Chapter 87
Infant Feeding in 20 Developing Countries with Focus on Infant Undernutrition in Cambodia

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Abstract The Demographic and Health Survey (DHS) data provide a strong base for evaluating guidelines for child feeding across multiple countries. Based on DHS data, breastfeeding was widely practiced and a high percentage of mothers continued to breastfeed through the first year of life in 20 countries that were identified by the World Bank as among the poorest economically. However, many mothers in these 20 countries began feeding sweetened liquids and solid food to their babies earlier than recommended by the World Health Organization (WHO). In one of these countries – Cambodia – we compared DHS infant feeding data collected in 2000 to date from 2005 and assessed the WHO core feeding indicators recommended for healthy growth. In Cambodia, fewer children exhibited underweight in most age categories in 2005 than in 2000; however, the prevalence of stunting among 18- to 23-month-old children was not less in 2005 and remained above 50%. In this Cambodian study, prevalence of compliance with all age-based breastfeeding and complementary feeding WHO indicators increased significantly between surveys in 2000 and 2005, except percent of mothers currently breastfeeding at 12–15 months which remained relatively constant (2000: 87.1%; 2005: 89.6%). In particular, among Cambodian 0- to 5-month-old infants, prevalence of exclusive breastfeeding increased fivefold and prevalence of early breastfeeding initiation increased threefold between 2000 and 2005. While prevalence of meeting the WHO complementary feeding indicator for feeding diversity increased between 2000 and 2005, the prevalence remained very low for the WHO indicators of feeding diversity and minimal acceptable diet among various age groups. However, multivariate regression models demonstrated no overall general association of the WHO feeding indicators with undernutrition measures of underweight and stunting. There were some age-specific associations: 0- to 5-month-old infants, whose mothers were in compliance with both exclusive breastfeeding and breastfeeding initiation guidance and were at significantly lower risk of underweight; and 6- to 11-month-old infants, whose mothers were in compliance with the overall solid food guidance and were at significantly reduced risk of stunting but not underweight. Our primary finding from models of the WHO feeding indicators in Cambodia was a consistent positive association of reduction in risk of stunting and underweight with increases in relative wealth. In conclusion, many mothers in developing countries continue to breastfeed their babies through the first 12 months as recommended by the WHO. Among the WHO feeding indicators, focus on complementary feeding, particularly increased diversity of foods among children over 6 months of

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age, is indicated as a potential approach to reduce the high prevalence of stunting among children over 18 months of age in poor countries.

Abbreviations

DHS	Demographic and Health Surveys
NCHS	National Center for Health Statistics, USA
PAHO	Pan American Health Organization
Under-5 children	Children under the age of 5 years
WHO	World Health Organization
X mo child	x-month-old child

87.1 Introduction

Globally 8.8 million children under the age of 5 (under-5 children) die each year (UNICEF, 2009). Analyses have attempted to identify how this figure can be reduced (Black et al., 2003, 2008; Jones et al., 2003; Bhutta et al., 2008). Research has implicated a diversity of factors including poverty (Blakely et al., 2005), inequality of distribution of childhood vaccines and sanitation resources (Jones et al., 2003; Merchant et al., 2003), oral rehydration therapy (Black et al., 2003), and maternal education (Ruel and Menon, 2002). However, undernutrition has been identified as the single largest risk factor for global disease burden in children (Bryce et al., 2008), accounting for 3.5 million deaths and 11% of the total global disability-adjusted life years (Bhutta et al., 2008; Black et al., 2008). Stunting (low height for age), wasting (low weight for height), and underweight (low weight for age) are growth statistics that most commonly are used to measure undernutrition.

Timing and duration of breastfeeding and introduction of appropriate complementary foods have been identified as factors not only in the reduction in risk of infant morbidity and mortality (Bhandari et al., 2003; Bahl et al., 2005) but estimates indicate that improvement in breastfeeding rates alone could prevent 13% of deaths annually in under-5 children (Jones et al., 2003). To help developing country policymakers address the global issue of undernutrition, the World Health Organization (WHO) has developed child feeding guidance for the breastfed and non-breastfed child (Pan American Health Organization (PAHO), 2003; Dewey et al., 2004; Dewey, 2005; WHO, 2005) and indicators to measure feeding patterns at the population level (WHO, 2008b).

The Demographic and Health Surveys (DHS) provide publicly available data on families in developing countries. These studies have been conducted since 1986 and shown to be an excellent source for analysis of infant feeding practices (Ruel and Menon, 2002; Arimond and Ruel, 2004). The surveys originally focused on contraception and family planning but have expanded to collect data on maternal/infant health, food intake, and general demographics to provide standardized base of health statistics for the source countries (ORC Macro, 2007). New survey instruments are developed approximately every 5 years and include nationally representative samples of women of childbearing age (ORC Macro, 2002; Rutstein and Rojas, 2003; Croft, 2005).

We have used the DHS data in combination with the WHO growth standards (WHO Multicentre Growth Reference Study Group, 2006; WHO, 2008a) to study the relationship between young child feeding practices and growth outcomes in low-income countries. Here we present an overview of child feeding practices in 20 developing countries and then provide a more in-depth assessment of factors related to feeding practices and growth in one of the countries, Cambodia.

We chose Cambodia as a focus because undernutrition is viewed as the most important risk factor for infant mortality in Cambodia (Collins et al., 2007). The DHS country report for Cambodia in 1999 indicated high rates of undernutrition as measured by stunting (44.3%), wasting (15.0%), and

underweight (45.3%) in under-5 children (National Institute of Statistics et al., 2002). Information on young child feeding patterns was similarly discouraging with low compliance with recognized WHO guidance on breastfeeding and complementary feeding (National Institute of Statistics et al., 2002; Dewey, 2004, 2005).

In 2005, Cambodia released findings from a second DHS survey that demonstrated significant improvement in undernutrition indicators: stunting (37.3%), wasting (7.3%), and underweight (35.6%) (National Institute of Public Health and National Institute of Statistics (Cambodia) and ORC Macro, 2006). The improvement in growth indicators provided an opportunity for us to investigate the potential association of these growth factors with compliance with the new WHO healthy child feeding indicators (WHO, 2008b). We used the two DHS surveys that were 5 years apart and whose timing reflected the stabilization in social and economic conditions in the country. Our overall hypothesis was that there was a positive association between compliance with the WHO feeding indicators and improvement in growth outcomes in Cambodia.

87.2 Methods

87.2.1 Survey Instrument, Study Samples, and Variables

87.2.1.1 Twenty Countries

For the initial assessment of feeding practices in the 20 developing countries, we accessed "MEASURE DHS+" data collected between 1999 and 2003. Thirty-eight surveys were conducted in five regions globally during this time period. Of these 38 surveys, we included those countries that provided child-level data sets, had included 24-h and 7-day intake questions, and included an English-language survey instrument, which enabled us to conduct a careful comparison of all questions and response options across the countries and recode as needed. In the analysis we included [country (survey year)]: Ethiopia (2000), Ghana (2003), Kenya (2003), Malawi (2000), Namibia (2000), Nigeria (2003), Uganda (2001), Zambia (2001), Zimbabwe (1999), Armenia (2000), Egypt (2000), Jordan (2002), Bangladesh (1999), Cambodia (2000), India (1999), Indonesia (2002), Nepal (2001), Philippines (2003), Vietnam (2002), and Kazakhstan (1999).

We selected the youngest living child less than 1 year of age in each of the families, excluded deceased children, and excluded all children for whom age information was missing. Analyses were conducted separately for infants less than 6 months old (0–6 months) and infants 6 months but less than 12 months old (6–12 months). Our variables included maternal last birth, next-to-last birth, child living or deceased, child twin, child age, breast feeding still, times breast fed in last 24 h, other liquids in last 24 h, solid foods in last 24 h, liquids in the last 7 days, and solids in last 7 days.

87.2.1.2 Cambodia

To provide an in-depth focus on whether the feeding practices in Cambodia met the current WHO guidance and if compliance with these feeding guidelines was associated with improved growth outcomes, we used the same "MEASURE DHS+" data collected in Cambodia in 2000 and added the 2005 data set (ORC Macro, 2007).

