International Journal of Epidemiology
© International Epidemiological Association 1996
Vol. 25, No. 4
Printed in Great Britain

REVIEW ARTICLE

Is Prolonged Breastfeeding Associated with Malnutrition? Evidence from Nineteen Demographic and Health Surveys

LAURA E CAULFIELD, MARGARET E BENTLEY AND SAIFUDDIN AHMED

Caulfield L E (Division of Human Nutrition, Department of International Health, The Johns Hopkins University School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, MD 21205, USA), Bentley M E and Ahmed S. Is prolonged breastfeeding associated with malnutrition?: Evidence from nineteen demographic and health surveys. *International Journal of Epidemiology* 1996; **25:** 693–703.
Background. A growing body of literature suggests that prolonged breastfeeding (typically defined as beyond the first year of life) may be a risk factor for malnutrition.
Methods. To examine the extent to which continued breastfeeding is a risk factor for malnutrition, we used multiple regression techniques to relate current breastfeeding status to weight and stature in children <36 months old whose mothers participated in one of 19 Demographic and Health Surveys (DHS) conducted between 1987 and 1989.
Results. The data from 9 of 11 countries outside sub-Saharan Africa (SSA) indicated that among older children, those still breastfed are shorter and lighter than those no longer breastfed. These differences, which reached statistical significance in five countries, become apparent at 12–18 months of age. In contrast, in five of eight SSA countries, younger still breastfed children are significantly shorter and lighter than those no longer breastfed, but, the differences are largely diminished among older children. These basic patterns were not altered by adjustment for family sociodemographic characteristics, health care utilization, and recent child illness.
Conclusions. Important differences in nutritional status associated with continued breastfeeding are observed throughout the developing world, and are not likely due to confounding by family sociodemographic characteristics, health care utilization or recent child illness. A unifying interpretation of the observed relationships is that child size is somehow related to the decision to wean, and that whereas in SSA, the biggest children are weaned first, in non-SSA countries, the smallest children are weaned last.
Keywords: breastfeeding, malnutrition, weaning, diet

Studies conducted worldwide have supported the axiom that 'breast is best'. Because of the multiple benefits of breastfeeding for both the infant and mother,[1–3] it is recommended that breastfeeding continue for as long as possible.[4]

However, several studies reported during the last 20 years have suggested that prolonged breastfeeding (typically defined as beyond the first year of life) may be a risk factor for malnutrition. Of 13 studies reviewed by Grummer-Strawn,[5] 11 report negative associations between prolonged breastfeeding and weight-for-age, height-for-age, or weight-for-height. Since then, several other studies have been published with some,[6,7] but not all,[8,9] finding negative associations between breastfeeding and nutritional status among older children. It is difficult to reach any firm conclusions from this literature because the studies differ with respect to population, study design, and methodology. They are largely observational and cross-sectional in nature, and thus the direction of causality is not clear. In fact, the possibility that the findings are due to reverse causality, that is, that poorly growing children continue to be breastfed, is high. Further, few studies control for important confounding variables related to socioeconomic status or food availability at the household level, which would lend some credence to interpretations of causality from cross-sectional associations.

Since 1984, the Demographic and Health Surveys (DHS) Program* has used uniform sampling and data collection methodologies to obtain information on

Division of Human Nutrition, Department of International Health, The Johns Hopkins University School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, MD 21205, USA.
* The DHS program is being carried out by Macro International, Inc., Calverton, Maryland, USA, and is funded by the United States Agency for International Development (USAID).

TABLE 1 *Prevalence of breastfeeding and stunting by age (months) in 19 DHS I surveys*

Country	N			Still breastfed (%)			Stunted (%)[a]		
	≤12	13–24	25–36	≤12	13–24	25–36	≤12	13–24	25–36
Latin America									
Bolivia	808	884	520	86 7	48.8	19.4	16.5	41.5	46.7
Brazil	88	102	124	40.9	17.7	22.6	11.4	28.4	24.2
Colombia	363	447	304	54.8	30.0	13.2	14.6	26.2	29.9
Guatemala	719	773	475	91.1	69 5	39.8	34.4	69.8	67.9
Caribbean									
Dominican Republic	444	750	489	46.4	30.7	16.6	11.7	25.9	22 5
Trinidad & Tobago	244	276	201	45.9	24.6	16 4	6.2	5.1	3.0
North Africa									
Egypt	617	648	480	86 6	60.8	21.5	25.9	42.0	40.0
Morocco	954	937	622	81.2	39.6	5.8	12.2	32 2	34.2
Tunisia	628	657	416	79.0	49.3	17.8	13.7	21.0	23.3
Asia									
Sri Lanka	572	681	495	87.1	67.6	12.9	16.8	32.3	37.0
Thailand	543	649	515	71.0	40.5	17 2	12.3	22.2	24.9
Sub-Saharan Africa									
Burundi	287	592	492	98.3	83.5	44.7	48.2	46.6	60 6
Ghana	274	674	495	98.2	70.0	23.8	22.6	39.6	51.9
Mali	220	486	335	97.3	67.3	41.5	27.5	27.1	34.3
Nigeria (Ondo)	220	526	392	90.9	52.7	24.2	13.2	34.2	47.2
Senegal	168	271	172	98.2	64.2	28.5	15.9	26.5	30.1
Togo	172	481	343	98.8	79.2	24.8	25.7	36 9	33.2
Uganda	315	782	361	94.3	63.9	11.4	37.7	52.7	53.7
Zimbabwe	168	539	425	95 8	59.6	11.1	23.2	34.5	37.2

[a] Height-for-age <–2 Z.

important aspects of maternal and child health in developing countries.[10] Although the focus of the surveys is not nutrition *per se*, women are asked some questions about infant feeding and, in the majority of surveys, weight and stature are measured for all children under five.

