

Prevalence and Determinants of Protein Energy Malnutrition in Children Under Five Years

Ratna Dhaneshbhai Bhojak¹, Tirth Limbani², Lomabhai R. Solanki³

¹Assistant Professor, Department of Pediatrics, GMERS Medical College, Vadnagar, Gujarat, India

²MBBS, GMERS Medical College, Vadnagar, Gujarat, India

³DGO, Department of Obstetrics & Gynaecology, GMERS Hospital, Navsari, Gujarat, India

Received: 21-11-2025 / Revised: 18-12-2025 / Accepted: 22-12-2025

Corresponding author: Dr. Lomabhai R. Solanki

Conflict of interest: Nil

Abstract

Background: Protein energy malnutrition (PEM) remains a significant public health challenge affecting millions of children globally, particularly in developing countries. Understanding the prevalence and associated determinants of PEM is essential for developing targeted intervention strategies.

Methods: A community-based cross-sectional study was conducted among 624 children aged 6-59 months. Anthropometric measurements were obtained and compared against WHO growth standards. Sociodemographic, maternal, child, and household characteristics were collected using structured questionnaires. Chi-square tests and multivariate logistic regression analyses were performed to identify determinants of malnutrition.

Results: The prevalence of stunting, wasting, and underweight was 34.6%, 12.8%, and 23.4%, respectively. Severe acute malnutrition was identified in 3.4% of children. Multivariate analysis revealed that low maternal education (OR: 2.87, 95% CI: 1.89-4.36, $p < 0.001$), household food insecurity (OR: 3.42, 95% CI: 2.24-5.22, $p < 0.001$), lack of exclusive breastfeeding (OR: 2.14, 95% CI: 1.45-3.16, $p < 0.001$), poor dietary diversity (OR: 2.56, 95% CI: 1.72-3.81, $p < 0.001$), and history of diarrheal illness (OR: 1.98, 95% CI: 1.34-2.92, $p = 0.001$) were significant independent predictors of PEM. Children from households with monthly income below poverty level had 2.34 times higher odds of being malnourished compared to those from higher-income households.

Conclusion: The burden of protein energy malnutrition among children under five remains unacceptably high. Multisectoral interventions addressing maternal education, household food security, optimal infant feeding practices, and disease prevention are urgently needed to reduce childhood malnutrition.

Keywords: Protein Energy Malnutrition; Stunting; Wasting; Underweight; Children Under Five; Determinants; Food Security.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Protein energy malnutrition (PEM) represents one of the most significant global public health challenges, affecting approximately 149 million children under five years of age worldwide [1]. Characterized by inadequate intake of protein and energy relative to the body's requirements, PEM manifests clinically as stunting, wasting, and underweight, with severe forms presenting as marasmus or kwashiorkor [2].

The consequences of childhood malnutrition extend far beyond immediate physical effects, contributing to impaired cognitive development, reduced educational attainment, diminished economic productivity, and increased susceptibility to infections and chronic diseases in later life [3]. Despite considerable global efforts and investments in nutrition programs, the burden of PEM remains

disproportionately concentrated in low- and middle-income countries, where approximately 45% of all under-five deaths are attributable to undernutrition [4]. Sub-Saharan Africa and South Asia continue to bear the highest burden, with stunting prevalence exceeding 30% in many regions [5]. The Sustainable Development Goals target to end all forms of malnutrition by 2030 appears increasingly challenging given current trajectories and the additional setbacks imposed by the COVID-19 pandemic and global food insecurity [6].

The etiology of PEM is multifactorial, encompassing immediate causes such as inadequate dietary intake and infectious diseases, underlying determinants including household food insecurity, inadequate care practices, and poor water and

sanitation, and basic causes related to socioeconomic and political structures [7]. The UNICEF conceptual framework for malnutrition provides a comprehensive model for understanding these interconnected factors and their relative contributions to nutritional status [8].

Recent epidemiological studies have emphasized the critical importance of the first 1000 days from conception to the child's second birthday as a window of opportunity for nutrition interventions [9]. Evidence demonstrates that growth faltering often begins in utero and accelerates during the complementary feeding period, highlighting the need for interventions targeting both maternal and infant nutrition [10]. Furthermore, the intergenerational transmission of malnutrition, whereby malnourished mothers give birth to low birth weight infants who are subsequently at increased risk of malnutrition, perpetuates cycles of poverty and poor health outcomes [11].