We tested eight core WHO indicators for assessing infant and young child feeding using definitions and parameters for child feeding associated with each indicator (Table 87.1) and disaggregated the data by the WHO specified age groups. Indicators for infants 0–5 months were initiation of

Table 87.1 Eight core indicators for assessing infant and young child feeding[a,b]

1. Early initiation of breastfeeding:
Children born in last 23.9 months and put to breast within 1 h of birth
Disaggregated and reported for live births in the last 11.9 months and live births occurring between the last 12 and 23.9 months
2. Exclusive breastfeeding under 6 months:
Infants 0–5.9 months of age who received only breastmilk during the previous day
Infants 0–5.9 months of age
Disaggregated for the age groups: 0–1.9, 2–3.9, 4–5.9 months
3. Continued breastfeeding at 1 year:
Children 12–15.9 months of age who received breastmilk during the previous day
Children 12–15.9 months of age
4. Introduction of solid, semi-solid, or soft foods:
Infants 6–8.9 months of age who received solid, semi-solid, or soft foods during the previous day
Infants 6–8.9 months of age
5. Minimum dietary diversity:
Children 6–23.9 months of age who received foods from ≥4 food groups during the previous day
Children 6–23.9 months of age
Disaggregated for age group 6–11.9, 12–17.9, 18–23.9 months
6. Minimum meal frequency:
Breastfed children 6–23.9 months of age who received solid, semi-solid, or soft foods the minimum number of times or more during the previous day
Breastfed children 6–23.9 months of age
Disaggregated for age group 6–11.9, 12–17.9, 18–23.9 months where minimum equals:
Two times for breastfed infants 6–8.9 months
Three times for breastfed children 9–23.9 months
7. Minimum acceptable diet:
Breastfed children 6–23.9 months of age who received at least the minimum dietary diversity and the minimum meal frequency during the previous day
Breastfed children 6–23.9 months of age
Disaggregated for age group 6–11.9, 12–17.9, 18–23.9 months
8. Consumption of iron-rich or iron-fortified food:
Children 6–23.9 months of age who received an iron-rich food
or a food that was specially designed for infants and young children and was fortified with iron,
or a food that was fortified in the home with a product that included iron during the previous day
Children 6–23.9 months of age
Disaggregated for age group 6–11.9, 12–17.9, 18–23.9 months

[a]Underlined text = definition of indicator

[b]This table lists the World Health Organization (WHO) indicators which can be used with national health data to determine if child feeding practices are meeting WHO feeding recommendations in that country

Source: Indicators for assessing infant and young child feeding practices, conclusions of a consensus meeting held 6–8 November 2007 in Washington, DC, USA (Working Group on Infant and Young Child Feeding Indicators, 2007). Adapted with permission from Marriott et al. (2007)

breastfeeding in the first hour after birth and exclusive breastfeeding. Complementary feeding indicators were dietary diversity, feeding frequency, feeding iron-fortified foods, and minimum acceptable diet (a combination of dietary diversity and feeding frequency). Breastfeeding at 1 year (aged 12–15 months) and introduction of solid, semi-solid, and soft foods (hereafter complementary foods) (aged 6–8 months) were tested independently because of their unique age ranges. We scored infants whose mothers feeding behavior matched all of the core indicators that were relevant for their age (i.e., the breastfeeding indicators for infant under 6 months of age and dietary diversity, feeding frequency, and iron-fortified foods for those aged 6–23 months) as being compliant with all of the relevant indicators. In the Cambodian DHS 2000 and 2005 reports measures of undernutrition were generated using the US National Center for Health Statistics (NCHS) growth standards whose results

have been shown to differ from use of the WHO standards (Victora et al., 1998). In our analyses we used the WHO growth standards (Garza and de Onis, 2004; WHO, 2008a).

87.2.2 Analytical and Statistical Methods

87.2.2.1 Both Studies

We used sample weights for all analyses, taking into account the sample design information in the DHS manual (Rutstein and Rojas, 2006). DHS+ data are weighted within each country to account for variability of the country-based sampling models overall. The sampling frame for the surveys was complex and included multi-stage, clustering, stratification, and unequal probability sampling.

We used SAS (Version 9.2; SAS Institute, Cary, NC, USA) statistical software program (SAS Institute Inc., 2004). Standard errors were estimated using the Taylor series linearization method that incorporated sampling weights and used variance formulas appropriate for the DHS sample design, using the SAS mean, *t*-test, and logistic procedures. We used *t*-tests on weighted percentages to compare results between the 2000 and 2005 Cambodia surveys.

87.2.2.2 Twenty Countries

In the survey instrument, mothers were asked if they were still breastfeeding and how many times their infant was fed specific liquids or solids in the last 24 h. We created a set of binary indicators for whether infants consumed each item. In these indicators, we assumed that responses of "don't know" meant that the item was not consumed. The indicators were set to missing if the corresponding survey item was missing. We calculated the country-level percentage of infants who consumed each item for each of the 20 countries. We also calculated the pooled mean across all countries; these pooled means are weighted based on the number of respondents from each country (Peng et al., 1998).

87.2.2.3 Cambodia

We used logistic regression models to estimate the relationship between the feeding indicators and two outcome measures – stunting and underweight. Height and weight more than two *z*-scores below the reference population mean were classified as stunted or underweight, respectively (WHO Multicentre Growth Reference Study Group, 2006).

To calculate minimum food diversity in the prior 24 h for children aged 6–23.9 months, reported intake of complementary food types were grouped into six rather than seven food groups (WHO, 2008b) because use of dairy foods was not recorded in the Cambodia surveys. We used a report of intake of at least four of six food groups during the previous day as meeting the minimum dietary diversity indicator (Table 87.1).

We performed multivariate analysis separately for breastfeeding indicators (indicators 1 and 2 in Table 87.1) and complementary food feeding indictors (indicators 5–8). We estimated separate models for 2000 and 2005, allowing examination of changes in the relationship between outcomes and feeding practices at each time. The models estimated the relationship between overall compliance with the feeding practice indicators and outcomes (underweight and stunting). We report odds ratios and the 95% confidence interval of odds ratios and Wald chi-square tests to determine statistical significance (SAS Institute Inc., 2004).

Covariates in the statistical models included measures of compliance with the feeding indicators and indicators for the age and gender of the infant, mother's age, and a measure of family wealth. Instead of family income or individual income variables the DHS includes an asset-based wealth index (Rutstein and Johnson, 2004). We included covariates for the family's asset index quintile in our models.

Infant weight at birth was only collected in a small subset of survey participants and was thus not included as a covariate in our models. As an alternative, we created a "healthy pregnancy index" to provide a baseline covariate for infant health status at birth. We based this index on indicators of the mother's health/status and recommended perinatal practices (Black et al., 2008): whether the mother had a body mass index (BMI) > 18.5, height > 150 cm, antenatal care, a tetanus injection, an iron supplement, no night blindness, and assistance at birth. We specified each indicator as a binary variable. The healthy pregnancy index was calculated as the number of these indicators met by the mother. We included the healthy pregnancy index as a covariate in the models estimated for 0- to 5-month-olds.

87.3 Results and Discussion

87.3.1 Twenty Countries

Descriptive information about the 20 countries are included in Table 87.2, with the percent of infants who were currently breastfed and who were fed four categories of liquids and any solid food in the last 24 h shown for 0–6 and 6–12 month, and pooled estimates in Figs. 87.1 and 87.2, respectively. The pooled estimates for the food types are summarized in Table 87.3. Reported current breastfeeding for 0- to 6-month-old infants was high and ranged from 80.5% (Philippines) to 100% (Malawi, Zimbabwe, and Nepal) with a pooled estimate of 96.6% for the 20 countries. As expected, the proportion of 6- to 12-month infants who were currently breastfeeding was lower, ranging from 53.4% in Armenia to 99.4% in Malawi; however, the pooled estimate for these 20 countries remained high at 87.9%. Current reported breastfeeding was consistent within countries across the two age categories in that countries that reported the highest percentages of current breastfeeding of infants at 0–6 months by mothers also reported the highest percentage for infants at 6–12 months. These pooled estimates indicate that overall approximately 97% of 0- to 6-month-old infants were breastfed at least once in the day preceding the survey while 88% of 6- to 12-month-old infants were breastfed. The high reported prevalence of breastfeeding is encouraging in light of many recent concerns about changes in breast feeding practices [(cf., WHO Collaborative Study Team on the Role of Breastfeeding on the Prevention of Infant Mortality, 2000 (Lauer et al., 2004)]. In fact, the pooled mean for any current breastfeeding through 12 months (nearly 88%) was substantially higher than that reported for the sample of mothers selected for study in the construction of WHO's growth curves of 68% (WHO Multicentre Growth Reference Study Group, 2006).

The reported prevalence of water feeding in 0- to 6-month-old infants varied widely among the 20 countries ranging from 15.1% of Ugandan infants to 87.9% of Cambodian infants. There was less diversity among 6- to 12-month-olds – the prevalence of water feeding ranged from 65.9% in Uganda to 97.5 and 99.3% in Cambodia and Jordan, respectively. Across all countries, the prevalence of water feeding was almost twice as high for infants at 6–12 months (87.4%) as for 0- to 6-month-old infants (45.9%).