To investigate further the relationship between prolonged breastfeeding and malnutrition, we analysed data relating breastfeeding and nutritional status during the first 3 years of life from 19 countries collected as part of the DHS Phase I (DHS I). Although the DHS data are cross-sectional, they allow for a systematic examination of: 1) the extent to which prolonged breastfeeding may be associated with malnutrition worldwide; and 2) the extent to which these relationships remain after adjusting for various potentially confounding factors.

METHODS

Data Sets

The data come from DHS surveys conducted in 19 developing countries between 1986 and 1989 (Table 1). The surveys are designed to provide data on a representative sample of women in their childbearing years and their children in each country, although in some countries, only ever married women are included. Thus, the samples are not representative of children *per se*, and certain sub-groups, e.g. orphans, are by definition, excluded.

Women are interviewed regarding their reproductive history, their knowledge and use of family planning and other health services, and the socioeconomic environment in which they live. Breastfeeding and recent health histories are collected for all children born to each mother during the 5 years prior to the survey. For the last-born child, women are asked whether or not they are currently breastfeeding the child. The analyses therefore are focused on the current breastfeeding status (bfd) of the last-born child. For purposes of presentation, children will be referred to as 'still breastfed' or 'no longer breastfed', even though it may be true that some children, in fact, were never breastfed.

Weight and stature are measured for all children (under a certain age) living with their mother. Weight is measured to the nearest 100 g using hanging spring balance scales, and stature (length <24 months of age, or height ≥24 months of age) is taken to the nearest 0.5 cm using specially constructed measuring boards. Observers are trained in anthropometry prior to the survey, and measurement reliability tests are conducted.

To describe the data in the 19 DHS I country surveys, the sample sizes and prevalences of breastfeeding and stunting (height-for-age <–2.0 Z) by categories of age are presented in Table 1. With the exception of the Dominican Republic (in which children were measured beginning at 6 months of age), surveys from countries outside of sub-Saharan Africa (SSA) collected data on children 3–36 months old. Only children aged 9–36 months are included in the analyses of data from SSA, although younger children were included in the surveys. In general, few SSA children <9 months old are reported to be no longer breastfed, and of those that are, many have weights and heights that would be considered extreme outliers, suggesting error in either age or anthropometry. To avoid their having undue influence on the results, they were removed from the analyses.

TABLE 2 *Potentially confounding variables of the relationship between breastfeeding and nutritional status of children in DHS I surveys*

Socio-demographic characteristics
maternal age in years
maternal years of schooling
residence (urban or rural)
mother currently employed
% mother's children who have died
child's birth order (1–2, 3–4, >4)
Health care utilization
mother knows about Oral Rehydration Solution (ORS)[a]
mother currently uses any method of contraception
child has health card
child has been vaccinated[b]
Child morbidity in previous 2 weeks
diarrhoea
cough/difficulty breathing[c]
fever[d]
Other characteristics
mother currently pregnant
index child wanted[e]

[a] Not available in Brazil, Morocco, Senegal, Zimbabwe.
[b] Available in Mali, Senegal, Togo, Zimbabwe only.
[c] Available in Colombia, Ghana, Mali, Nigeria, Uganda.
[d] Available in Burundi, Ghana, Nigeria, Mali, Uganda.
[e] Not available in Nigeria, Senegal, Zimbabwe

Statistical Methods

The pattern of the relationship between breastfeeding status and nutritional status was examined visually by plotting weight and stature versus age among still breastfed and no longer breastfed children in each country. Initial analyses were performed for boys and girls separately, and because the basic relationships did not differ, the data were pooled for subsequent analyses, with the variable, sex, included as a covariate.

The patterns were then described using multiple regression equations[11] of the following forms:

a) $\text{weight (or stature)} = b_0 + b_1\text{age} + b_2\text{bfd} + b_3\text{age\_bfd} + b_4\text{age}^2 + b_5\text{age}^2\text{\_bfd}$

b) $\text{weight (or stature)} = b_0 + b_1\text{age} + b_2\text{bfd} + b_3\text{age\_bfd}$

In (a), age (in months) is fit as a quadratic function to capture the diminishing rates of change in nutritional status over the age range (3–36 months) of the samples. Equation (a) was applied to survey data from non-SSA countries. In (b), age is fit as a simple linear function; this equation provided a better fit to the data from SSA countries than (a), because of the reduced age range (9–36 months) of the samples in these countries. As shown, product terms between child's age and breastfeeding status (age_bfd, age^2_bfd) are included in the models to assess whether differences in nutritional status by breastfeeding status vary over the age range of the sample. In all models, the beta coefficients for the main effects are considered to be statistically significant at $P < 0.05$. Because we are interested in identifying whether the relationship between breastfeeding status and nutritional status depends upon the age of the child, the interaction terms age_bfd and age^2_bfd are considered statistically significant at $P < 0.15$.

Using stepwise regression (SAS Institute, Cary, NC), a set of variables describing the sociodemographic characteristics of the household, health care utilization, and the child's recent illness history, were tested for inclusion in the models (Table 2). Variables were retained in each model if their beta coefficients were statistically significant at the 0.05 level.