While global and national estimates of malnutrition prevalence are well-documented, significant heterogeneity exists across geographic regions, socioeconomic strata, and population subgroups [12]. Context-specific data on the prevalence and determinants of PEM are essential for informing locally appropriate intervention strategies and targeting resources effectively [13]. Understanding the unique constellation of risk factors operating within specific communities enables the development of tailored programs that address the most salient drivers of malnutrition [14].

The aim of this study was to determine the prevalence of protein energy malnutrition and identify the sociodemographic, maternal, child, and household determinants associated with malnutrition among children aged 6-59 months in a semi-urban community.

Materials and Methods

Study Design and Setting: A community-based cross-sectional study was conducted in a semi-urban district comprising 12 administrative wards with a total population of approximately 185,000. The study area is characterized by diverse socioeconomic conditions, with agriculture, small-scale trading, and informal employment as the primary livelihood sources. Healthcare services are provided through one district hospital, three primary health centers, and multiple community health posts.

Study Population and Sampling: The study population comprised children aged 6-59 months residing in the study area for at least six months prior to data collection. Children with known chronic medical conditions affecting growth,

congenital anomalies, and those whose caregivers declined participation were excluded.

Sample size was calculated using the single population proportion formula, assuming a stunting prevalence of 35% based on regional estimates, 95% confidence level, 5% margin of error, and design effect of 1.5 for multistage sampling, yielding a minimum required sample of 588 children. Accounting for 10% non-response, 650 children were targeted for enrollment.

A multistage sampling technique was employed. First, six wards were randomly selected from the 12 administrative wards. Second, two villages were randomly selected from each ward. Third, systematic random sampling was used to select households with eligible children from household listings obtained from community health workers. In households with multiple eligible children, one child was randomly selected for inclusion.

Data Collection: Data were collected by trained research assistants using a structured questionnaire administered to primary caregivers (predominantly mothers) through face-to-face interviews. The questionnaire captured sociodemographic characteristics (child age, sex, birth order, maternal age, maternal education, paternal education, maternal occupation, household size, and household income), maternal and reproductive factors (parity, antenatal care attendance, place of delivery, and birth weight), infant and young child feeding practices (breastfeeding initiation, exclusive breastfeeding duration, age at complementary food introduction, and dietary diversity), child morbidity (diarrhea, fever, and acute respiratory infection in the preceding two weeks), household food security (using the Household Food Insecurity Access Scale), and water, sanitation, and hygiene practices.

Anthropometric measurements were obtained following standardized WHO protocols. Weight was measured to the nearest 0.1 kg using calibrated digital scales with children minimally clothed.

Recumbent length was measured for children under 24 months using infantometers, while standing height was measured for older children using stadiometers, both to the nearest 0.1 cm. Mid-upper arm circumference (MUAC) was measured to the nearest 0.1 cm using non-stretchable measuring tapes. All measurements were taken in duplicate, with a third measurement obtained if discrepancies exceeded acceptable limits.

Anthropometric Indices and Definitions: Z-scores for height-for-age (HAZ), weight-for-height (WHZ), and weight-for-age (WAZ) were calculated using WHO Anthro software based on the 2006 WHO Child Growth Standards. Stunting was defined as $HAZ < -2 SD$, wasting as $WHZ < -2 SD$,

and underweight as WAZ < -2 SD. Severe forms were defined as z-scores < -3 SD. Overall PEM was defined as the presence of any form of malnutrition (stunting, wasting, or underweight).

Household food insecurity was categorized as food secure, mildly food insecure, moderately food insecure, or severely food insecure based on the Household Food Insecurity Access Scale.

Dietary diversity was assessed using the WHO minimum dietary diversity indicator, with consumption of foods from fewer than four food groups in the preceding 24 hours classified as poor dietary diversity.

Statistical Analysis: Data were entered into EpiData version 3.1 and analyzed using STATA version 16.0. Continuous variables were expressed as mean \pm standard deviation or median with interquartile range, and categorical variables as frequencies and percentages. Bivariate analysis using chi-square tests identified variables associated with malnutrition at $p < 0.05$. Variables

meeting this threshold were entered into multivariate logistic regression models to identify independent determinants. Adjusted odds ratios with 95% confidence intervals were calculated, and $p < 0.05$ was considered statistically significant. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test.