The use of tinned, powdered, or other milks was generally low (pooled estimate 11.9%) for 0- to 6-month-old infants but was higher as was all reported fluid feeding in 6- to 12-month age infants.

Table 87.2 Sample description: mean ages and overall average age of infants and sample size for each age group in the 20 countries[a]

Country	0–6 months Mean age months (s.d.)	Sample	6–12 months Mean age months (s.d.)	Sample
Ethiopia	2.6 (1.6)	975	8.3 (1.7)	947
Ghana	2.8 (1.7)	345	8.5 (1.8)	403
Kenya	2.6 (1.6)	609	8.5 (1.7)	612
Malawi	2.7 (1.6)	1260	8.4 (1.7)	1204
Namibia	2.7 (1.6)	413	8.5(1.7)	419
Nigeria	2.8 (1.6)	616	8.3 (1.7)	633
Uganda	2.8 (1.6)	667	8.6 (1.7)	721
Zambia	2.7 (1.6)	656	8.5 (1.7)	651
Zimbabwe	2.5 (1.5)	356	8.4 (1.8)	314
Armenia	2.8 (1.6)	157	8.8 (1.6)	160
Egypt	2.6 (1.6)	1219	8.3 (1.7)	1146
Jordan	2.7 (1.6)	514	8.5 (1.6)	679
Bangladesh	2.5 (1.5)	753	8.6 (1.7)	528
Cambodia	2.7 (1.6)	885	8.4 (1.7)	838
India	2.8 (1.6)	5533	8.3 (1.7)	5083
Indonesia	2.7 (1.6)	1660	8.4 (1.7)	1454
Nepal	2.9 (1.6)	637	8.5 (1.7)	622
Philippines	2.7 (1.6)	627	8.4 (1.7)	751
Vietnam	2.7 (1.5)	193	8.6 (1.7)	194
Kazakhstan	2.7 (1.5)	99	8.4 (1.7)	115
Mean[b]	2.7 (0.1)		8.5 (0.1)	

[a]This table shows that the mean age for the 20 country-based samples did not differ for 0- to 6 or 6- to 12-month aged children

[b]The mean values are the average and standard deviation of the mean ages across the 20 countries

Source: Adapted with permission from Marriott et al. (2007)

There was considerable variability across countries. Among 0- to 6-month-old infants in Indonesia, Malawi, and Zimbabwe less than 2% of mothers responded that they used these other types of milks (0.7, 1.4, and 1.6% respectively) while over a third of mothers in Kenya reported their use for the same age group (35.1%). Use of these products was higher among 6- to 12-month-old infants, with a 29.6% average across all countries.

Mothers also reported feeding their infants a wide diversity of other liquids. Many of these liquids were reported in very few cases and often were country specific or cultural specific. Use of three specific sweetened liquids was queried in all 20 countries: fruit juice, herbal tea, and sugar water. Combined, these three types of liquids were in widespread use and more mothers reported the use of these liquids than other milks or formulas (pooled estimates: 0–6 months: 15.1%; 6–12 months: 41.6%). Reported use ranged from 2.8% in Nepal to 48.1% in Armenia for 0- to 6-month-old infants. Among 6- to 12-month-olds, reported use ranged from 15.8% in Nepal to 91.8% in Kazakhstan. In 2000 in Cambodia, 6.7 and 29% of mothers fed their babies other liquids at 0–6 and 6–12 months, respectively. Large differences were seen among countries in mothers' use of these categories of liquids. The high percentage of mothers reporting feeding their infants products from the "other liquids" category is of concern given that this category is comprised entirely of sweetened beverages.

Sixteen countries (Ethiopia, Namibia, India, and Nepal being the exceptions) included a specific question on commercial formula use. Use of infant formula was relatively low across all countries; overall an estimated 9.0% of 0- to 6-month-olds and 15.1% of 6- to 12-month-olds received commercial formula. Eleven of the 16 countries reported less than 10% formula use. The exceptions were Indonesia, Jordan, and the Philippines in which mothers reported 24.2, 25.1, and 30.0% respective

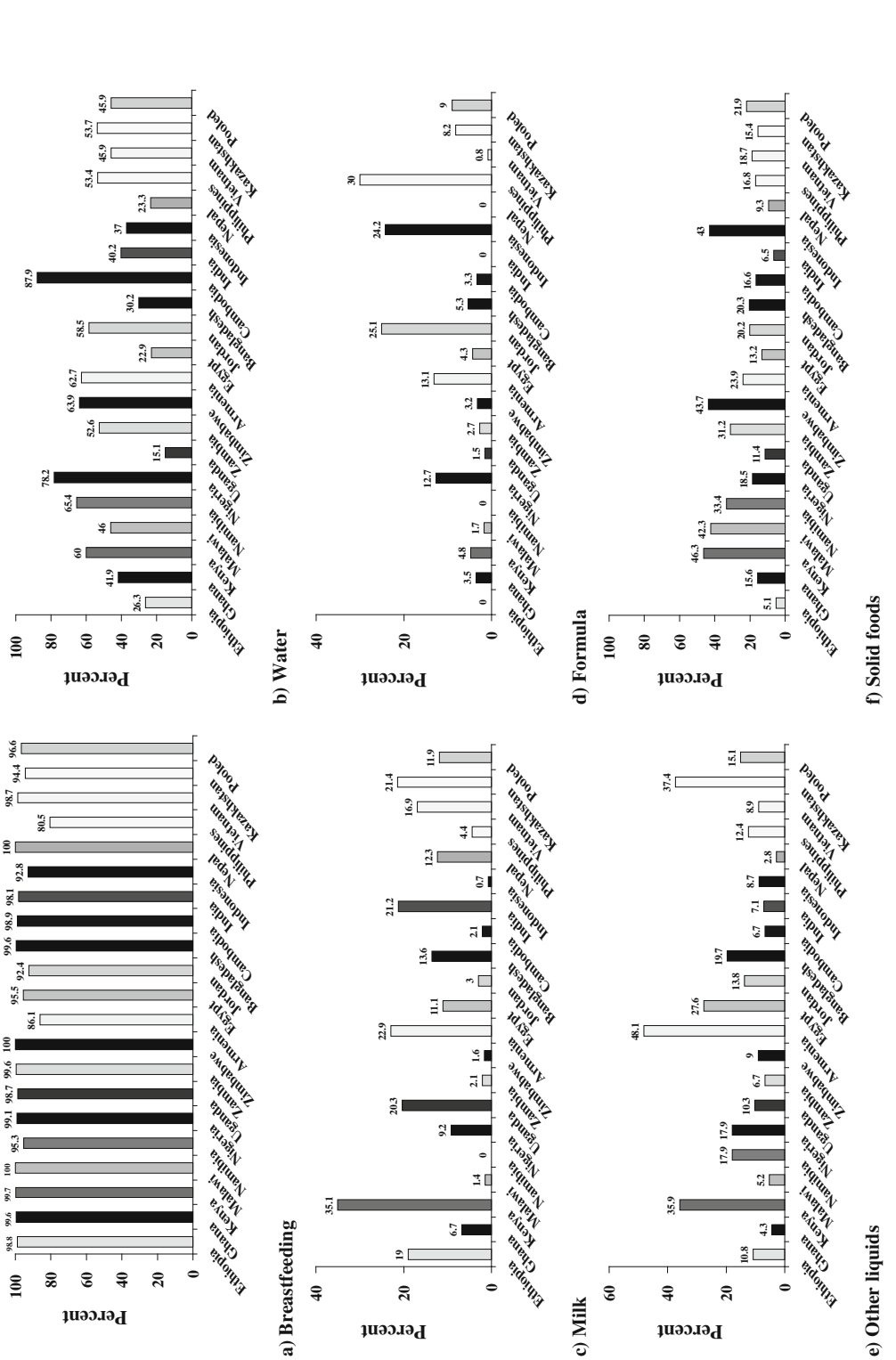

Fig. 87.1 Percent of mothers who stated that they were currently breastfeeding their infants (**a**), fed their infants water (**b**), tinned, powered, or other milk, excluding formula (**e***), formula (**d***), other liquids, including fruit juice, herbal tea, and sugar water (**e**), and/or any solid foods (**f**) in the past 24 h by country for infants aged 0–6 months. **Note*: this question was not asked in those countries where the value is shown as zero. Source: Adapted with permission from Marriott et al. (2007)