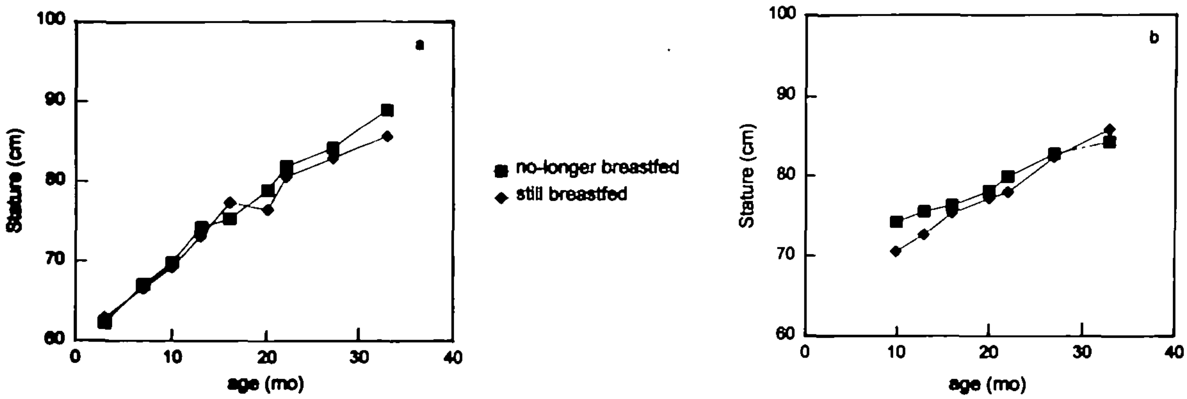

FIGURE 1 *Differences in average stature (cm) between still breastfed and no longer breastfed children <36 months old in Colombia (a) and Nigeria (b). Values are plotted at the mid-point of each age interval*

To illustrate the implications of the findings, differences in weight and stature between still breastfed and no longer breastfed children were converted to standardized scores. This was accomplished by subtracting the predicted weight or stature (from the regression models) of no longer breastfed children at a specified age from that of still breastfed children of the same age and dividing this difference by the standard deviation of weight or stature for children of that same age (sexes combined) according to the international growth reference.[12] The resulting standardized differences allow for examination of the direction of the differences in nutritional status across the age range associated with continued breastfeeding, as well as the magnitude of the observed differences in nutritional status relative to the expected variability in nutritional status in children of that age. The values are plotted across the distribution of ages for which at least 10% of children in that age range were either no longer breastfed (younger ages) or still breastfed (older ages).

RESULTS

In examining the raw data in each country, two distinct patterns relating breastfeeding status to nutritional status were noted. These patterns are illustrated in Figure 1 using data on stature from Colombia and Nigeria. The first pattern, illustrated in Figure 1a with data from Colombia, indicates that among younger children, no differences in average stature are noted depending on current breastfeeding status, but among older children, a divergence in nutritional status is apparent, with still breastfed children increasingly observed to be, on average, shorter than those no longer breastfed. This pattern was observed in surveys from Latin America, The Caribbean, North Africa and Asia. The second pattern, represented in Figure 1b with data from Nigeria, was observed to varying degrees in all nine surveys from sub-Saharan Africa. As shown, among younger children, those no longer breastfed are on average taller than those still breastfed. These differences are less evident among older children, and in fact, among children 30–36 months of age, those still breastfed are observed to be somewhat taller than those reported to be completely weaned from the breast.

As described earlier, linear regression equations were then estimated to relate breastfeeding status, age and weight or stature in each country. The estimated regression (beta) coefficients and standard errors (SE) from these models are presented in Tables 3 and 4. In general, these models explained 40–80% of the variation in weight and stature in the data.

In non-SSA countries, although not always statistically significant, the bfd coefficients are generally negative, indicating that among the youngest infants there is a tendency for breastfed infants to be lighter and shorter than those no longer breastfed. The coefficients for the age_bfd interaction terms are generally positive but not statistically significant, indicating generally comparable nutritional status between still breastfed and no longer breastfed younger children. The age^2 coefficients are negative indicating the diminishing rates of change in weight and stature with age among older children, and the coefficients for the age^2_bfd terms are largely negative, indicating slower rates of change in weights and heights with age among the still breastfed, as compared to no longer breastfed older children. The coefficients for this term are negative for either weight or stature in nine, and statistically significantly negative in five, of the 11 non-SSA

