Published in final edited form as:
Matern Child Health J. 2015 January ; 19(1): 217–226. doi:10.1007/s10995-014-1513-0.

Gendered Effects of Siblings on Child Malnutrition in South Asia: Cross-sectional analysis of Demographic and Health Surveys from Bangladesh, India, and Nepal

Anita Raj, PhD[1,2,3], **Lotus P McDougal, MPH**[1,2,4], and **Jay G Silverman, PhD**[1,2]

Anita Raj: anitaraj@ucsd.edu; Lotus P McDougal: lmcdouga@ucsd.edu; Jay G Silverman: jgsilverman@ucsd.edu

[1]Division of Global Public Health, Department of Medicine; University of California, San Diego School of Medicine, San Diego, CA, USA

[2]Center on Gender Equity and Health; University of California, San Diego, CA, USA

[3]Boston University School of Medicine/Boston Medical Center, Department of Medicine, Section of General Internal Medicine, Clinical Addiction Research and Education, Boston, MA, USA

[4]Joint Doctoral Program in Public Health (Global Health), San Diego State University/University of California, San Diego, San Diego, CA, USA

Abstract

Objective—This study examines the effects of number and sex of siblings on malnutrition of boys and girls under-5 in South Asia.

Methods—Cross-sectional analyses were conducted on Demographic and Health Surveys (DHS) data on children under-5 in Bangladesh (N=7,861), India (N=46,655) and Nepal (N=2,475). Data were pooled across countries, and multinomial logistic regression was used to assess the relationship between number and sex of siblings and malnutrition outcomes (wasting, stunting, underweight; based on anthropometric data), adjusting for country and key social and maternal-child health indicators in sex stratified analyses.

Results—Number of brothers increased the odds for severe wasting (1 versus 0 brothers adjusted odds ratio [AOR]= 1.31, 95% CI= 1.11, 1.55; 2 versus 0 brothers AOR= 1.36, 95% CI= 1.07, 1.73) for girls but not boys. Having more male siblings and more female siblings increased the odds of stunting for boys and girls, but effect of 3+ sisters on severe stunting was significantly stronger for girls than boys (girls- 3+ versus 0 sisters AOR= 2.25, 95% CI= 1.88, 2.70; boys- 3+ versus 0 sisters AOR= 1.37, 95% CI= 1.13, 1.67). For underweight, three or more sisters increased the odds for severe underweight for girls (AOR=1.27, 95% CI= 1.04, 1.57) but not boys.

Conclusion—Having brothers heightens girl risk for acute malnutrition (wasting), where having multiple sisters increases girl risk for chronic malnutrition (stunting/ underweight). Boy malnutrition is less affected by siblings. Findings suggest that issues of son preference/daughter aversion may affect child malnutrition in South Asia.

Corresponding Author Information: Anita Raj, PhD, 10111 N. Torrey Pines Rd., MC0507; Institute of the Americas, La Jolla, California 92093-0507, Phone: 858-822-0229, Fax: 858-534-7566, anitaraj@ucsd.edu, Webpage: http://gph.ucsd.edu/people/raj.shtml.

Keywords

child malnutrition; South Asia; girls; son preference

Globally, an estimated 165 million children under-5 years of age (26% of all under-5 children) are stunted, 52 million (8% of all under-5 children) are wasted, and 100 million (16% of all under-5 children) are underweight (1). Malnutrition accounts for 35–45% of deaths to children under-5, worldwide (2, 3). Children in South Asia are disproportionately at risk, with 37% stunted (short height for age), 15% wasted (less weight for height) and 30% underweight (less weight for age) (1). Poverty, rural residence, and family size are primary contributors to child malnutrition (1, 3, 4). Recommendations to alleviate the issue focus on improved access to nutritious food for mother and child, reduction in infectious disease, and maternal empowerment efforts (5). However, reduction of differential vulnerability of girls is also likely needed, at least in the context of South Asia, where 'son preference' (i.e., preferred treatment/opportunity for boys over girls) has been described extensively (6–10) and blamed for the millions of "missing" girls in the population (11, 12). Given the issue of son preference and the fact that South Asia is the only world region with higher under-5 mortality for girls than boys (13), gendered effects of siblings may be a factor in regional child malnutrition.

Research from South Asia and elsewhere document that greater numbers of siblings and later birth order increase risk for child malnutrition, particularly stunting (14–17), due to greater food insecurity in such contexts. Birth spacing also compromises risk for young children, with those born in close proximity (<2 years) to a prior birth being more vulnerable to stunting, though again, not wasting (16, 18–26). These sibling-related factors should be of equivalent concern for both boys and girls, but a recent study from rural India found that greater number of siblings affected girl but not boy malnutrition (27), suggesting that these factors should be reviewed more carefully by sex.

Nationally representative data from the region indicate little to no differentiation in feeding practices by sex (28) and the only sex difference in malnutrition rates is boys' greater risk for wasting than girls (29, 30). Studies from India do, however, indicate that boys are less likely than girls to be stunted when all older living siblings are girls (i.e., when boys are in short supply), but more likely when all older siblings are boys (i.e., when girls are in short supply) (17, 29). These findings suggest a complexity where birth order and number and sex of siblings contribute to malnutrition differentially for boys and girls, and more in situations of acute rather than chronic malnutrition (i.e., stunting rather than wasting). Prior analyses, however, were restricted to India and used data that are now more than a decade old. Thus, the purpose of this study is to examine associations of sibling indicators (birth order, birth spacing between siblings, and number and sex of siblings) and under-5 malnutrition, and whether these associations are similar for boys and girls in South Asia.