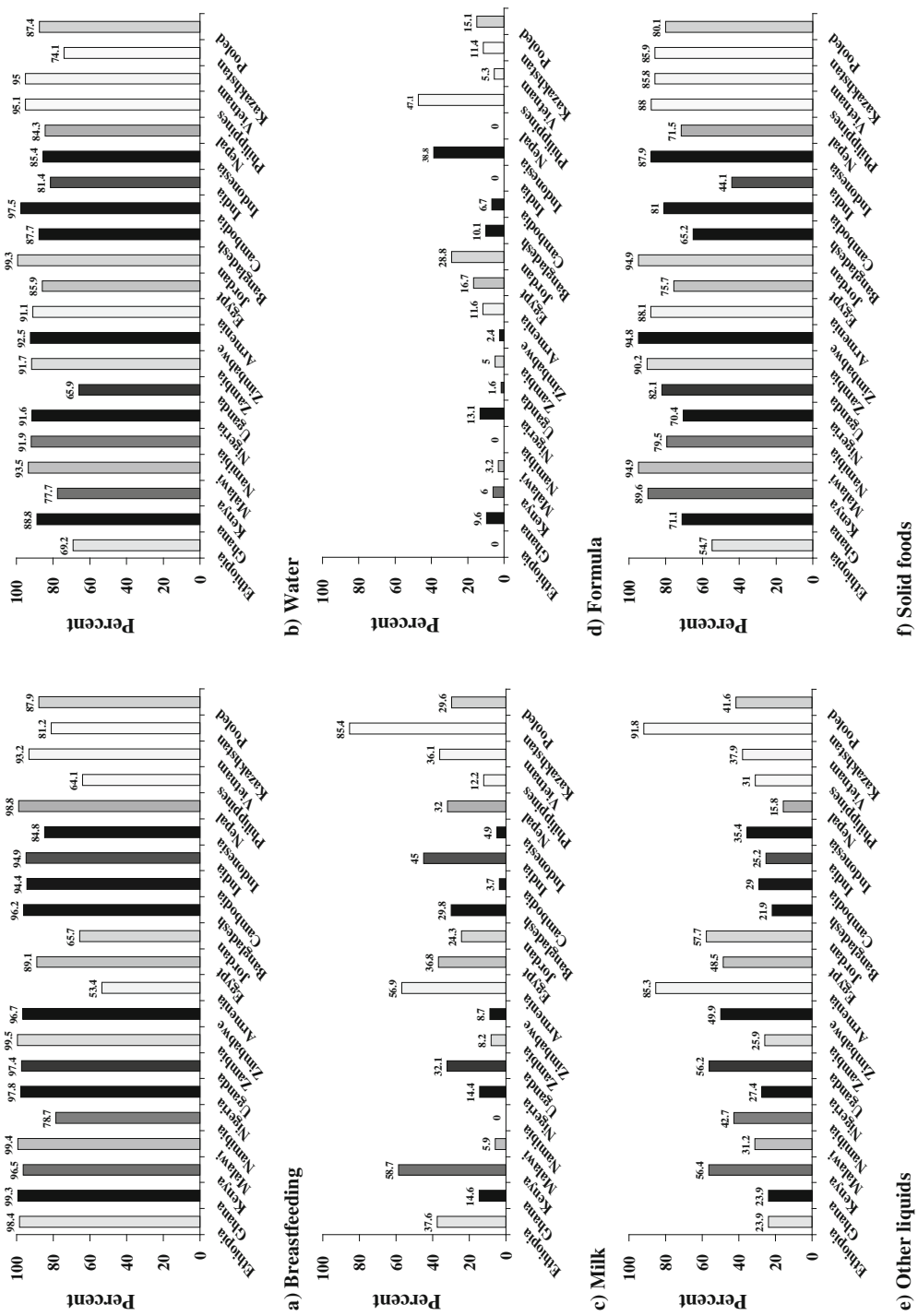

Fig. 87.2 Percent of mothers who stated that they were currently breastfeeding their infants (**a**), fed their infants water (**b**), tinned, powered, or other milk, excluding formula (**c***), formula (**d***), other liquids, including fruit juice, herbal tea, and sugar water (**e**), and/or any solid foods (**f**) in the past 24 h by country for infants aged 6–12 months. **Note*: this question was not asked in those countries where the value is shown as zero. Source: Adapted with permission from Marriott et al. (2007)

Table 87.3 Population–weighted averages of mothers who reported selected feeding practices in the last 24 h for infant age groups 0–6 and 6–12 months in 20 countries[a]

	Infant age (months)	
	0–6	6–12
Feeding practices[a]	*Percentage (weighted N)*	
Current breast feeding	96.6 (22,781)	87.9 (18,944)
Gave infant		
Water	45.9 (10,767)	87.4 (18,663)
Tinned/powdered or other milk	11.9 (2769)	29.6 (6238)
Commercial formula	9.0 (1261)	15.1 (1911)
Other liquids	15.1 (3531)	41.6 (8902)
Any solid food	41.6 (5131)	80.1 (17119)

[a]This table provides overall percentages for feeding practices for 0- to 6 and 6- to 12-month-old children in the 20 countries

Source: Adapted with permission from Marriott et al. (2007)

use of infant formula for 0- to 6-month-old children. For 14 of the 16 countries where information on use of commercial formula was available, reported use was higher for older infants. However, in Zimbabwe and Armenia, the opposite pattern was observed (Zimbabwe: 0–6 months: 3.2%; 6–12 months: 2.4%; Armenia: 0–6 months 13.1%; 6–12 months: 11.6%). In Cambodia, in 2000, only 3.3% of 0- to 6-month-olds and 6.7% of 6- to 12-month-olds received infant formula. Across all countries, the use of commercial formula was lower than that of the other three categories of liquids (water, tinned/powdered or other milk, other liquids).

This study found that over 20% of mothers are providing some type of solid foods to infants earlier than 6 months, but the practice varied greatly across the countries. Ethiopian and Indian mothers reported the lowest percentage of solid food use for their 0- to 6-month-old infants, 5.1 and 6.5% respectively, but more than 40% of mothers in Malawi, Indonesia, Zimbabwe, and Kenya reported feeding solid foods to their 0- to 6-month-old infants. Reported use of solid foods doubled to 80.1% (pooled value) for 6- to 12-month-old infants, with reported percentages ranging from a low of 44.1% by Indian mothers to over 90% by mothers in Zambia (90.2%), Zimbabwe (94.8%), Malawi (94.9%), and Jordan (94.9%). Solid food feeding, based on pooled analysis, was higher than expected for both age categories with mothers reporting feeding solid food to 21.9% of infants 0–6 months of age and 80.1% of infants 6–12 months of age. Introduction of solids by 6 months is WHO's recommendation (Dewey, 2004); our data thus show that approximately 20% of infants in the 20 developing countries in our sample are not compliant with this recommendation. A lower percent of Cambodian mothers evidenced early solid food feeding (16.6%). These data are similar to reports of feeding practices from other countries where a high prevalence of premature feeding of complementary foods was reported (Gonzalez-Cossio et al., 2006).

87.3.2 Cambodia

With this overview of infant feeding patterns, including data from the 2000 Cambodia DHS survey, we turn to an in-depth examination of Cambodia as a country where social stability and economic rebuilding has led to a government commitment to improved health for its citizens (Cambodian Ministry of Health, 2002; Dara, 2003; Adams et al., 2007; Collins et al., 2007; Lane, 2007; UNICEF, 2008). In particular Cambodia has set as its health targets improvement in the Millennium Development Goals (WHO, 2008c) development goal 4 to reduce child mortality (Collins et al., 2007; Carmichael, 2009).

For this study, our final sample included 3027 and 3112 mother infant pairs from the 2000 and 2005 Cambodia DHS, respectively (Table 87.4). Since height and weight data were collected on fewer mothers, our maternal BMI sample sizes were less (1491 and 1508, respectively) and the table illustrates the various sample sizes that match the WHO indicator specifications. Comparison of *t*-tests of data from the two surveys indicated that there were no statistical differences in the distribution of male and female children ($p = 0.53$) between the surveys, whereas in 2005 maternal age was significantly lower ($p < 0.0001$). Changes in the overall economy in Cambodia appear to have been reflected in differences in maternal characteristics between the 2000 and 2005 surveys. More mothers had a higher BMI ($p = 0.012$), attained a primary or secondary level of education, and the prevalence of no education was lower in 2005 ($p < 0.0001$). More mothers reported working in 2005 ($p < 0.0001$), but there was no significant difference in the proportion of women who reported working outside the home ($p = 0.157$).

The overall healthy pregnancy index score also was significantly higher in 2005 than in 2000 ($p < 0.0001$). Within the healthy pregnancy index, there was no significant difference in the proportion of mothers with BMI $\geq$18.5 or in the proportion of mothers with height >150 cm ($p = 0.197$ and $p = 0.58$, respectively). However, significantly more women engaged in healthful perinatal behaviors in 2005: tetanus injection ($p < 0.0001$), iron supplement ($p < 0.0001$), any assistance at birth ($p < 0.0001$), and antenatal care ($p < 0.0001$). The difference in the proportion of women reporting no night blindness was not statistically significant between the two surveys ($p = 0.253$).