TABLE 3 *Effects[a] of age and breastfeeding status on weight (kg) of children*

Country	b_0 (SE)	sex (SE)	age (SE)	bfd (SE)	age_bfd (SE)	age^2 (SE)	age^2_bfd (SE)
Latin America							
Bolivia	6.12*	0.49*	0.23*	–0.61‡	0.06*	–0.0014*	–0.0018*
	(0.29)	(0.06)	(0.03)	(0.32)	(0.03)	(0.0006)	(0.0008)
Brazil	5.29*	0.46*	0.33*	0.17	0.02	–0.0030*	–0.0015
	(0.51)	(0.18)	(0.05)	(0.79)	(0.10)	(0.001)	(0.0024)
Colombia	5.40*	0.54*	0.30*	–0.30	0.06§	–0.0024*	–0.0031*
	(0.26)	(0.08)	(0.03)	(0.35)	(0.04)	(0.0006)	(0.0012)
Guatemala	5.01*	0.53*	0.26*	0.20	–0.03	–0.0021*	0.0002
	(0.31)	(0.05)	(0.03)	(0.33)	(0.03)	(0.0007)	(0.0008)
Caribbean							
Dominican Republic	6.32*	0.41*	0 24*	–0.09	0.01	–0.0013*	–0.0006
	(0.27)	(0.07)	(0.03)	(0.42)	(0 04)	(0.0007)	(0.0012)
Trinidad & Tobago	4.98*	0.56*	0.37*	1.06*	–0.11*	–0.0037*	0.0017
	(0.32)	(0:11)	(0.03)	(0.47)	(0 06)	(0.0008)	(0.0016)
North Africa							
Egypt	5.24*	0.66*	0.31*	–0 29	0.01	–0 0027*	–0.0011
	(0.33)	(0 07)	(0.03)	(0.37)	(0.04)	(0.0007)	(0 0010)
Morocco	5 61*	0.55*	0.29*	–0.73*	0.09*	–0.0026*	–0.0045*
	(0.22)	(0.06)	(0.02)	(0.26)	(0.03)	(0.0005)	(0.0010)
Tunisia	5.43*	0.56*	0 32*	–0.29	0.04	–0.0030*	–0.0020‡
	(0.31)	(0.08)	(0.03)	(0.36)	(0 04)	(0.0008)	(0.0011)
Asia							
Sri Lanka	4.82*	0.47*	0.29*	0.11	–0.03	–0.0034*	0.0005
	(0.33)	(0 06)	(0.03)	(0.35)	(0.04)	(0 0007)	(0.0008)
Thailand	5.67*	0.45*	0 26*	–0.23	0.00	–0.0022*	–0 0006
	(0.22)	(0.06)	(0.02)	(0.27)	(0.03)	(0.0005)	(0.0008)
Sub-Saharan Africa							
Burundi	7.25*	0.52*	0.12*	–1 49*	0.04*	na[b]	na
	(0.34)	(0.07)	(0.01)	(0.35)	(0.01)	na	na
Ghana	6.67*	0.55*	0.14*	–0.30	–0.01	na	na
	(0.26)	(0.07)	(0.01)	(0 29)	(0.01)	na	na
Mali	8.72*	0.62*	0.06*	–2.79*	0.08*	na	na
	(0.34)	(0 09)	(0.01)	(0.36)	(0.01)	na	na
Nigeria (Ondo)	7 13*	0.67*	0 12*	–1.11*	0.04*	na	na
	(0.22)	(0.08)	(0.01)	(0.26)	(0.01)	na	na
Senegal	7.46*	0.27*	0.13*	–0.74	0.02	na	na
	(0.47)	(0.12)	(0.02)	(0.51)	(0 02)	na	na
Togo	8.14*	0.44*	0.11*	–1.37*	0.01	na	na
	(0.37)	(0 08)	(0.01)	(0.40)	(0.02)	na	na
Uganda	7 04*	0.46*	0.14*	–0.30	–0.02‡	na	na
	(0.24)	(0.08)	(0.01)	(0.29)	(0.01)	na	na
Zimbabwe	7.30*	0.52*	0.15*	–0.46*	–0.00	na	na
	(0.16)	(0.08)	(0.00)	(0.22)	(0.01)	na	na

[a] Beta coefficients and their standard errors (SE) estimated using linear regression, b_0 (intercept), sex (male = 1), age (in months), bfd (still breastfed = 1), age_bfd (product of age and bfd), age^2 (age squared), age^2_bfd (product of age^2 and bfd).

* $P < 0.05$; ‡ $P < 0.10$; § $P < 0$ 15.

[b] na, not applicable.

