Original Article

Effects of socio-economic and behavioural factors on childhood malnutrition in Yemen

T.S. Sunil*Department of Sociology, University of Texas at San Antonio, One UTSA Circle, San Antonio, Texas, USA***Abstract**

This study examined the effects of socio-economic and behavioural factors on childhood malnutrition in Yemen. The three anthropometric indicators such as height-for-age, weight-for-height and weight-for-age are used to examine the nutritional status of children aged less 5 years in Yemen. The independent variables include background characteristics, behavioural risk factors and illness characteristics. Data for the study come from the most recent Yemen Demographic and Health Survey, a nationally representative sample, conducted in Yemen in 1997. Logistic regression analysis is used to estimate the odds of being malnourished. The three anthropometric indicators show high to very high levels of child malnutrition in Yemen. The prevalence of stunting and underweight is so widespread that almost every other child under the age of 5 is either stunted or underweight. Social, economic and behavioural factors show very significant association with childhood malnutrition. The study results indicate the importance of social and behavioural factors in describing childhood malnutrition in Yemen. The study results will help develop nutritional and health promotion policies in order to improve childhood malnutrition in this country.

Keywords: malnutrition, childhood, Yemen, *qat*, smoking, socio-economic status.

Introduction

The nutritional level in children is a vital component to their survival and development in their early years

Correspondence: Thankam S. Sunil, Department of Sociology, University of Texas at San Antonio, One UTSA Circle, San Antonio, TX 78249, USA. E-mail: thankam.sunil@utsa.edu

(Waterlow *et al.* 1977; Jensen & Ahlburg 1998). Low levels of nutrition among children cause serious long- and short-term consequences in their physical and mental growth. Studies report high levels of mortality among malnourished children (Pelletier *et al.* 1993). Further, malnourished children are more likely to have functional impairment in adult life [World Health Organization (WHO) 1999a], leading to a

reduction in productive life and thus affecting the overall economic productivity of the society (de Onis *et al.* 2000). For example, it is widely accepted that adults who survive malnutrition as children are more likely to suffer from higher levels of chronic illness and disability (UNICEF 1998; Smith & Haddad 2000). Recent estimates show that 'more than 200 million children under 5 years fail to reach their potential in cognitive development because of poverty, poor health and nutrition, and deficient care' (Grantham-McGregor *et al.* 2007, p. 60).

Improved child health and survival are considered universal humanitarian goals. In this regard, understanding nutritional status of children has far-reaching implications for the better development of future generations (Chen *et al.* 1980; Pelletier 1994). Despite the vast amount of knowledge we have today on the importance of childhood nutrition, malnutrition levels are still alarmingly high around the world, particularly in developing countries (de Onis *et al.* 2000; WHO 2000). A recent report by UNICEF estimated that about 146 million children under 5 years of age are underweight in the developing world (UNICEF 2006). It was also reported that undernutrition contributes to the deaths of about 5.6 million children each year.

A number of studies have shown the importance of socio-economic factors on the study of childhood malnutrition (Gwatkin *et al.* 2000; El-Ghannam 2003; Bloss *et al.* 2004). However, little is available in the literature regarding the nutritional status of children in many developing countries, including Yemen. In the present study, we analysed nationally representative data collected in Yemen to understand the effects of socio-economic and behavioural factors on childhood malnutrition in the Republic of Yemen.

Data and methods

The data for the study come from the Demographic and Health Survey conducted in Yemen in 1997. The Yemen Demographic and Maternal and Child Health Survey (YDMCHS) is the second national survey conducted in Yemen since the unification of the country. The YDMCHS-1997 was designed to collect data on households and ever-married women of

reproductive age (15–49). This survey interviewed 10 414 of the 11 158 eligible ever-married women in the age group 15–49 years [Central Statistical Organization (CSO) (Yemen) and Macro International Inc. (MI) 1998]. Responses from the 'Maternal and Child Health Questionnaire' module are used in the present study.