The significant improvement in the healthy pregnancy index in 2005 and the perinatal maternal behaviors and access to health-care services that comprised it may be partly the result of the investment of the Cambodian government and international organizations at the local level on reducing poverty and improving health-care delivery systems in the country (Pavignani, 2006; Adams et al., 2007; Cambodian Ministry of Health, 2002; Lane, 2007). These changes may also reflect improvements in wealth that occurred in the country between 2000 and 2005.

By design, the DHS asset index was constructed so that about 20% of the population is in each quintile (across the entire sample for any country). In our analytic sample, there was a significantly lower proportion of individuals in asset index quintile 4 in 2005 ($p < 0.0001$) and a significantly higher proportion in asset index quintile 5 ($p < 0.0001$).

Using the WHO growth standards, we found fewer children in 2005 were underweight (age groups: 0–5, 6–11, 12–17 and 12–23 months, $p < 0.01$) or stunted (age group 0–5, 6–11months, $p < 0.01$) using the undernutrition age groups from the WHO indicators (Table 87.4). For 12- to 17-, 18- to 23-, and 12- to 23-month-old children, the prevalence of stunting was lower but did not reach statistical significance in 2005. Among 18- to 23-month-olds, the prevalence of stunting remained over 50% (2000: 54.0%; 2005: 52.9%). In 2005, the prevalence of stunting for 18- to 23-month-old children was more than three times as high as for the 0- to 5-month and 6- to 11-month age groups. In 2005, 0- to 5-month-old males were at higher risk of being stunted and underweight than females. Factors including higher energy requirements (Butte et al., 2000) and genetic, developmental, and sociological factors (Galler et al., 1998; Ward et al., 2000; Migeon, 2006; Di Renzo et al., 2007) may dispose male infants to greater growth risks as seen in Cambodia and elsewhere (Espo et al., 2002; Shah et al., 2003; Margai, 2007).

We show the prevalence of compliance with the WHO feeding indicators for 2000 and 2005 in Table 87.5. With the exception of the currently breastfeeding at 12- to 15-month indicator, the prevalence of compliance with *each* indicator for both breastfeeding and complementary food feeding among all age groups increased significantly in 2005 ($p < 0.01$). Criteria for meeting the complementary food indicators were met by a higher percent of mothers in 2005 than in 2000. The largest difference was the over fivefold increase in the prevalence of exclusive breastfeeding and threefold increase in breastfeeding initiation among infants aged 0–5 months. These data suggest that health educational interventions about breastfeeding in Cambodia such as the Baby-Friendly Community

Table 87.4 Demographic and lifestyle characteristics of mothers and infants[a] and Cambodian Demographic and Health Surveys 2000 and 2005[a]

	2000		2005	
Characteristic (*N*: 2000; 2005)	Mean % (SEM)	*N*	Mean % (SEM)	*N*
Infant gender (3027; 3112)				
Male (%)	50.9 (0.91)	1438	50.1 (0.90)	1490
Female (%)	49.1 (0.91)	1390	49.9 (0.90)	1487
Average maternal age (years) (3027; 3112)	29.6 0.12		28.4** 0.12	
Mother's education (3027; 3112)				
None (%)	32.1 (0.85)	908	22.5** (0.75)	671
Primary (%)	53.1 (0.91)	1502	59.6** (0.88)	1775
Secondary or higher (%)	14.8 (0.65)	418	17.8** (0.68)	531
Mother working (3027; 3112)				
Mother works (%)	78.7 (0.75)	2222	99.6** (0.11)	2956
Mother works outside home (%)	19.4 (0.81)	431	17.7 (0.80)	386
Mother's BMI (1491; 1508)				
Mother's mean BMI	20.4 0.06		20.7* 0.07	
Healthy pregnancy index (children 0–5 months) (420; 342)				
Mothers with BMI>18.5 (%)	86.5 (1.67)	332	83.1 (2.03)	261
Mothers with height > 150 cm	71.9 (2.20)	277	65.6 (2.57)	206
Antenatal care (%)	2.6 (0.77)	10	75.5** (2.33)	237
Tetanus injection (%)	51.7 (2.44)	199	77.9** (2.25)	244
Iron supplement (%)	30.6 (2.25)	118	71.0** (2.46)	223
No night blindness (%)	89.7 (1.48)	345	92.2 (1.46)	289
Assistance at birth (%)	2.3 (0.73)	9	53.8** (2.70)	169
Mean total index score	3.4 (0.06)		5.2** (0.08)	
Asset index (3027; 3112)				
Quintile 1	25.9 (0.80)	733	26.4 (0.79)	786
Quintile 2	22.8 (0.76)	644	21.7 (0.74)	647
Quintile 3	19.2 (0.72)	542	18.4 (0.69)	546
Quintile 4	19.2 (0.72)	542	16.2** (0.66)	483
Quintile 5	12.9 (0.61)	366	17.3** (0.68)	514

	Undernutrition indicators by age					
	Number of children in sample		Underweight (WHO) % (SEM)		Stunted (WHO) % (SEM)	
Child age (months)	2000	2005	2000 Mean % (SEM)	2005	2000 Mean % (SEM)	2005
0–5	355	291	21.5 (2.01)	9.8** (1.63)	27.3 (2.18)	17.2** (2.08)
6–11	363	367	25.8 (2.19)	17.6** (1.95)	33.6 (2.36)	17.5** (1.95)
12–17	331	359	34.0 (2.48)	21.6** (2.14)	40.0 (2.56)	37.2 (2.52)
18–23	262	378	36.8 (2.84)	30.4 (2.34)	54.2 (2.94)	52.7 (2.56)
12–23	593	737	35.3 (1.86)	26.2** (1.60)	46.3 (1.95)	45.4 (1.82)

SEM: standard error of mean

[a]This table shows the mean percent, standard error of the mean, and sample size for the basic demographic characteristics and mean percent, standard error of the mean, and sample size of child underweight and stunting from birth to 2 years that we calculated using the Cambodian Demographic and Heath Survey (DHS) Data from 2000 and 2005. This table also includes means, standard errors of the mean, and sample sizes for selected lifestyle characteristics used in this study, including the characteristics that we used to construct the Healthy Pregnancy Index and the total index based on the 2000 and 2005 DHS Cambodian data

**Statistically significant at $p < 0.01$

Source: Adapted with permission from Marriott et al. (2010)

Table 87.5 Prevalence of overall compliance with WHO feeding indicators[a]: overall and age-based, Demographic and Health Surveys Cambodia 2000 and 2005[b]

	2000			2005		
Breastfeeding indicators	Mean % (SEM) *N*			Mean % (SEM) *N*		
Initiation of breastfeeding in first hour	**0–11 mo** 11.1 (0.77) 1672		**12–23 mo** 12.5 (0.94) 1245	**0–11 mo** 34.8** (1.21) 1542		**12–23 mo** 33.8** (1.21) 1529
Exclusive breastfeeding	**0–1 mo** 18.0 (2.51) 234	**2–3 mo** 11.7 (1.77) 329	**4–5 mo** 5.6 (1.34) 296	**0–1 mo** 73.8** (2.93) 226	**2–3 mo** 66.4** (2.85) 275	**4–5 mo** 48.7** (3.20) 245
Currently breastfeeding (aged 12–15 months)		87.1 (1.50) 505			89.6 (1.33) 532	
Introduction of complementary foods (aged 6–8 months)		74.7 (2.10) 431			82.4** (1.92) 393	

Complementary feeding indicators by age

	Sample size		Feeding frequency		Feeding diversity		Minimum acceptable diet		Iron-rich and iron-fortified foods (including formula)	
			2000	2005	2000	2005	2000	2005	2005	2000
	2000	2005	Mean % (SEM)		Mean % (SEM)		Mean % (SEM)		Mean % (SEM)	
6–11 mo	830	790	52.1 (1.74)	62.2** (1.73)	20.4 (1.40)	27.4** (1.60)	13.9 (1.20)	20.9** (1.45)	52.9 (1.75)	59.4** (1.75)
12–17 mo	713	794	59.9 (1.84)	70.8** (1.62)	21.9 (1.04)	26.2** (1.11)	14.5 (0.88)	20.7** (1.02)	41.9 (1.25)	51.5** (1.27)
18–23 mo	610	758	62.1 (2.00)	64.8 (1.74)	44.7 (2.02)	56.6** (1.80)	31.2 (1.88)	41.5** (1.80)	84.3 (1.54)	91.0** (1.05)

SEM: standard error of mean

[a]Indicators for assessing infant and young child feeding practices, conclusions of a consensus meeting held 6-8 November 2007 in Washington DC, USA (Working Group On Infant And Young Child Feeding Indicators 2007)

[b]This table shows the percent of mothers in 2000 and 2005 (with standard error of the mean and sample size) in Cambodia who were compliant or met the World Health Organization (WHO) healthy feeding indicators in feeding their babies for breastfeeding indicators and complementary feeding indicators at specific ages for their children that we calculated based on the Cambodian 2000 and 2005 Demographic and Health Survey (DHS) data. The DHS sample is representative of all women and babies in Cambodia in 2000 and 2005; therefore, these prevalence values are indicative of the situation in Cambodia at these time points

** Statistically significant at $p < 0.01$

Source: Adapted with permission from Marriott et al. (2010)

Initiative (Collins et al., 2007) and the various child and maternal health education and health support programs instituted in Cambodia (Cambodian Ministry of Health, 2002; Dara, 2003; Lane, 2007; UNICEF, 2008) had a positive impact on infant feeding practices, particularly exclusive breastfeeding. However, while initiation of breastfeeding within the first hour of life improved in prevalence from 2000 to 2005, only one-third of Cambodian women in 2005 followed this practice. In contrast, in 2005, almost 90% of women in Cambodia reported continuing to breastfeed their babies through the first year of life.