TABLE 4 *Effects[a] of age and breastfeeding status on stature (cm) of children*

Country	b_0 (SE)	sex (SE)	age (SE)	bfd (SE)	age_bfd (SE)	age^2 (SE)	age^2_bfd (SE)
Latin America							
Bolivia	60.93*	1.37*	0.96*	–4.44*	0.40*	–0.0066*	–0.0101*
	(0.93)	(0.18)	(0.09)	(1.03)	(0.11)	(0.0020)	(0.0027)
Brazil	56.66*	1.39*	1.32*	0.07	0.06	–0.0112*	–0 0031
	(1.34)	(0.47)	(0.15)	(2 08)	(0.26)	(0.0035)	(0.0064)
Colombia	57.05*	1.41*	1.32*	–1 22	0.16	–0.0111*	–0.0066‡
	(0.74)	(0.23)	(0.08)	(1.02)	(0.13)	(0.0019)	(0.0036)
Guatemala	55.77*	1.41*	1.21*	–0.77	0.02	–0.0111*	–0.0021
	(1.04)	(0.18)	(0.10)	(1.10)	(0.11)	(0.0023)	(0.0028)
Caribbean							
Dominican Republic	60.78*	0.73*	1.08*	–0.63	0.06	–0.0068*	–0.0025
	(0.83)	(0.22)	(0.08)	(1.27)	(0.14)	(0 0020)	(0.0035)
Trinidad & Tobago	55.97*	1.11*	1.65*	2.51*	–0.32*	–0.0169*	0.0073‡
	(0.80)	(0.27)	(0.09)	(1.15)	(0.15)	(0.0021)	(0.0039)
North Africa							
Egypt	57.06*	1.53*	1.31*	–0.79	0.02	–0.0125*	–0.0027
	(1.16)	(0 23)	(0.11)	(1.27)	(0.13)	(0 0026)	(0 0034)
Morocco	58 97*	1.55*	1.18*	–3 80*	0.55*	–0.0110*	–0.0218*
	(0.67)	(0.17)	(0.07)	(0.78)	(0.10)	(0.0015)	(0.0030)
Tunisia	58 92*	1.68*	1.29*	–1.78‡	0.13	–0.0118*	–0.0040
	(0.94)	(0.23)	(0.10)	(1 07)	(0.13)	(0 0023)	(0.0034)
Asia							
Sri Lanka	55.80*	1 42*	1.45*	0.70	–0.12	–0 0162*	0.0027
	(1 06)	(0.18)	(0.10)	(1.13)	(0.11)	(0.0023)	(0.0027)
Thailand	57.72*	1.18*	1.33*	–2 18*	0.22*	–0 0123*	–0.0075*
	(0.65)	(0.18)	(0.07)	(0.80)	(0.09)	(0.0016)	(0.0024)
Sub-Saharan Africa							
Burundi	65.88*	1.26*	0.57*	–4.68*	0.14*	na[b]	na
	(1.14)	(0.24)	(0.04)	(1.19)	(0.05)	na	na
Ghana	67.7	1.31*	0.54*	–2.99*	0.02	na	na
	(0 84)	(0.22)	(0.03)	(0.92)	(0.04)	na	na
Mali	74.40*	1.46*	0.32*	–10.77*	0.29*	na	na
	(1.17)	(0.32)	(0.04)	(1.26)	(0.05)	na	na
Nigeria (Ondo)	68.42*	1.19*	0.48*	–5.03*	0.20*	na	na
	(0.72)	(0.26)	(0.03)	(0 84)	(0 04)	na	na
Senegal	68.76*	1.23*	0.52*	–5.37*	0.17*	na	na
	(1.26)	(0.34)	(0.05)	(1 38)	(0.06)	na	na
Togo	69.82*	1.17*	0.51*	–5.62*	0.07	na	na
	(1.25)	(0.28)	(0.04)	(1.34)	(0.05)	na	na
Uganda	65.54*	1.11*	0.59*	–2.44*	–0.02	na	na
	(0.78)	(0.25)	(0.03)	(0.93)	(0.04)	na	na
Zimbabwe	65.25*	0.99*	0.66*	–2.99*	0.06*	na	na
	(0.49)	(0.24)	(0 01)	(0.65)	(0.03)	na	na

[a] Beta coefficients and their standard errors (SE) estimated using linear regression, b_0 (intercept), sex (male = 1), age (in months), bfd (still breastfed = 1), age_bfd (product of age and bfd), age^2 (age squared), age^2_bfd (product of age^2 and bfd).

* $P < 0.05$; ‡ $P < 0.10$; § $P < 0.15$.

[b] na, not applicable.

countries: Bolivia, Morocco, Colombia, Thailand (stature only), Tunisia (weight only).

In SSA countries, the bfd coefficients are uniformly negative and statistically significant in the majority of the models, indicating relatively poorer nutritional status associated with breastfeeding among younger children. The age_bfd coefficients are generally positive and statistically significant, indicating faster rates of change in nutritional status with age among still breastfed children as compared to no longer breastfed children, leading to a diminution in the differences in nutritional status between older children associated with breastfeeding status. It can be estimated from the equations that by 30–36 months of age, the observed deficits in nutritional status of still breastfed children are lessened, no longer evident, or reversed, depending on the country.

To assess whether these trends persist after controlling for various socioeconomic and demographic characteristics of the household, health care utilization, and the recent illness history of the child (Table 2), a second set of regression equations was estimated. Of those variables considered, maternal education and urban residence were the most important, being significantly and positively associated with weight or stature in 16/19 and 13/19 countries, respectively. After adjustment, the improvement in the R^2 of the models ranged from 2% to 5%. Minimal shifts in the estimated coefficients occur as a result of adjusting for these potentially confounding factors. In all models, the greatest changes occur in the intercept (b_0) and bfd terms, indicating that with adjustment, the nutritional status of younger breastfed children are comparable to that of no longer breastfed children. Although diminished somewhat in magnitude, the patterns of statistical significance of the age_bfd and age^2bfd interaction terms do not change with adjustment for these factors.

Standardized differences in weight and stature between still breastfed and no longer breastfed children in each country were estimated from the adjusted models, and are presented in Figure 2. As described earlier, in non-SSA countries, younger children who are still breastfed have better nutritional status than no longer breastfed children (positive differences), but that beyond 12–18 months of age, the nutritional status of still breastfed children becomes poor relative to that of children of the same age who are completely weaned from the breast (negative differences). As shown in Figure 2, this 'falling off' in the weight and stature of still breastfed children generally occurs around 18 months of age for countries in Latin America and The Caribbean, but occurs earlier—around 12 months of age—for countries in North Africa and Asia. In contrast, in SSA countries, the nutritional status of still breastfed children 12–18 months of age is poor relative to their no longer breastfed counterparts, but among older children in most of these countries, the nutritional status of the two groups is comparable, and in fact, in some countries, a trend towards better nutritional status is observed for those breastfed the longest.

The values plotted approximate the estimated differences in weight and stature Z-scores (SD scores) associated with continued breastfeeding across the age range of the data for each country. Thus, at 24 months of age, children in Latin America and The Caribbean who are still breastfed are estimated to be 0.2–1.2 SD, and those in North Africa and Asia are estimated to be 0.2–0.9 SD, shorter and lighter than those no longer breastfed. Among children in SSA, at 18 months of age—when as few as 10% of children are completely weaned—still breastfed children are estimated to be 0.1–0.9 SD lighter and shorter than those no longer breastfed. In most of these countries, these differences diminish such that by 30 months of age—when 40–70% of children are completely weaned—the weight and stature of still breastfed children are estimated to be from 1.0 SD *less* to 0.3 SD *more* than those of no longer breastfed children.