Three dependent variables, namely height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ), are used in the present study. These indicators measure both long-term and short-term nutritional status of children in any given society (WHO 2000). For example, HAZ (or stunting) is a measure of linear growth retardation and indicates the chronic malnutrition in children, WHZ (or wasting) indicates the acute level of malnutrition or the current nutritional status of children, and WAZ (or underweight) is a composite measure that indicates both acute and chronic malnutrition in children. WHO recommends that a child's height and weight be standardized using the median and SD of an international reference standard of children of the same sex and age (Dibley *et al.* 1987). Children whose values (height-for-age, weight-for-height or weight-for-age) are below -2 SD from the median of the reference population (United States) are considered malnourished. The values are calculated using the *Epiinfo* software. This program transforms the international growth reference curves into a Z-score representation. Smoothed normalized curves are fitted by polynomial normalized regression and cubic spline techniques, and these curves are used to calculate all other normalized Z-score values. The dependent variables are coded 1 if the Z-score is less than -2 SD and coded 0 if the Z-score is -2 or higher.

The independent variables comprised of region, place of residence, age of the child (in months), sex of the child, illness conditions (has fever or has diarrhoea), age of the mother at the time of birth, educational level of the mother, socio-economic status (SES), number of prenatal care visits, smoking status of the mother and chewing *qat* during pregnancy. These variables represent the basic and underlying conditions that affect the nutritional status of children. Prior studies have reported that risk-taking behaviours and illness characteristics (Yassin 2000; Rao *et al.* 2004; Zottarelli *et al.* 2007) of the mother

were significant in understanding the variation in nutritional levels in children. In the present study, we used all children in the household aged less than 5 years. Chi-square technique was used to test the significant association between the dependent variables and independent variables. We also used Cramer's *V* statistic to test the association between the independent variables. Logistic regression analysis is used for the estimation of the odds of being malnourished. For each dependent variable, logistic regression analysis was conducted with all the independent variables mentioned above. Interaction effect between selected independent variables was also tested and did not find any statistical significance. However, the results should be interpreted with caution due to confounding nature of variables used in the model. The statistical analysis was performed using SAS 9.1 statistical software for Windows (SAS Inc. 2006).

Results

Table 1 presents the percentage distribution of children aged less than 5 years who are below -2 SD units for the three anthropometric measures (HAZ, WHZ and WAZ) according to selected socio-economic and behavioural characteristics. Overall, all of the indicators show high to very high levels of child malnutrition in Yemen. Chronic levels of malnutrition (or stunting) are higher in the mountainous region (58.8%) and in rural areas (55.8%). Similar trends are observed in the case of percentage of children who are born underweight. However, levels of acute malnutrition (or wasting) in children were higher in coastal areas compared WITH other parts of the country. All the indicators of malnutrition show that in general, the percentage of children with malnutrition decreases as mother's education and social and economic condition increases. Higher percentage of malnourished children was also born to mothers who smoked cigarettes during pregnancy.

To test the association between the independent variables, we used Cramer's *V* statistic. Results are presented in Table 2. In general, the level of association ranges from weak to moderate between independent variables.

Table 3 presents the results from the logistic regression analysis for the three indicators of malnutrition. The dependent variables are coded 1 if the value falls below -2 SD units and coded 0 otherwise. In other words, the variable gets a value 1 if the child is malnourished and 0 otherwise.

Stunting

Most of the variables used in the model are found to be statistically significant at $P < 0.05$. Children living in coastal areas have lower odds of being malnourished compared with children living in other parts of the country. Similarly, children born in urban areas of Yemen have lower odds [odds ratio (OR) = 0.74; $P < 0.001$; 95% confidence interval (CI) = 0.65–0.86] of being malnourished compared with their rural counterparts. The odds of being stunted, in general, increases as age progresses. Illness variables such as a recent incidence of diarrhoea take a toll on the nutritional status on the children. For example, children who had diarrhoea have higher odds (OR = 1.25; $P < 0.05$; 95% CI = 1.10–1.41) of being stunted as compared with children who did not have diarrhoea recently.

In addition to the illness variables, social and economic factors are also statistically significant in explaining the odds of children being chronically malnourished. Mothers with some basic education have an advantage over mothers with no education with respect to the levels of stunting in their children (OR = 0.81; $P < 0.001$; 95% CI = 0.70–0.95). The odds of being stunted decreases with an increase in the SES of the mother. Low SES increases the odds of being stunted by 1.7 ($P < 0.001$; 95% CI = 1.45–1.99), and this is 1.73 times higher among mothers living in medium SES ($P < 0.001$; CI = 1.51–1.99) compared with mothers living in high socio-economic status.

In the present study, we included three behavioural variables (number of prenatal visits, smoking status and chewing *qat*¹ during pregnancy). Children of

¹*Qat* is a leafy narcotic from the *Catha edulis* tree, which is widely consumed in many Middle Eastern and North African countries. Some statistics report that people spend about one-quarter to one-third of their cash income on *qat* (Khalis 1993).