Seventy-five percent of babies aged 6–8 months received solid food in 2000, compared to 82% in 2005. The mean prevalence for four of the solid food feeding indicators (feeding frequency, feeding diversity, minimum acceptable diet, and consumption of iron-rich and iron-fortified foods) was significantly higher for all age sub-groups in 2005 compared to 2000. However, while the prevalence for the feeding frequency and consumption of iron-rich/fortified foods was relatively high, the prevalence of feeding diversity and the composite measure, minimum acceptable diet, remained low in 2005, particularly for the 6- to 11- and 12- to 17-month age ranges (feeding diversity: 27.4 and 26.2%; minimum acceptable diet: 20.9 and 20.7%, respectively). For the 18- to 23-month-old children, the prevalence of meeting these feeding indicators was higher at 57 and 42%, respectively.

In Fig. 87.3 we present the prevalence of exclusive breastfeeding and complementary food intake for each month across the first 6 months of life in Cambodia and further illustrate the feeding differences found when comparing the 2000 and 2005 DHS surveys. Significantly more women exclusively breastfed their infants in each of the first 6 months of life in 2005 than in 2000 (68 versus 18% in month 1 and 33 versus 3% in month 5, respectively). The rates of change in breastfeeding initiation in 2005 and the decrease in breastfeeding rates between months 1 and 5 in both years were statistically significant ($p < 0.0001$). In contrast, complementary food feeding practices were similar across the two survey years. In both years, some mothers introduced complementary foods earlier than recommended with 17% of children in 2000 and 9% of children in 2005 receiving

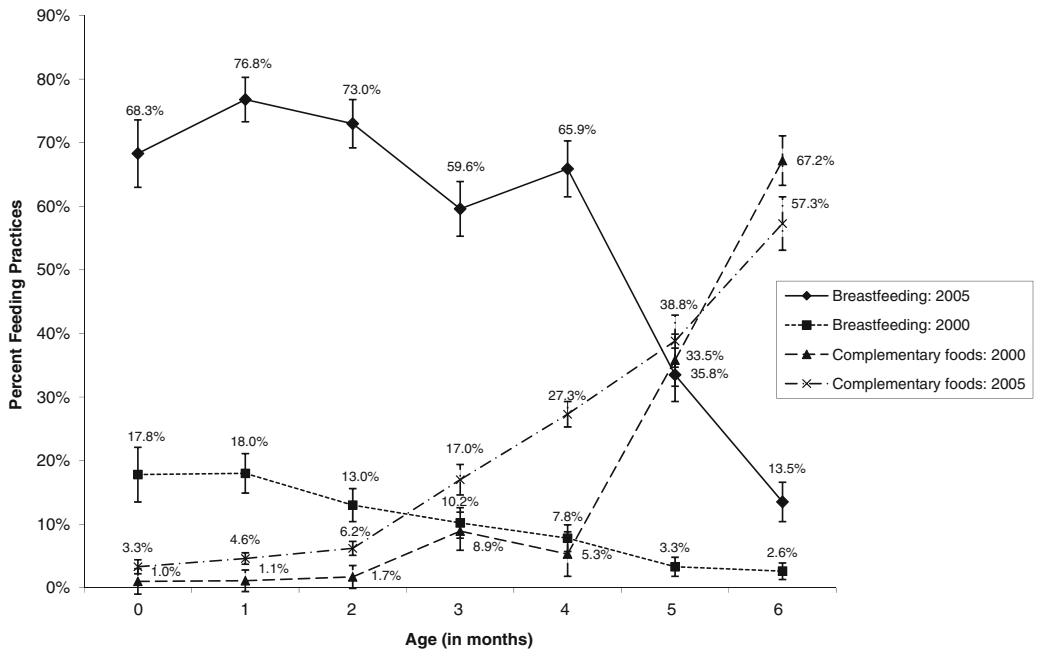

Fig. 87.3 Exclusive breastfeeding and complementary foods: comparison of percent feeding, Cambodia Demographic and Health Surveys, 2000 and 2005. Source: Adapted with permission from Marriott et al. (2010)

complementary foods in their third month of life. Also in both years, the prevalence of mothers feeding complementary foods to their babies increased sharply in the fifth month (2000: 27% in month 4 to 39% in month 5; 2005: 5% in month 4 to 36% in month 5). By the sixth month, over 50% of infants were receiving complementary foods in both years of the survey (2000: 57%; 2005: 67%).

Table 87.6 presents the results of logistic regression models testing the association of the overall feeding indicators with lowered stunting and underweight for the 2000 and 2005 Cambodia DHS data. Table 87.7 shows the relationship between the specific feeding indicators and the two outcome measures. In general, we found no relationship between the feeding indicators (either compliance with all relevant indicators or compliance with individual age-specific indicators) and growth indicators. The one exception was that, in 2005, 0- to 5-month-old infants whose mothers were in compliance with both the exclusive breastfeeding and breastfeeding initiation indicators had a significantly lower risk of being underweight. Compliance with breastfeeding indicators was not positively associated with a reduced risk of stunting in this same age group, perhaps reflecting the longer term chronic undernutrition that underpins stunting. Our primary finding in these models was a consistent positive association of reduction in risk of stunting and underweight with increases in relative wealth.

We disaggregated the variables that comprise the DHS asset index to explore the changes in household wealth that occurred in Cambodia between 2000 and 2005 for each item used in the asset index (Table 87.8). Consistent with the profile of a country with improving economic conditions, mean values were higher in 2005 than they were in 2000 for most of the variables ($p < 0.05$ or $p < 0.01$), and, for some items in the asset index, the changes were substantial. For example, the proportion of families with a phone increased from 3.6% in 2000 to more than 20% in 2005; the proportion with a TV increased from 32.6 to 55.2%; the proportion with piped water increased from 5.9 to 10.5%; and the proportion with a flush toilet increased from 13.7 to 24.4%.

While the prevalence of meeting all of the complementary food feeding guidance indicators in 2005 for 6- to 23-month-old children was higher than in 2000, there was little evidence from our modeling analyses that these changes in feeding practices were associated with decreases in underweight and stunting, at least as measured by the core feeding indicators. For 6- to 11-month-old infants, while prevalence of stunting and underweight in Cambodia significantly dropped to below 20% in 2005, meeting the overall solid food feeding indicators in this age group was associated in regression models with a significantly reduced risk of stunting in 2005, but no significant association with underweight. Among 12–17 mo children, prevalence of underweight similarly dropped significantly to 16% in 2005. However, for children 18–23 months, prevalence of underweight was not significantly lower in 2005 and remained at 30%. None of the feeding indicators for 12- to 23-month children were associated with reduced risk of undernutrition.

Other authors have identified the high level of stunting among 12- to 23-month-old children in Cambodia as problematic (Collins et al., 2007). Prevalence of meeting a minimum acceptable diet improved to approximately 42% among 18- to 23-month-old children in 2005. However, stunting is an indicator of chronic undernutrition (WHO, 2008a). Therefore, stunting in 18- to 23-month-old children probably reflects individual child feeding patterns at a younger age. While this is a cross-sectional study, the low percent of 6- to 17-month-old children with a minimally acceptable diet may be a feeding pattern that could predispose these children to stunting at 18–23 months.

Similar to earlier studies (Nandy et al., 2005; Van de Poel et al., 2008), in Cambodia we found an association between higher relative wealth and reduced risk of stunting and underweight. Examination of the asset index illustrated household-level improvements in household structure, water sources, sanitation, and cooking facilities that touched all aspects of family lives. Similar to other reports (Blakely et al., 2005; Nandy et al., 2005; Gonzalez-Cossio et al., 2006; Van de Poel et al., 2008), relative reduction in poverty status led to household changes that may have been key factors in the decline in undernutrition in Cambodia.