DISCUSSION

The results of these analyses of data from 19 countries indicate that differences do exist in the nutritional status of children during the first 3 years of life depending on whether they continue to be breastfed. Of 11 non-SSA countries examined, the data from nine of them indicate that older still breastfed children are lighter and/or shorter than no longer breastfed children; these differences appear between 12–18 months of age, and become greater over time. The differences in weight or stature associated with breastfeeding status reach statistical significance in five of these countries. Beyond 24 months of age, the nutritional status of older still breastfed children is generally of the order of 0.2–1.0 SD below that of no longer breastfed children of the same age. Among most of the SSA countries examined, differences in nutritional status are also noted depending on the reported breastfeeding status of the child. In five of the eight countries, these differences are greatest during the younger ages (12–18 months), and diminish over time. Among younger children, the weight and stature of still breastfed children are, in general, 0.5–1.5 SD lower than those of no longer breastfed children, whereas among older children, the weight and stature of those still breastfed may be either greater or

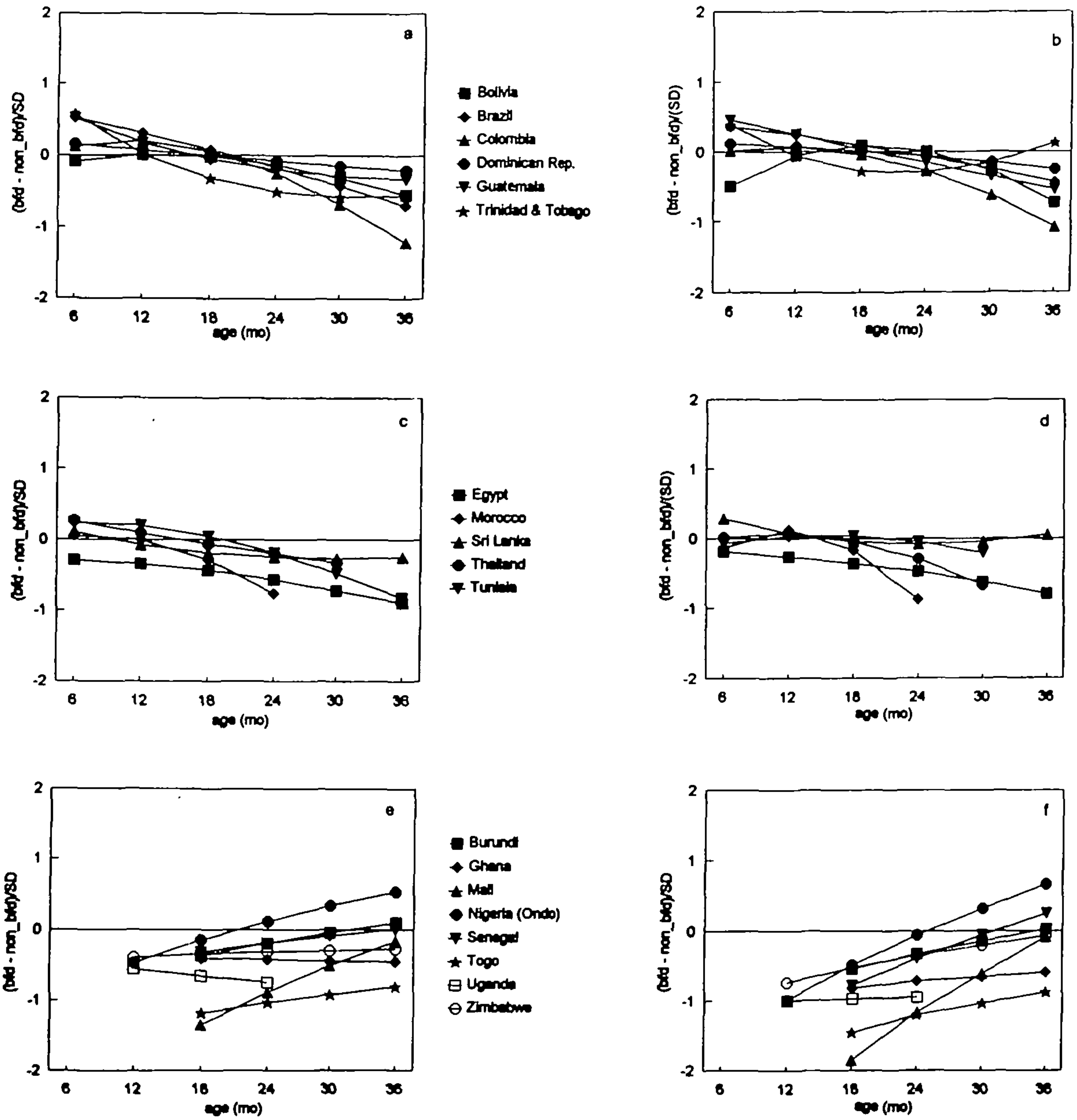

FIGURE 2 *Adjusted differences in weight (a, c, e) and stature (b, d, f) of still breastfed as compared to no longer breastfed children by age in DHS I surveys conducted in Latin America & The Caribbean (a, b), Asia and North Africa (c, d), and sub-Saharan Africa (e, f). Values plotted are the differences in predicted weight or stature between still breastfed (bfd) and no longer breastfed (non_bfd) children of the same age standardized according to a combined-sex estimate of the standard deviation (SD) of weight or stature of children of the same age from the International Growth Reference*[12]

less than those no longer breastfed. For the countries whose data do not follow these trends, the nutritional status of still breastfed children is estimated to be similar (Ghana [weight]) or significantly worse (Ghana [stature], Togo, Uganda [stature], Zimbabwe [weight]) than that of no longer breastfed children across the entire age range of the data. Only the weight data for Ugandan children suggest the age-associated decline in nutritional status associated with continued breastfeeding seen in non-SSA countries.