Table 1. Percentage distribution of nutritional status of children by background characteristics (Yemen 1997)*

Characteristics	HAZ	WHZ	WAZ	Unweighted sample
Region				
Coastal	42.0	20.1	46.0	1920
Mountainous	58.8	12.9	52.1	1748
Plateau	52.9	9.4	43.2	3815
Place of residence				
Urban	40.3	10.4	35.6	2231
Rural	55.8	13.7	49.9	5252
Age				
0–5	16.4	10.9	12.9	906
6–11	33.1	18.9	41.8	1040
12–23	60.8	19.2	54.8	1540
24–35	58.0	10.4	53.4	1430
36–47	62.2	9.0	51.0	1297
48–59	64.7	8.3	50.8	1270
Sex of the child				
Male	52.3	13.7	47.0	3852
Female	51.0	12.0	45.2	3649
Has fever				
Yes	51.0	16.2	49.8	2941
No	52.1	10.7	43.8	4538
Had diarrhoea recently				
Yes	53.1	17.3	51.9	2060
No	51.2	11.2	44.0	5436
Age of mother at birth				
Less than 20 years	54.7	11.3	47.3	1115
20–29 years	51.7	12.8	45.5	3871
30 and above	50.4	13.7	46.5	2515
Mother's education				
Illiterate	54.3	13.4	48.5	5987
Literate	47.0	12.6	39.5	528
Primary	41.6	9.2	36.0	598
Preparatory	30.5	10.7	34.3	174
Secondary and above	18.5	7.9	19.1	233
Socio-economic status				
Low	57.0	15.7	52.7	2502
Medium	56.5	12.5	48.5	2540
High	38.9	9.7	34.5	2412
Number of prenatal visits				
0	55.2	13.5	50.0	4604
1–3	49.9	11.9	42.0	1833
4+	38.6	11.3	35.9	992
Smoked during pregnancy				
Yes	57.5	14.9	53.6	1536
No	50.2	12.4	44.2	5945
Chewed <i>qat</i> during pregnancy				
Yes	50.2	12.4	44.2	6099
No	57.6	14.9	53.6	1368
Total	51.7	12.9	46.1	7483

HAZ, height-for-age; WHZ, weight-for-height; WAZ, weight-for-age; *chi-square test is used (all variables are significant at $P < 0.05$).

Table 2. Association between independent variables using Cramer's V statistic

	Region	Place of residence	Age of the child	Sex of the child	Has fever	Had diarrhoea recently	Age of the mother at birth	Mother's education	SES	Number of PNC visits	Smoked during pregnancy	Chewed <i>qat</i> during pregnancy
Region	–											
Place of residence	0.316*	–										
Age of the child	0.044*	0.034	–									
Sex of the child	0.019	0.001	0.023	–								
Has fever	0.069*	0.03	0.123*	0.031*	–							
Had diarrhoea recently	0.077*	0.049	0.206*	0.039*	0.328*	–						
Age of the mother at birth	0.031	0.041	0.032	0.018	0.034**	0.023	–					
Mother's education	0.188*	0.337*	0.024	0.002	0.037*	0.042*	0.211*	–				
SES	0.228*	0.542*	0.042*	0.014	0.085*	0.085*	0.017	0.34*	–			
Number of PNC visits	0.146*	0.368*	0.037**	0.014	0.013	0.028**	0.02	0.338*	0.244*	–		
Smoked during pregnancy	0.196*	0.041*	0.028	0.012	0.084*	0.065*	0.079*	0.134*	0.171*	0.1*	–	
Chewed <i>qat</i> during pregnancy	0.202*	0.082*	0.045**	0.005	0.112*	0.071*	0.102*	0.155*	0.21*	0.115*	0.554*	–

SES, socio-economic status; PNC, prenatal care; * $P < 0.001$; ** $P < 0.05$.

mothers who smoked cigarettes and chewed *qat* during pregnancy have a higher odds of being stunted. The odds are 1.23 ($P < 0.05$; 95% CI = 1.05–1.43) and 1.19 ($P < 0.05$ and 95% CI = 1.05–1.36) times higher, respectively, among these children.