Table 87.6 Association of stunting and underweight and overall compliance with WHO feeding indictors[a] for children of different age groups[a], Demographic and Health Survey, Cambodia, 2000 and 2005[b]

	Stunting (odds ratio (95% CI))				Underweight (odds ratio (95% CI))			
	2000 models		2005 models		2000 models		2005 models	
	Model 1	Model 1a	Model 1	Model 1a	Model 1	Model 1a	Model 1	Model 1a
Age	1.06** (1.04, 1.08)	1.07** (1.05, 1.09)	1.11** (1.09, 1.13)	1.12** (1.09, 1.15)	1.05** (1.03, 1.07)	1.06** (1.04, 1.08)	1.07§* (1.05, 1.09)	1.06** (1.03, 1.9)
Infant is male	1.21 (0.96, 1.51)	1.22 (0.97, 1.53)	1.64** (1.28, 2.10)	1.67** (1.30, 2.13)	1.26 (0.99, 1.60)	1.26 (0.99, 1.60)	1.77** (1.34, 2.33)	1.76** (1.33, 2.32)
Mother's age	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)	1.02 (1.00, 1.04)	1.02 (1.00, 1.04)	1.01 (1.00, 1.03)	1.01 (1.00, 1.03)	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)
Asset index: Quintile 2	0.66* (0.48, 0.91)	0.65** (0.47, 0.90)	0.82 (0.58, 1.16)	0.82 (0.58, 1.16)	0.75 (0.54, 1.04)	0.75 (0.54, 1.04)	1.08 (0.75, 1.55)	1.07 (0.75, 1.54)
Asset index: Quintile 3	0.60** (0.43, 0.84)	0.59** (0.42, 0.83)	0.71 (0.49, 1.01)	0.71 (0.49, 1.01)	0.57** (0.39, 0.81)	0.56** (0.39, 0.81)	0.55** (0.36, 0.84)	0.55** (0.36, 0.83)
Asset index: Quintile 4	0.82 (0.59, 1.15)	0.82 (0.59, 1.15)	0.62* (0.43, 0.91)	0.62* (0.42, 0.91)	0.78 (0.55, 1.10)	0.78 (0.55, 1.10)	0.71 (0.47, 1.08)	0.69 (0.45, 1.06)
Asset index: Quintile 5	0.56** (0.37, 0.84)	0.57** (0.38, 0.85)	0.30** (0.20, 0.46)	0.30** (0.20, 0.46)	0.54** (0.35, 0.84)	0.56* (0.36, 0.88)	0.33** (0.20, 0.54)	0.32** (0.20, 0.53)
Compliant with all relevant indicators	1.21 (0.92, 1.61)		0.91 (0.71, 1.17)		1.09 (0.81, 1.46)		0.85 (0.64, 1.12)	
Compliant and age 0–5 months		2.88** (1.50, 5.52)		1.38 (0.84, 2.27)		2.33* (1.17, 4.62)		0.50* (0.26, 0.96)
Compliant and age 6–11 months		0.71 (0.36, 1.41)		0.33** (0.16, 0.71)		1.23 (0.63, 2.40)		1.04 (0.56, 1.92)
Compliant and age 12–17 months		1.23 (0.82, 1.85)		0.87 (0.60, 1.28)		1.05 (0.68, 1.62)		0.89 (0.58, 1.37)
Compliant and age 18–23 months		0.94 (0.57, 1.54)		0.95 (0.63, 1.43)		0.68 (0.40, 1.16)		0.99 (0.63, 1.55)

Note that model 1 includes an indicator for whether the infant was in compliance with all the age-specific relevant feeding indicators while model 1A includes interaction terms between age and compliance

95% CI: 95% confidence interval

[a]Indicators for assessing infant and young child feeding practices, conclusions of a consensus meeting held 6–8 November 2007 in Washington, DC, USA (Working Group on Infant and Young Child Feeding Indicators, 2007). Sample size varied with age group and indicator. See Table 87.2.

[b]This table presents the results of regression analysis in terms of the odds ratios (and confidence intervals) of the association between infants being stunted and underweight and compliance of the mother with all relevant World Health Organization (WHO) healthy feeding indicators for specific age ranges (model 1). In model 1a statistical interactions between age and compliance are included.

*Statistically significant, $p < 0.05$

**Statistically significant, $p < 0.0\,1$

Source: Adapted with permission from Marriott et al. (2010)

Table 87.7 Association of stunting and underweight with age-based WHO feeding indicators[a] and Demographic and Health Surveys Cambodia 2000 and 2005[b]

	WHO feeding indicators							
	Stunting (odds ratio (95% CI))				Underweight (odds ratio (95% CI))			
	2000 models		2005 models		2000 models		2005 models	
0- to 5- month-olds[c]								
Pregnancy index	0.80* (0.64, 1.00)		1.13 (0.88, 1.46)		0.88 (0.69, 1.11)		0.73 (0.53, 1.01)	
Initiated breastfeeding in first hour	0.94 (0.44, 2.03)		1.62 (0.85, 3.11)		0.82 (0.34, 1.97)		2.28 (0.98, 5.33)	
Exclusive breastfeeding	3.59** (1.74, 7.42)		1.00 (0.49, 2.02)		2.91** (1.35, 6.29)		0.56 (0.23, 1.35)	
6- to 23- month-olds[d]	**Model 1**	**Model 1a**	**Model 1**	**Model 1a**	**Model 1**	**Model 1a**	**Model 1**	**Model 1a**
Minimum acceptable diet		0.99 (0.71, 1.37)		0.80 (0.60, 1.08)		1.01 (0.71, 1.42)		1.01 (0.73, 1.39)
Dietary diversity	0.85 (0.61, 1.17)		0.75 (0.56, 1.02)		1.04 (0.74, 1.45)		0.93 (0.67, 1.29)	
Feeding frequency	0.94 (0.72, 1.24)		1.12 (0.83, 1.51)		0.95 (0.72, 1.27)		1.14 (0.82, 1.57)	
Iron-fortified foods	0.96 (0.69, 1.36)	0.89 (0.64, 1.23)	0.80 (0.52, 1.24)	0.80 (0.52, 1.21)	0.91 (0.64, 1.31)	0.92 (0.65, 1.29)	0.93 (0.58, 1.49)	0.93 (0.59, 1.48)

Note that these models also included age, gender, mother's age, and asset quintile as covariates
95% CI: 95% confidence interval
[a]Indicators for assessing infant and young child feeding practices, conclusions of a consensus meeting held 6–8 November 2007 in Washington, DC, USA (Working Group On Infant And Young Child Feeding Indicators, 2007)
[b]This table presents the results of regression analysis in terms of the odds ratios (and confidence intervals) of the association between infants being stunted and underweight and compliance of the mother with each of the World Health Organization (WHO) healthy feeding indicators for specific age ranges based on the 2000 and 2005 Demographic and Health Survey (DHS) data
[c]Sample size for 0- to 5-month models: 2000 = 956; 2005 = 1104
[d]Sample size for 6- to 23-month models: 2000 = 355; 2005 = 291
*Statistically significant, $p < 0.05$
**Statistically significant, $p < 0.01$
Source: Adapted with permission from Marriott et al. (2010)

Table 87.8 Household possessions and housing characteristics[a] included in the Cambodian Demographic and Health Surveys Asset Indices based on the Household Surveys[b] in 2000 and 2005[c]