Grummer-Strawn[5] suggests that the negative associations between continued breastfeeding and nutritional status reported in the literature may be spurious, because they result from inadequate control of confounding factors such as poverty, lack of health care, inappropriate feeding practices, and child morbidity which lead to malnutrition on the one hand, and continued breastfeeding on the other. The results described above, however, persist after adjusting for variables that directly or indirectly describe many aspects of these factors. It may be true that these variables are not sufficiently sensitive descriptors of variation in socioeconomic status, health care utilization and the determinants of child health and feeding decision-making to fully control for their influence here. However, to the extent to which we can address this issue, we find no evidence that the differences in nutritional status associated with continued breastfeeding are the result of failure to control for these types of confounding factor.

The magnitude of the observed differences in nutritional status associated with continued breastfeeding are similar for both weight and height. This suggests that still breastfed children are lighter and shorter, but not necessarily thinner, than children of the same age who are no longer breastfed. We also found that adjusting for whether the child had been ill in the 2 weeks prior to the survey did not influence the interpretation of the results with respect to either weight or stature. Thus, recent illness is not likely to explain the overall lower nutritional status of still breastfed children.

In these surveys, the prevalences of underweight (not shown) and stunting (Table 1) among children >12 months of age are 20–70%. This suggests that the average Z-scores for weight-for-age and height-for-age of children in these populations are between –1 to –3 SD. In many countries, we are observing 0.2–1.0 SD *worse* nutritional status associated with breastfeeding in populations of children whose average nutritional status is already considered poor. Presented in this way it is clear that the consistency and magnitude of the observed differences are of biological and public health significance and deserve further attention.

The observed relationships between nutritional status in the non-SSA countries conform to our expectations based on the literature.[5] However, the 'fall-off' in nutritional status occurs between 12 and 18 months of age in most countries, not at 12 months of age, the suggested definition for prolonged breastfeeding in the literature. It also occurs earlier in Asia and North Africa where the nutritional status of children is poor relative to Latin America. The relationships observed in SSA countries are in the opposite direction however, indicating greater disparity in nutritional status associated with breast feeding among younger children, with improvement over time. How can one explain these apparently contradictory results?

Clearly, a complex series of events determine how long children are breastfed, as well as the course of their growth and development. Due to the cross-sectional nature of the data, we cannot ascertain the direction of the relationship between prolonged breastfeeding and nutritional status, that is whether continued breastfeeding leads to difference in nutritional status, or whether differences in nutritional status (i.e. big or small body size, slow or fast rates of growth, or the perception of them) influence whether or not breastfeeding continues. Likewise, we cannot determine the extent to which our results are due to cohort effects or secular trends, although the consistency of the trends across countries argue against this possibility.

The observed relationships could result from earlier events in the child's life. It may be true, for example, that events in the past, such as illnesses, cause children to still be breastfed and also to have poorer overall nutritional status. Delayed introduction of solids (and the associated delay in learning to eat foods with differing textures) may predispose a child to feeding difficulties later on, resulting in a preference for breastmilk (and other liquids) over non-breastmilk foods.[13–15] Thus, a preference for breastmilk would lead to continued breastfeeding, while a lack of acceptance of the weaning diet would likely impair growth. However, in some environments infants weaned early may not adapt well to the weaning diet either and may grow more slowly after weaning than their still breastfed counterparts. Such behavioural influences on growth could explain our findings, as they are likely to be somewhat independent of the family's socioeconomic status and other characteristics of the household and environment adjusted for in our analyses. The influence of early infant health, nutritional status, and feeding decision-making, on feeding decisions and child nutritional status months or years later, is not well understood. Longitudinal studies beginning at birth are necessary to address such questions.

Strong differences exist in the overall patterns of weaning between SSA and non-SSA countries (Table 1). In the SSA countries surveyed, only small numbers of children are weaned prior to 18 months of age, and in many countries 20–40% of children continue to be breastfed throughout the third year of life. In contrast, in the non-SSA countries, many 3–6 month old infants are already weaned, and few children are breastfed beyond 18–24 months of age. We also know that the weaning decision is largely undirectional, in that children once weaned are not likely to return to breastfeeding.[16] Thus, in our analyses we are comparing the nutritional status of still breastfed children with those who have left the still breastfed group and joined the no longer breastfed group (at some prior moment). Given that the weaning decision-making process is multifactoral in nature and subject to much variability even within a specified culture, it is likely that the relationships we observe depend largely upon the characteristics of children weaned at either the beginning or the end of each population's weaning process. Thus, the observed differences in nutritional status in SSA countries are likely to be driven by the characteristics of the younger children who are already weaned when most children are still breastfed, whereas in non-SSA countries, they are driven by the characteristics of the older children who are still breastfed when most are already weaned.