Results

Sociodemographic Characteristics: Of 650 children approached for enrollment, 624 were included in the final analysis, yielding a response rate of 96.0%. The mean age of children was 28.6 ± 15.4 months, with 52.4% being male. The majority of caregivers were biological mothers (94.2%), with a mean maternal age of 27.3 ± 5.8 years.

Approximately 38.5% of mothers had no formal education or only primary education. The median household size was 6 members (IQR: 4-8), and 42.3% of households had monthly income below the poverty line. Detailed sociodemographic characteristics are presented in Table 1.

Table 1: Sociodemographic Characteristics of Study Participants (N=624)

Characteristic	n (%) or Mean \pm SD
Child Characteristics	
Age (months), mean \pm SD	28.6 \pm 15.4
Age categories	
6-11 months	98 (15.7)
12-23 months	167 (26.8)
24-35 months	142 (22.8)
36-47 months	118 (18.9)
48-59 months	99 (15.9)
Sex	
Male	327 (52.4)
Female	297 (47.6)
Birth order	
First born	168 (26.9)
Second or third	284 (45.5)
Fourth or higher	172 (27.6)
Birth weight (kg), mean \pm SD	2.89 \pm 0.52
Low birth weight (<2.5 kg)	112 (17.9)
Maternal Characteristics	
Maternal age (years), mean \pm SD	27.3 \pm 5.8
Maternal education	
No formal education	87 (13.9)
Primary education	153 (24.5)
Secondary education	264 (42.3)
Tertiary education	120 (19.2)
Maternal occupation	
Housewife/Unemployed	312 (50.0)
Farmer	124 (19.9)
Trader/Business	108 (17.3)
Formal employment	80 (12.8)
Household Characteristics	
Household size, median (IQR)	6 (4-8)
Monthly income below poverty line	264 (42.3)
Food security status	

Food secure	198 (31.7)
Mildly food insecure	156 (25.0)
Moderately food insecure	168 (26.9)
Severely food insecure	102 (16.3)
Improved water source	478 (76.6)
Improved sanitation facility	412 (66.0)

Infant Feeding Practices and Child Morbidity:

Breastfeeding was initiated within one hour of birth in 58.3% of children, and 42.6% were exclusively breastfed for six months. The mean age at introduction of complementary foods was 5.2 ± 1.8 months. Dietary diversity was poor in 54.8% of children. Regarding morbidity, 28.4% of children had experienced diarrhea and 34.1% had fever in the two weeks preceding the survey.

Prevalence of Protein Energy Malnutrition: The prevalence of stunting, wasting, and underweight

was 34.6%, 12.8%, and 23.4%, respectively. Severe stunting affected 11.5% of children, severe wasting 3.4%, and severe underweight 6.4%. Overall, 41.8% of children had at least one form of malnutrition. Co-occurrence of multiple forms of malnutrition was observed in 9.6% of children. The mean anthropometric z-scores were HAZ -1.42 ± 1.38 , WHZ -0.78 ± 1.24 , and WAZ -1.18 ± 1.31 . Prevalence by age group and sex is presented in Table 2.

Table 2: Prevalence of Malnutrition by Age Group and Sex (N=624)

Category	Stunting n (%)	Wasting n (%)	Underweight n (%)
Age Group			
6-11 months	24 (24.5)	18 (18.4)	21 (21.4)
12-23 months	62 (37.1)	28 (16.8)	48 (28.7)
24-35 months	58 (40.8)	16 (11.3)	38 (26.8)
36-47 months	42 (35.6)	10 (8.5)	24 (20.3)
48-59 months	30 (30.3)	8 (8.1)	15 (15.2)
p-value	0.042	0.038	0.047
Sex			
Male	124 (37.9)	48 (14.7)	86 (26.3)
Female	92 (31.0)	32 (10.8)	60 (20.2)
p-value	0.068	0.132	0.072
Severity			
Moderate (-3 to <-2 SD)	144 (23.1)	59 (9.5)	106 (17.0)
Severe (<-3 SD)	72 (11.5)	21 (3.4)	40 (6.4)
Overall Prevalence	216 (34.6)	80 (12.8)	146 (23.4)