	2000	2005
Variable	Mean % (SEM)	Mean % (SEM)
Household possessions		
Radio	42.3 (0.45)	49.6** (0.42)
TV	32.6 (0.42)	55.2** (0.42)
Phone	3.6 (0.17)	20.1** (0.34)
Refrigerator	1.8 (0.12)	2.9** (0.14)
Wardrobe	21.2 (0.37)	30.0** (0.38)
Sewing machine	7.6 (0.24)	8.4* (0.23)
Means of transport		
Bicycle	52.6 (0.45)	68.3** (0.39)
Animal-drawn cart	27.2 (0.40)	24.1** (0.36)
Motorcycle/scooter	23.2 (0.38)	34.7** (0.40)
Car/truck	2.3 (0.14)	3.9** (0.16)
Boat with motor	3.6 (0.17)	3.4 (0.15)
Boat without motor	5.3 (0.20)	5.4 (0.19)
Has electricity	16.6 (0.34)	20.5** (0.34)
Main floor material		
Earth, sand	9.0 (0.26)	8.5 (0.23)
Wood planks	44.9 (0.45)	48.1** (0.42)
Palm, bamboo	36.9 (0.44)	30.0** (0.38)
Ceramic tiles	5.2 (0.20)	5.9* (0.20)
Cement	2.6 (0.14)	6.8** (0.21)
Roofing		
Natural roofing (palm, bamboo, thatch)	40.8 (0.44)	24.5** (0.36)
Metal	25.2 (0.39)	38.2** (0.41)
Tiles/cement	33.5 (0.43)	37.0** (0.40)
Water Source		
Piped water	5.9 (0.24)	10.5** (0.31)
Well	56.9 (0.50)	56.1 (0.50)
Surface water	28.0 (0.45)	24.2** (0.43)
Rain	1.1 (0.10)	2.1** (0.14)
Tanker	4.6 (0.21)	5.3** (0.22)
Bottled	0.1 (0.03)	1.6** (0.12)
Other	3.4 (0.18)	0.2** (0.02)
Toilet facilities		
Flush	13.7 (0.31)	24.4** (0.36)
Latrine	7.0 (0.23)	1.8** (0.11)
Composting toilet	79.1 (0.37)	71.5** (0.38)
Type of cooking fuel		
LPG/natural gas	3.1 (0.16)	7.3** (0.22)
Kerosene	0.5 (0.06)	0.0** (0.02)
Charcoal	6.6 (0.22)	7.9** (0.23)
Firewood	89.7 (0.28)	84.4** (0.30)

SEM: standard error of the mean

[a]Item categories with mean values of less than 1% in both time periods are not reported

[c]This table shows the components of the Demographic and Health Survey (DHS) asset index and the prevalence (in terms of mean percent and standard error of the mean) based on the Cambodian 2000 and 2005 DHS data. Highly statistically significant differences were evident in the majority of the components of the Cambodian DHS asset index between 2000 and 2005 in that at the household level economic improvement was indicated across household possessions and house characteristics

[b]Sample sizes in the household surveys: 2000 = 12,236; 2005 = 12,243

*Statistically significant at the 5% level, $p < 0.05$

**Statistically significant at the 1% level, $p < 0.01$

Source: Adapted with permission from Marriott et al. (2010)

87.4 Conclusions

Our data show that a high percentage of mothers in 20 developing countries breastfeed their babies through the end of the first year of their infant's life but that a high percent also provided sweetened liquids and introduced solid foods often well before the sixth month of life. In Cambodia we found that increased relative wealth was associated with reduction in risk of stunting and underweight, but there was little relationship between the WHO core feeding indicators and reduction in risk for these outcomes. While the prevalence of exclusive breastfeeding and meeting the criteria for other core feeding practices were higher in 2005 than in 2000 in Cambodia, we did not find evidence that these changes were related to feeding practices.

In particular, while associated with relative wealth in regression modeling, the prevalence of stunting among 18- to 23-month-old children was greater than 50% in both years. Less than 30% of women with 12- to 17-month-old infants met the criteria for meeting feeding diversity and the minimum acceptable diet.

Undernutrition in first 2 years of life has been associated with poor later health outcomes and loss of human capital (Hoddinott et al., 2008; Victora et al., 2008). Stunting in particular has been associated with poor performance on cognitive tests in older children (Mendez and Adair, 1999). The second year of life is recognized as a critical period in terms of child mortality (Black et al., 2008; Victora et al., 2008). The cross-sectional nature of the DHS survey data makes it impossible for us to analyze the relationship between early exclusive breastfeeding and outcomes later in life for the individual infant. However, the findings of this study support recent analyses which show that strategies for breastfeeding promotion can impact the feeding practices among children who are not exclusively breastfed (Black et al., 2008). However, the high prevalence of stunting in 18- to 23-month-old children coupled with low proportion of infants meeting the complementary feeding recommendations indicates that special attention needs to be paid to complementary feeding at the critical 6- to 23-month age range (Mendez and Adair, 1999; Piwoz et al., 2003; Black et al., 2008; Hoddinott et al., 2008; Victora et al., 2008). These results suggest a need to focus attention on the core feeding indicators targeted to the second year of life. Specifically, inclusion of information on the quantity of food intake could enhance the dietary diversity indicator for tracking feeding changes and outcomes among young children.

We were disappointed to not find predictive value in the complementary food feeding indicators, particularly for stunting. It may be that the factors precipitating stunting are not dietary in nature, or perhaps the low prevalence of dietary diversity and minimally acceptable diet limit the dynamic range of the relationship between the feeding indicators and outcomes. One major non-dietary factor confounding diet is violence, though Cambodia was at peace during these surveys. Another non-dietary variable, wealth, was taken into account in the analyses, suggesting the possibility that diet was considerably less important than wealth. The possibility that the dynamic range was limiting could be tested by broadening the approach to a group of countries, and we are currently conducting these studies.

87.5 Applications

Mothers in developing countries should continue to be encouraged to breastfeed their babies in compliance with the WHO guidance because these feeding behaviors appear to be associated with a reduction in risk of underweight among 0- to 5-month-old infants. Child feeding education programs should provide information about the problems of providing sweetened liquids and solid foods earlier

than recommended by the WHO. Stunting remains a widespread problem among children aged 18–23 months and maternal well child education could focus attention on the importance of dietary diversity of complementary foods beginning at 6 months to help reduce the risk of stunting. As exemplified by Cambodia, economic stability coupled with a focus on health outcomes can result in significant improvements in child and family well-being.

Summary Points

- The DHS data provide a strong base for evaluating guidelines for child feeding with comparison across multiple countries.
- Breastfeeding in 20 countries that are classed by the World Bank among the poorest economically was widely practiced and a high percentage of mothers continued to breastfeed through the first year of life as recommended by the WHO.
- Many mothers in these 20 countries began feeding sweetened liquids and solid food to their babies earlier than recommended by the WHO.
- In one of these countries, Cambodia:
    - Prevalence of underweight was less for most age categories in 2005 than in 2000; however, prevalence of stunting among 18- to 23-month-old children was not less in 2005 and remained above 50%.
    - Prevalence of compliance with all age-based breastfeeding and complementary feeding WHO indicators increased significantly between surveys in 2000 and 2005, except percent of mothers currently breastfeeding at 12–15 months which remained relatively constant (2000: 87.1%; 2005: 89.6%).
    - In particular, among 0- to 5-month-old infants prevalence of exclusive breastfeeding increased fivefold and prevalence of early breastfeeding initiation increased threefold between 2000 and 2005.
    - While prevalence of meeting the complementary feeding indicator for feeding diversity increased between 200 and 2005, the prevalence remained very low for feeding diversity and minimal acceptable diet among various age groups.
    - However, age-based regression models demonstrated no overall general association of WHO feeding indicators with undernutrition measures of underweight and stunting. There were some age-specific associations.
    - 0- to 5-month-old infants, whose mothers were in compliance with both exclusive breastfeeding and breastfeeding initiation guidance, were at significantly lower risk of underweight.
    - 6- to 11-month-old infants, whose mothers were in compliance with the overall solid food guidance, were at significantly reduced risk of stunting but not underweight.
    - Our primary finding from models of WHO feeding indicators was a consistent positive association of reduction in risk of stunting and underweight with increase in relative wealth.
- Among the WHO feeding indicators, focus on complementary feeding, particularly increased diversity of foods with consideration of food quality among children over 6 months, is indicated as a potential approach to reduce the high prevalence of stunting among children over 18 months.

Key facts about Cambodia

- Cambodia has undergone dramatic change in the last decade that has led to stabilization of the country and an increase in the gross domestic product (GDP) from 3.7 billion in 2000 to 6.2 billion in 2005 (US $) (World Bank, 2008a)
- This economic growth is reflected in an increase in the per capita gross national income (GNI – purchasing power parity) from 860 to 1380 (2006 US dollars), export of rice and other commodities, and foreign investments (World Bank, 2008a)
- As a result, Cambodia increased investments in health service delivery (Pavignani, 2006) and made strides toward implementing a national poverty reduction strategy (Cambodian Ministry of Health, 2002; Lane, 2007)
- Between 1999 and 2005, life expectancy at birth in Cambodia increased from 56.5 to 58.3 years and under-5 mortality rates declined from 104.2 to 85.4 per 1000 children (World Bank, 2008a)
- Also during this time, rural inequality of consumption stabilized and inequality non-consumption measures of living standards narrowed, including access to roads, clean water, electricity, schooling, and health care (Lane, 2007)
- Nonetheless, Cambodia remains a poor country, which is included among the World Bank's 53 low-income economies and ranks economically as 180th of 209 global countries (World Bank, 2008b). In addition, the urban–rural gap in access to amenities remains wide in Cambodia and is a continued target for further poverty reduction (Adams et al., 2007)

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