These complex points lead to the simple conclusion that perhaps a relationship exists between child size and the decision (whether maternal or child-driven) to continue breastfeeding, regardless of the socioeconomic and health-related factors influencing weaning and nutritional status in the population. In SSA, the first children to be weaned are among the tallest and the heaviest for their age; as more children are weaned, many of them are lighter and shorter (for whatever reason), thus diminishing over time the observed differences between the two groups. In a similar fashion, in non-SSA countries, many children are weaned during early infancy and as a group they appear largely indistinguishable in nutritional status from those still breastfed. However, at older ages as fewer and fewer children remain in the still breastfed group, it becomes apparent that the last children to be weaned are among the lightest and the shortest for their age. Viewed in this light, the results from SSA and non-SSA countries are no longer contradictory. To our knowledge there is little more than anecdotal support for this interpretation of the data from the scientific literature, with the exception of one study suggesting that the child's length may influence weaning.[17]

In summary, the results presented here suggest that throughout developing countries important differences in nutritional status are observed depending on the breastfeeding status of the child. Despite differences between SSA and non-SSA countries, there is remarkable consistency in the observed relationships between breastfeeding status, age and nutritional status across the countries surveyed. Thus, it is likely that observations of poorer nutritional status associated with continued breastfeeding among children <3 years old will be reported in many situations and/or settings throughout the developing world. Providing a correct interpretation to these associations is therefore critical. Due to the limitations of the data, the direction of the relationship cannot be ascertained with certainty, but overall, the results suggest that child size may, in some way, determine breastfeeding or rather, weaning decision-making. To test this interpretation of the data, prospective longitudinal research is needed investigating the relationship between child size and weaning decision-making, especially as it relates to older children. However, simpler research designs can be used to begin to describe the reasons why some SSA mothers would discontinue breastfeeding during the first year of life, and why other mothers throughout the rest of the world continue breastfeeding beyond 12–18 months.

ACKNOWLEDGEMENTS

This research was supported in part by a grant from the Rockefeller Foundation through the Demographic and Health Surveys Small Grants Program.

The authors would like to thank Robert E Black, MD MPH, and Jean Humphrey, ScD, for their thoughtful comments regarding the manuscript.

REFERENCES

[1] Jelliffe D B, Jelliffe P. *Human Milk in the Modern World.* Oxford: Oxford University Press, 1978.

[2] Kovar M G, Serdula M K, Marks J S, Fraser D W. Review of the epidemiologic evidence for an association between infant feeding and infant health *Pediatrics* 1984; **(Suppl.)**: 615–38.

[3] Prentice A. Breastfeeding and the older infant. *Acta Paediatr Scand* 1991; **374(Suppl.)**: 78–88.

[4] World Health Organization (WHO). *The Innocenti Declaration: On the protection, promotion and support of breastfeeding*, Florence, Italy, 1990. (Report of WHO/UNICEF policy makers' meeting on 'Breastfeeding in the 1990s: A global initiative'.)

[5] Grummer-Strawn L M. Does prolonged breast-feeding impair child growth? A critical review. *Pediatrics* 1993; **91**: 766–71.

[6] Rao S, Kanade A N. Prolonged breast-feeding and malnutrition among rural Indian children below 3 years of age. *Eur J Clin Nutr* 1992; **46**: 187–95.

[7] Chirmulay D, Nisal R. Nutritional status of tribal underfive children in Ahmadnagar District, Maharashtra in relation to weaning/feeding practices. *Indian Pediatr* 1993; **30**: 215–22.

[8] Cousens S, Nacro B, Curtis V *et al* Prolonged breast-feeding: no association with increased risk of clinical malnutrition in young children in Burkina Faso. *Bull World Health Organ* 1993; **71**: 713–22.

[9] Taren D, Chen J. A positive association between extended breast-feeding and nutritional status in rural Hubei Province, People's Republic of China. *Am J Clin Nutr* 1993; **58**: 862–67.

[10] Sommerfelt A E, Stewart M K. *Children's Nutritional Status.* Demographic and Health Surveys (DHS) Comparative

Studies No. 12. Calverton, Maryland: Macro International, Inc., 1994.

[11] Allen D M, Cady F B. *Analyzing Experimental Data by Regression*. London: Lifetime Learning Publications, 1982.

[12] Dibley M J, Goldsby J, Staehling N, Trowbridge F L. Development of normalized curves for the international growth reference; historical and technical considerations. *Am J Clin Nutr* 1987; **46:** 736–48.

[13] Illingworth R S, Lister J. The critical or sensitive period, with special reference to certain feeding problems in infants and children. *J Pediatr* 1964; **65:** 839–48.

[14] Stevenson R D, Allaire H. The development of normal feeding and swallowing. *Pediatr Clin North Am* 1991; **38:** 39–53.

[15] Bentley M E, Stallings R Y, Fukumoto M, Elder J A. Maternal feeding behavior and child acceptance of food during diarrhea, convalescence, and health in the central northern sierra of Peru. *Am J Public Health* 1991; **81:** 43–47.

[16] Zohoori N, Popkin B M, Fernandez M E. Breast-feeding patterns in the Philippines: A prospective analysis. *J Biosoc Sci* 1993; **25:** 127–38.

[17] Harrison G A, Brush G, Zumrawi F Y. Interrelationships between growth, weaning and disease experience in Khartoum infants. *Eur J Clin Nutr* 1992; **46:** 273–78.

(Revised version received December 1995)