 wk. There are reasons to believe that measuring practices in the short term can be a good proxy for practices over longer periods of time, as suggested by some of the literature on the "clustering" of practices within and across dimensions (20). 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.

For 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, were generally normally distributed and were associated with nutritional status, especially after 12 mo of age.

The main advantages of creating indices are that indices can be made age specific, and they can capture multiple dimensions of child feeding practices into 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 information for the targeting of 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, compared with 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 (20). 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 (24). Although only a few individual practices were significantly 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, one disadvantage of indices is that they conceal the specific practices that they include and thus may mask the existence of important associations between specific practices and the outcomes of interest. Although 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, and for program design and targeting.

In conclusion, 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 (25) that is now increasingly recognized as a key determinant of child nutrition along with food security and availability of health services (26).

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 effect. 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 effect of nutrition education and behavior change interventions and to improve child feeding practices globally.

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