Wasting

Among all the variables included in the model, illness variables and socio-economic and educational status of the mother were found to be important in describing the odds of wasting in children in Yemen. The odds of wasting (or acute malnutrition) was twice higher in the coastal region (OR = 2.45, $P < 0.001$; 95% CI = 2.07–2.91) and 1.12 times higher in the mountainous region ($P < 0.05$) as compared with the plateau region. Similar to the odds of stunting, wasting is somewhat lower in urban areas compared with rural areas (OR = 0.94; $P < 0.05$; 95% CI = 0.75–1.16). Illness factors such as recent incidences of fever or diarrhoea have higher odds of children being stunted than their counterparts. Similarly, mothers with some education have lower odds of their children being wasted, which is 0.84 times compared with mothers with no education ($P < 0.001$; 95% CI = 0.67–1.05). Odds of acute malnutrition in children decreases with an increase in the SES of the mother ($P < 0.001$). Behavioural factors such as smoking and chewing *qat* are not found to be significant in the presence of other variables.

Underweight

Underweight is a reflection of both chronic and acute malnutrition in the society. Regarding children being born underweight, the odds are higher in the coastal region (OR = 1.14, $P < 0.001$; 95% CI = 1.01–1.3) as compared with children born in the plateau region. The odds of children being underweight is also lower among urbanites (OR = 0.8, $P < 0.001$; 95% CI = 0.69–0.92) and mothers with some education (OR = 0.79, $P < 0.01$; 95% CI = 0.68–0.92). Illness factors such as incidences of fever (OR = 1.12, $P < 0.001$; 95% CI = 1.00–1.25) and diarrhoea (OR = 1.31, $P < 0.05$; 95% CI = 1.17–1.48) have higher odds of children being underweight. In addition, the odds of being underweight decreases with increase in SES of the

Table 3. Multivariate logistic regression analysis for HAZ, WHZ and WAZ

Characteristics	HAZ		WHZ		WAZ	
	OR	CI	OR	CI	OR	CI
Region						
Coastal	0.61	0.54–0.70	2.45	2.07–2.91	1.14	1.01–1.30
Mountainous	1.01	0.89–1.16	1.12	0.92–1.35	1.10	0.97–1.25
Plateau						
Place of residence						
Urban	0.74	0.65–0.86	0.94	0.75–1.16	0.80	0.69–0.92
Rural						
Age						
0–5	0.09	0.07–0.11	1.24	0.92–1.68	0.12	0.09–0.15
6–11	0.22	0.19–0.27	2.45	1.87–3.20	0.60	0.50–0.71
12–23	0.77	0.65–0.91	2.53	1.97–3.25	1.05	0.90–1.23
24–35	0.70	0.59–0.82	1.28	0.97–1.68	1.02	0.87–1.20
36–47	0.88	0.74–1.05	1.09	0.82–1.45	0.97	0.83–1.15
48–59						
Sex of the child						
Male	0.92	0.83–1.01	0.89	0.77–1.02	0.93	0.84–1.02
Female						
Has fever						
Yes	0.90	0.80–1.01	1.32	1.13–1.53	1.12	1.00–1.25
No						
Had diarrhoea recently						
Yes	1.25	1.10–1.41	1.19	1.01–1.40	1.31	1.17–1.48
No						
Age of mother at birth						
Less than 20 years	1.22	1.04–1.43	0.94	0.75–1.18	1.12	0.96–1.32
20–29 years	1.11	0.99–1.24	0.97	0.83–1.14	1.01	0.91–1.13
30 and above						
Mother's education						
No education						
Some education	0.81	0.70–0.95	0.84	0.67–1.05	0.79	0.68–0.92
Socio-economic status						
Low	1.70	1.45–1.99	1.44	1.14–1.81	1.59	1.36–1.85
Medium	1.73	1.51–1.99	1.27	1.00–1.57	1.46	1.27–1.67
High						
Number of prenatal visits						
0	1.25	1.05–1.48	1.15	0.90–1.48	1.27	1.08–1.51
1–3	1.23	1.03–1.47	1.06	0.81–1.37	1.09	0.91–1.29
4+						
Smoked during pregnancy						
Yes	1.23	1.05–1.43	0.93	0.75–1.15	1.20	1.01–1.39
No						
Chewed <i>qat</i> during pregnancy						
Yes	1.19	1.05–1.36	0.97	0.81–1.17	1.14	1.00–1.30
No						
Constant	1.31		0.05		0.65	

HAZ, height-for-age; WHZ, weight-for-height; WAZ, weight-for-age; OR, odds ratio; CI, confidence interval.

mother (OR decreased from 1.59 for low SES to 1.46 for medium SES; $P < 0.001$). Children born to mothers who never had prenatal visits to a clinic or hospitals have higher odds (OR = 1.20, $P < 0.05$; 95% CI = 1.08–

1.51) of being underweight as compared with children born to mothers who had four or more prenatal visits. Other behavioural factors such as smoking (OR = 1.2, $P < 0.001$; 95% CI = 1.01–1.39) and chewing of *qat*

(OR = 1.4, $P < 0.001$; 95% CI = 1.00–1.30) during pregnancy have statistically significant higher odds of children being underweight as compared with their respective counterparts.