Determinants of Protein Energy Malnutrition:

Bivariate analysis identified multiple factors significantly associated with PEM. Multivariate logistic regression revealed independent determinants of overall PEM (Table 3). Low maternal education (no formal/primary only) was associated with 2.87 times higher odds of PEM (95% CI: 1.89-4.36, $p<0.001$). Children from food-insecure households had 3.42 times higher odds of

malnutrition compared to those from food-secure households (95% CI: 2.24-5.22, $p<0.001$). Lack of exclusive breastfeeding for six months (OR: 2.14, 95% CI: 1.45-3.16, $p<0.001$), poor dietary diversity (OR: 2.56, 95% CI: 1.72-3.81, $p<0.001$), history of diarrhea in preceding two weeks (OR: 1.98, 95% CI: 1.34-2.92, $p=0.001$), and low birth weight (OR: 2.23, 95% CI: 1.48-3.36, $p<0.001$) were also significant independent predictors.

Table 3: Multivariate Logistic Regression Analysis of Determinants of PEM (N=624)

Variable	COR (95% CI)	AOR (95% CI)	p-value
Maternal Education			
Secondary/Tertiary	Reference	Reference	
No formal/Primary	3.24 (2.28-4.61)	2.87 (1.89-4.36)	<0.001
Household Income			
Above poverty line	Reference	Reference	
Below poverty line	2.89 (2.08-4.02)	2.34 (1.58-3.47)	<0.001
Food Security Status			
Food secure	Reference	Reference	
Food insecure	4.12 (2.87-5.92)	3.42 (2.24-5.22)	<0.001

Exclusive Breastfeeding			
Yes (6 months)	Reference	Reference	
No	2.56 (1.84-3.56)	2.14 (1.45-3.16)	<0.001
Dietary Diversity			
Adequate (≥ 4 groups)	Reference	Reference	
Poor (< 4 groups)	3.18 (2.24-4.52)	2.56 (1.72-3.81)	<0.001
Diarrhea (past 2 weeks)			
No	Reference	Reference	
Yes	2.34 (1.67-3.28)	1.98 (1.34-2.92)	0.001
Birth Weight			
Normal (≥ 2.5 kg)	Reference	Reference	
Low (< 2.5 kg)	2.78 (1.92-4.03)	2.23 (1.48-3.36)	<0.001
Water Source			
Improved	Reference	Reference	
Unimproved	1.89 (1.32-2.71)	1.54 (1.02-2.33)	0.042
Child Sex			
Female	Reference	Reference	
Male	1.38 (1.01-1.89)	1.42 (0.98-2.06)	0.064

COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval

Discussion

This community-based study revealed a substantial burden of protein energy malnutrition among children under five years, with over one-third of children stunted and nearly one-quarter underweight. These findings align with global estimates suggesting that malnutrition continues to affect millions of children, particularly in resource-limited settings [15].

The stunting prevalence of 34.6% observed in our study exceeds the WHO threshold of 30% indicating high public health significance [16]. This finding is consistent with regional surveys demonstrating persistent chronic undernutrition despite decades of nutrition interventions [17]. The peak prevalence of stunting observed in the 24-35 month age group supports the critical importance of interventions targeting the first 1000 days, as growth faltering established during this period is largely irreversible [18].

The wasting prevalence of 12.8% indicates a significant acute malnutrition burden requiring urgent attention. Wasting, reflecting recent nutritional deficits or acute illness, is associated with heightened mortality risk and requires timely identification and management [19]. The seasonal nature of data collection may influence wasting estimates, as acute malnutrition often fluctuates with agricultural cycles and disease epidemics [20].

Our finding that low maternal education was strongly associated with child malnutrition corroborates extensive literature demonstrating the protective effects of maternal schooling on child nutritional outcomes [21]. Educated mothers are more likely to adopt appropriate health-seeking behaviors, implement optimal feeding practices, and effectively utilize health services [22].

Investment in girls' education represents a powerful strategy for improving intergenerational nutrition outcomes. Household food insecurity emerged as the strongest predictor of PEM, with food-insecure households having over three times higher odds of having malnourished children. This finding underscores the fundamental importance of food availability and access in determining nutritional status [23]. Addressing food insecurity through social protection programs, agricultural interventions, and livelihood support is essential for sustainable malnutrition reduction [24].