Discussion

Although the relationship between socio-economic and behavioural factors and childhood malnutrition has been widely established in the literature, there are not many studies published on Yemen. According to the World Bank classification of countries, Yemen is one of the poorest countries in the world, with a GDP per capita income of US \$930. In 2005, the United Nations Development Programme (UNDP) ranked Yemen 153 out of 177 in the list of countries based on the Human Development Index (UNDP 2007).

While the estimates show a decline in malnutritional levels in developing countries in the last two decades, conditions are still poor in Yemen (de Onis *et al.* 2000). The most recent available estimates show that the malnutritional levels are exceedingly high in Yemen. Most alarmingly, the high prevalence of stunting and underweight signifies a public health problem. The prevalence of stunting and underweight is so widespread that almost every other child under the age of 5 is either stunted or underweight. In the present study, I have considered basic and underlying conditions that affect the nutritional status of children in Yemen. These conditions include socio-economic conditions and behavioural risk factors of the mother and illness characteristics of the child. Although I did not find any statistically significant interaction between the predictor variables, the non-significance of predictor variables in the multivariate analysis may suggest confounding of variables in the model.

The study results have made four important contributions towards our understanding in childhood malnutrition in Yemen. First, the study results showed the differentials and disparity in prevalence of stunting, wasting and underweight in children in Yemen. For example, while coastal areas of Yemen have the highest prevalence of wasting in children, mountainous regions have the highest prevalence of chronic malnutrition (or stunting) and underweight in children. The urban/rural differentials in child malnutri-

tion are also significant for policy developments. Studies have shown that wasting in children is often associated with childhood morbidity conditions (Martorell *et al.* 1994; Adair & Guilkey 1997). Although this is not directly reflected in the present study, more detailed information is needed to further substantiate this evidence.

Second, as discussed in the previous studies, social and economic conditions have a significant role in describing the nutritional status of the children in a society (Wagstaff & Watanabe 2000; Van de Poel *et al.* 2008). SES was one of the variables found to be significant across all three indicators of malnutrition. These conditions serve both as protective and preventive factors in dealing with malnutrition in children. For example, improving educational levels of women not only empower them with better opportunities and advanced knowledge skills, but also prevent them from making poor decisions on all aspects of life. Studies have shown that women's education has far reaching effect on family size (Weinberger *et al.* 1989; Martin 1995), improving child health and reducing infant mortality (Tulasidhar 1993; Sandiford *et al.* 1995; Kravdal 2004). This clearly establishes the importance of social developmental policies, particularly related to improving childhood education.

Studies on Yemen that focus on illness factors in children and the effects on their nutritional status are few and far between. This study's results show that recent incidences of fever and diarrhoea contributed to higher odds of stunting, wasting and being underweight in children. As pointed out in other studies (Forste 1998; WHO 1999b), illnesses such as diarrhoea and fever in children commonly occur in their early years of life when immunocompetence is impaired and they are exposed to various disease pathogens for the first time. This will lead to suppression of appetite and thus poor consumption of nutritional food, which in turn increases the risk of prolonged and recurrent diarrhoea (Marino 2007; Walker & Black 2007). In particular, diarrhoea is the leading cause of malnutrition in developing countries, which has a direct effect on the risk of childhood mortality from other diseases and interferes with their physical growth and mental development. While simple treatments such as oral rehydration therapy

(ORT) are widely used in controlling diarrhoea in many developing countries (WHO 1999b), the knowledge of ORT and recommended home fluids (RHF)² among mothers in Yemen is found to be very weak. The 1997 Yemen Demographic and Health Survey reported that among children with diarrhoea in the last 2 weeks prior to the survey, 35.4% of the children neither received ORS nor RHF nor increased fluids during the period [CSO (Yemen) and MI 1998].

Finally, it is important to note the effects of behavioural risk factors on childhood malnutrition in Yemen. I used three variables to reflect the behavioural characteristics – the number of prenatal visits to clinics/hospitals, smoking cigarettes and chewing *qat* during pregnancy. All three variables are found to be significant in describing the odds of children being stunted and underweight, but less so in describing wasting in children. While studies on malnutrition widely discussed about the importance of prenatal care and the effects of smoking on the nutritional status of children (Best *et al.* 2007; Semba *et al.* 2007), the consumption of *qat* and its effects on children has not received much attention in the nutrition literature, given the fact that more than one-third (38.2%) of the women reported that they chewed *qat* during pregnancy. While chewing *qat* is a social and cultural tradition deep-rooted in this society, its harmful effects on health are not thoroughly researched.

In sum, childhood malnutrition is a major public health concern in Yemen. Measuring the weight and height of the child actually measures much more than a single child – these measure the future of a country. Child health has a prominent role in shaping and defining the structure of a society. It shapes the quality of future human capital, helps population stabilization and furthers future economic growth, among other factors. The ways and means to control this health problem should be the priority of the government in order to build a productive and healthy future generation. In addition, international agencies such as the WHO, UNICEF, etc., must further extend and provide adequate resources to support and encourage ongoing efforts of the local agencies and the government to address this public health problem.

²Homemade sugar–salt–water solution.

Source of funding

None.

Conflicts of interest

None declared.

Key messages

- Child health has a prominent role in shaping and defining the structure of a society. It shapes the quality of future human capital, helps population stabilization and furthers future economic growth, among other factors.
- The prevalence of stunting and underweight is so widespread that almost every other child under the age of 5 is either stunted or underweight in Yemen.
- The consumption of *qat* and its effects on children has not received much attention in the nutrition literature, given the fact that more than one-third (38.2%) of the women reported that they chewed *qat* during pregnancy. While chewing *qat* is a social and cultural tradition deep-rooted in this society, its harmful effects on health are not thoroughly researched.
- The ways and means to control this health problem should be the priority of the government in order to build a productive and healthy future generation.

References

- Adair L.S. & Guilkey D.K. (1997) Age-specific determinants of stunting in Filipino children. *Journal of Nutrition* **127**, 314–320.
- Best C.M., Sun K., de Pee S., Bloem M.W., Stallkamp G. & Semba R.D. (2007) Parental tobacco use is associated with increased risk of child malnutrition in Bangladesh. *Nutrition* **23**, 731–738.
- Bloss E., Wainaina F. & Bailey R.C. (2004) Prevalence and predictors of underweight, stunting and wasting among children aged 5 and under in Western Kenya. *Journal of Tropical Pediatrics* **50**, 260–270.
- Central Statistical Organization (CSO) (Yemen) & Macro International Inc. (MI) (1998) *Yemen Demographic and Maternal and Child Health Survey 1998*. CSO and MI: Calverton, MD.
- Chen L.C., Chowdhury A.A.K.M. & Huffman S.L. (1980) Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool aged children. *American Journal of Clinical Nutrition* **33**, 1836–1845.
- Dibley M.J., Goldsby J.B., Staehling N.W. & Trowbridge F.L. (1987) Development of normalized curves for the international growth reference: historical and technical considerations. *American Journal of Clinical Nutrition* **46**, 736–748.