The association between suboptimal infant feeding practices and malnutrition observed in our study reinforces the importance of promoting exclusive breastfeeding and adequate complementary feeding [25]. Despite global recommendations, exclusive breastfeeding rates remain suboptimal in many settings, highlighting the need for continued counseling and support for breastfeeding mothers [26]. Similarly, poor dietary diversity reflects inadequate access to diverse nutrient-rich foods during the critical complementary feeding period.

The significant association between recent diarrheal illness and malnutrition illustrates the well-established bidirectional relationship between infection and undernutrition [27]. Diarrhea leads to nutrient losses and malabsorption, while malnutrition impairs immune function and increases susceptibility to infections, creating a vicious cycle [28]. Water, sanitation, and hygiene interventions are therefore integral components of comprehensive malnutrition prevention strategies. Low birth weight, reflecting intrauterine growth restriction or preterm birth, was a significant predictor of subsequent malnutrition. This finding emphasizes the importance of maternal nutrition

and antenatal care in preventing the intergenerational transmission of undernutrition [29]. Interventions to improve maternal nutritional status before and during pregnancy can yield substantial benefits for child growth outcomes.

Several limitations warrant acknowledgment. The cross-sectional design precludes causal inference regarding identified associations. Recall bias may affect reported feeding practices and morbidity history. Additionally, certain potential determinants such as maternal mental health and detailed micronutrient intake were not assessed.

Despite these limitations, this study provides valuable locally relevant data on the magnitude and determinants of PEM, informing priority-setting for nutrition interventions. The findings highlight the multifactorial nature of malnutrition and the need for integrated approaches addressing immediate, underlying, and basic causes.

Conclusion

This study demonstrates that protein energy malnutrition remains a significant public health problem among children under five years in the study area, with over one-third of children affected by stunting and nearly one-quarter by underweight. The identified determinants span multiple domains, including maternal education, household economic status, food security, infant feeding practices, child morbidity, and birth weight.

These findings underscore the need for multisectoral interventions integrating nutrition-specific approaches such as breastfeeding promotion and dietary diversification with nutrition-sensitive strategies addressing poverty, food insecurity, education, and water and sanitation. Prioritizing interventions during the critical first 1000 days of life, while simultaneously addressing the broader social determinants of malnutrition, is essential for achieving meaningful and sustainable reductions in childhood undernutrition.

References

1. Black RE, Victora CG, Walker SP, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013;382(9890):427-451. DOI: 10.1016/S0140-6736(13)60937-X
2. Bhutta ZA, Berkley JA, Bandsma RHJ, et al. Severe childhood malnutrition. *Nat Rev Dis Primers*. 2017;3:17067. DOI: 10.1038/nrdp.2017.67
3. Grantham-McGregor S, Cheung YB, Cueto S, et al. Developmental potential in the first 5 years for children in developing countries.

- Lancet*. 2007;369(9555):60-70. DOI: 10.1016/S0140-6736(07)60032-4
4. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. 2008;371(9608):243-260. DOI: 10.1016/S0140-6736(07)61690-0
5. UNICEF, WHO, World Bank Group. Levels and trends in child malnutrition: UNICEF/WHO/World Bank Group Joint Child Malnutrition Estimates. 2021. Available from: <https://data.unicef.org/resources/jme-report-2021/>
6. Headey D, Heidkamp R, Osendarp S, et al. Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. *Lancet*. 2020;396(10250):519-521. DOI: 10.1016/S0140-6736(20)31647-0
7. UNICEF. UNICEF's approach to scaling up nutrition for mothers and their children. Discussion paper. Programme Division, UNICEF. New York; 2015. Available from: <https://www.unicef.org/nutrition>
8. Stewart CP, Iannotti L, Dewey KG, et al. Contextualising complementary feeding in a broader framework for stunting prevention. *Matern Child Nutr*. 2013; 9(Suppl 2):27-45. DOI: 10.1111/mcn.12088
9. Victora CG, de Onis M, Hallal PC, et al. Worldwide timing of growth faltering: revisiting implications for interventions. *Pediatrics*. 2010;125(3):e473-e480. DOI: 10.1542/peds.2009-1519
10. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. *Paediatr Int Child Health*. 2014; 34(4):250-265. DOI: 10.1179/2046905514Y.0000000158
11. Martorell R, Zongrone A. Intergenerational influences on child growth and undernutrition. *Paediatr Perinat Epidemiol*. 2012;26(Suppl 1):302-314. DOI: 10.1111/j.1365-3016.2012.01298.x
12. De Onis M, Branca F. Childhood stunting: a global perspective. *Matern Child Nutr*. 2016; 12(Suppl 1):12-26. DOI: 10.1111/mcn.12231
13. Bhutta ZA, Das JK, Rizvi A, et al. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet*. 2013;382(9890):452-477. DOI: 10.1016/S0140-6736(13)60996-4
14. Ruel MT, Alderman H; Maternal and Child Nutrition Study Group. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet*. 2013;382(9891):536-551. DOI: 10.1016/S0140-6736(13)60843-0
15. De Onis M, Blössner M, Borghi E. Prevalence and trends of stunting among pre-school children, 1990-2020. *Public Health Nutr*. 2012;