- El-Ghannam A.R. (2003) The global patterns of child malnutrition and mortality in different world regions. *Journal of Health and Social Policy* **16**, 1–19.
- Forste R. (1998) Infant feeding practices and child health in Bolivia. *Journal of Biosocial Science* **30**, 107–125.
- Grantham-McGregor S., Cheung Y.B., Cueto S., Glewwe P., Richter L., Strupp B. *et al.* (2007) Developmental potential in the first 5 years for children in developing countries. *Lancet* **369**, 60–70.
- Gwatkin D.R., Rustein S., Johnson K., Pande R. & Wagstaff A. (2000) *Socioeconomic Differences in Health, Nutrition, and Population in Kenya*. Report by HNP/ Poverty Thematic Group of The World Bank's Health and Population Advisory Service, Washington, DC.
- Jensen E. & Ahlburg D. (1998) *Within-Family Resource Pressures and Child Health in Indonesia, Korea and the Philippines*. East West Center: Honolulu, HI.
- Khalis S.S. (1993) QAT: a problem for Yemen. *Yemen Times (San'a)*, December 12–18, III: 49, 14.
- Kravdal O. (2004) Child mortality in India: the community-level effect of education. *Population Studies* **58**, 177–192.
- Marino D.D. (2007) Water and food safety in the developing world: global implications for the health and nutrition of infants and young children. *Journal of the American Dietetic Association* **107**, 1930–1934.
- Martin T.C. (1995) Women's education and fertility: results from 26 Demographic and Health Surveys. *Studies in Family Planning* **26**, 187–202.
- Martorell R., Khan K. & Schroeder D.G. (1994) Reversibility of stunting: epidemiological findings in children from developing countries. *European Journal of Clinical Nutrition* **48**, S45–S57.
- de Onis M., Frongillo E.A. & Blossner M. (2000) Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980. *Bulletin of World Health Organization* **78**, 1222–1229.
- Pelletier D.L. (1994) The potentiating effects of malnutrition on child mortality: epidemiological evidence and policy implications. *Nutrition News* **52**, 409–415.
- Pelletier D.L., Frongilli E.A. & Habicht J.P. (1993) Epidemiologic evidence for a potentiating effect of malnutrition on child mortality. *American Journal of Public Health* **83**, 1130–1133.
- Rao R., Ladusingh L. & Pritamjit R. (2004) Nutritional status of children in North-East India. *Asia Pacific Population Journal* **19**, 39–56.
- SAS (2006) *SAS Software*, Release 9.1. 2006. SAS Institute: Cary, NC.
- Sandiford P., Cassel J., Montenegro M. & Sanchez G. (1995) The impact of women's literacy on child health and its interaction with access to health services. *Population Studies* **49**, 5–17.
- Semba R.D., Kalm L.M., de Pee S., Ricks M.O., Sari M. & Bloem M.W. (2007) Paternal smoking is associated with increased risk of child malnutrition among poor urban families in Indonesia. *Public Health Nutrition* **10**, 7–15.
- Smith L. & Haddad N. (2000) *Overcoming Child Malnutrition in Developing Countries: Past Achievement and Future Choices*. 2000. International Food Policy Research Institute: Washington, DC.
- Tulasidhar V.B. (1993) Maternal education, female labor force participation and child mortality: evidence from the Indian census. *Health Transition Review* **3**, 177–190.
- UNICEF (1998) *The State of the World's Children 1994*. UNICEF: New York.
- UNICEF (2006) *The State of the World's Children 2007*. UNICEF: New York.
- United Nations Development Program (2007) *Human Development Report: Fighting Climate Change, Human Solidarity in a Divided World*. United Nations Development Program: New York.
- Van de Poel E., Hosseinpour A.R., Speybroeck N., Van Orti T. & Vega J. (2008) Socioeconomic inequality in malnutrition in developing countries. *Bulletin of the World Health Organization* **86**, 282–292.
- Wagstaff A. & Watanabe N. (2000) *Socioeconomic Inequalities in Child Malnutrition in the Developing World*. Population Policy Research Working Paper Series No. 2434. The World Bank, Washington DC.
- Walker C.F. & Black R.E. (2007) Micronutrients and diarrheal disease. *Clinical Infectious Disease* **45**, S73–S77.
- Waterlow J.C., Buzina R., Keller W., Lane J.M., Nichaman M.Z. & Tanner J.M. (1977) The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. *Bulletin of World Health Organization* **55**, 489–498.
- Weinberger M.B., Lloyd C. & Blanc A.K. (1989) Women's education and fertility: a decade of change in four Latin American countries. *International Family Planning Perspectives* **15**, 4–28.
- World Health Organization (WHO) (1999a) *A Critical Link. Interventions for Physical Growth and Psychological Development: A Review*. WHO: Geneva.
- World Health Organization (WHO) (1999b) *Removing Obstacles to Healthy Development. Report on Infectious Diseases*. WHO: Geneva.
- World Health Organization (WHO) (2000) *WHO Global Database on Child Growth and Malnutrition*. Department of Nutrition for Health Development, WHO: Geneva.
- Yassin K. (2000) Morbidity and risk factors of diarrheal diseases among under-five children in rural upper Egypt. *Journal of Tropical Pediatrics* **46**, 282–287.
- Zottarelli L.K., Sunil T.S. & Rajaram S. (2007) Influence of parental and socioeconomic factors on stunting in children under 5 years in Egypt. *Eastern Mediterranean Health Journal* **13**, 1330–1342.