- 15(1):142-148. DOI: 10.1017/S1368980011001315
16. De Onis M, Borghi E, Arimond M, et al. Prevalence thresholds for wasting, overweight and stunting in children under 5 years. *Public Health Nutr.* 2019;22(1):175-179. DOI: 10.1017/S1368980018002434
 17. Akombi BJ, Agho KE, Hall JJ, et al. Stunting and severe stunting among children under-5 years in Nigeria: A multilevel analysis. *BMC Pediatr.* 2017;17(1):15. DOI: 10.1186/s12887-016-0770-z
 18. Leroy JL, Ruel M, Habicht JP, et al. Linear growth deficit continues to accumulate beyond the first 1000 days in low- and middle-income countries: global evidence from 51 national surveys. *J Nutr.* 2014;144(9):1460-1466. DOI: 10.3945/jn.114.191981
 19. Olofin I, McDonald CM, Ezzati M, et al. Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: a pooled analysis of ten prospective studies. *PLoS One.* 2013;8(5):e64636. DOI: 10.1371/journal.pone.0064636
 20. Egata G, Berhane Y, Worku A. Seasonal variation in the prevalence of acute undernutrition among children under five years of age in east rural Ethiopia: a longitudinal study. *BMC Public Health.* 2013;13:864. DOI: 10.1186/1471-2458-13-864
 21. Semba RD, de Pee S, Sun K, et al. Effect of parental formal education on risk of child stunting in Indonesia and Bangladesh: a cross-sectional study. *Lancet.* 2008;371(9609):322-328. DOI: 10.1016/S0140-6736(08)60169-5
 22. Frost MB, Forste R, Haas DW. Maternal education and child nutritional status in Bolivia: finding the links. *Soc Sci Med.* 2005; 60(2):395-407. DOI: 10.1016/j.socscimed.2004.05.010
 23. Ali D, Saha KK, Nguyen PH, et al. Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity. *J Nutr.* 2013; 143(12):2015-2021. DOI: 10.3945/jn.113.175182
 24. Ruel MT, Garrett JL, Hawkes C, et al. The food, fuel, and financial crises affect the urban and rural poor disproportionately: a review of the evidence. *J Nutr.* 2010;140(1):170S-176S. DOI: 10.3945/jn.109.110791
 25. Dewey KG, Adu-Afaruwah S. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Matern Child Nutr.* 2008;4(Suppl 1):24-85. DOI: 10.1111/j.1740-8709.2007.00124.x
 26. Victora CG, Bahl R, Barros AJ, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *Lancet.* 2016;387(10017):475-490. DOI: 10.1016/S0140-6736(15)01024-7
 27. Guerrant RL, DeBoer MD, Moore SR, et al. The impoverished gut—a triple burden of diarrhoea, stunting and chronic disease. *Nat Rev Gastroenterol Hepatol.* 2013;10(4):220-229. DOI: 10.1038/nrgastro.2012.239
 28. Checkley W, Buckley G, Gilman RH, et al. Multi-country analysis of the effects of diarrhoea on childhood stunting. *Int J Epidemiol.* 2008;37(4):816-830. DOI: 10.1093/ije/dyn099
 29. Christian P, Lee SE, Donahue Angel M, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. *Int J Epidemiol.* 2013;42(5):1340-1355. DOI: 10.1093/ije/dyt109.