Methods

Data source and sample

This analysis used data from the most recent Demographic and Health Surveys (DHS) in Bangladesh (2011), India (2005–06) and Nepal (2011). The DHS are nationally-representative, two-stage, stratified sample surveys designed to collect standardized information on population health and nutrition (31). These countries were selected based on their very high rates of child malnutrition (1), documented son preference and its effect on child survival (28, 32), and availability of a standard DHS completed in 2005 or later that included anthropometric data (i.e., height and weight measurement) for children under-5. As part of the DHS, individual interviews were conducted with women of reproductive age in selected households, and all children under-5 years of age living in the selected households were eligible to have height and weight measurements taken (33–35). Eligible women response rates were over 94% in all countries. This analysis utilized data from children under-5 years of age living in selected households who provided valid anthropometric data (Bangladesh N=7,861; India N=46,655; Nepal N=2,475), and whose mothers were ever-married, and had completed an individual interview (Bangladesh n=7,639; India n=41,265; Nepal n=2,335). This sample therefore included 97% of children who had anthropometric measurements recorded in Bangladesh, 88% in India and 94% in Nepal- 90% of all available data from these countries. Ethical approval for survey design and implementation was obtained from Measure DHS and the respective host country. Ethical approval for this analysis was provided by the University of California, San Diego Institutional Review Board.

Measures

Child malnutrition was assessed by three indices: weight for height (wasting), height for age (stunting) and weight for age (underweight) and categorized as not present (≥-2 and ≤6 standard deviations from the median of the international reference population), moderate (<-2 and ≥-3 standard deviations from the median of the international reference population) or severe (<-3 and ≥ −6 standard deviations from the median of the international reference population (1, 36). Malnutrition measures are presented for the overall population, as well as sex stratified. Sibling factors included birth order of index child (firstborn, second, third or higher), duration of the preceding birth interval (<24 months vs. ≥24 months/firstborn; selected based on its association with low birth weight which can affect chronic malnutrition indicators) (1), and number of living brothers and, separately, number of living sisters of the index child (0,1,2,3+).

Covariates included indicators at the level of household, mother and child that have demonstrated an association with child malnutrition (1–3), to address potential confounders in the regression models. Household covariates were country, wealth quintile, (37) and urban/rural residence. Maternal covariates included maternal age at marriage (<18 years, ≥18 years), maternal age at birth of index child (≤17, 18–19, 20–24, 25–34 and 35–49), maternal education (categorized into none, any primary, any secondary or higher), and maternal body mass index (BMI). Maternal BMI was calculated only for women who were not currently pregnant and had not given birth within the past 2 months, and was categorized into severely thin (BMI<16) and not severely thin (BMI≥16) (38). Child-level covariates included sex, age (in years), and whether the index child reported diarrhea in the 2 weeks prior to the survey (yes/no).

Data Analysis

All outcome variables were nominal, with three categories (none, moderate and severe). Children under-5 years of age were the unit of analysis for all models. Data were pooled across countries, and multinomial logistic regression was used to assess the relationship between independent variables and malnutrition outcomes. All models violated the proportional odds assumption; therefore ordinal logistic regression was not appropriate. Each of the nine malnutrition outcomes had a separate multinomial model fitted using all covariates, with two exceptions: (1) sex of child was excluded from sex stratified analyses of malnutrition outcomes, and (2) age of child was excluded from stunting and underweight analyses, as it is included in the calculation of the outcome. No collinearity was present in any of the nine models using a tolerance cutoff of 0.30. Reduced models were then constructed through manual backwards elimination with a $p<0.10$ cutoff point; consequently, different models may have different covariates. Reduced models were used to create more parsimonious models given small cell sizes for some outcomes, particularly in the case of sex stratified analyses. All analyses were adjusted for complex survey design and weighted with individual weights that adjusted for country population sizes (31, 39). All analyses were conducted in SAS v 9.3.

Results

Across the samples from the three countries of focus, 11–20% of children under 5 suffered from wasting, 40–48% of children were stunted, and 29–43% were underweight. (See Table 1.) Children living in India consistently demonstrated the highest rates of wasting, stunting and underweight, but also included older data than Bangladesh or Nepal. Pooled analysis indicated lower likelihood of wasting but greater likelihood of severe underweight for girls than boys ($p<.05$).

Associations between Sibling Effects and Wasting based on Reduced Models

For moderate wasting, higher birth order (3+ position versus 1st child AOR= 1.14, 95% CI= 1.04, 1.25) increased risk, where shorter birth spacing was protective (AOR=0.90, 95% CI=.81, .99). (See Table 2.) For severe wasting, higher birth order increased risk (2nd position versus 1st child AOR= 1.15, 95% CI= 1.01, 1.32; 3+ position versus 1st child AOR= 1.27, 95% CI= 1.11, 1.45) but birth spacing was not significant. Number of siblings, regardless of sibling sex, had no effect, and thus, these variables were dropped from analyses.

In sex stratified analyses, later birth order and shorter birth spacing were protective against wasting for boys but not girls. For girls but not boys, number of brothers increased risk for severe wasting (1 versus 0 brothers AOR= 1.31, 95% CI= 1.11, 1.55; 2 versus 0 brothers AOR= 1.36, 95% CI= 1.07, 1.73). The variable 3+ versus 0 brothers showed no significant effect on severe wasting, but this was likely due to small number of participants with three or more brothers. Notably, covariates at the levels of household, maternal, and child levels were retained in final models to predict wasting, with the exception of age of mother at birth.

Associations between Sibling Effects and Stunting based on Reduced Models

Shorter birth spacing (AOR=1.10, 95% CI=1.01, 1.20), having more male siblings (1 versus 0 brothers AOR= 1.25, 95% CI= 1.16, 1.35; 2 versus 0 brothers AOR= 1.32, 95% CI= 1.17, 1.49; 3+ versus 0 brothers AOR= 1.51, 95% CI= 1.28, 1.79), and having more female siblings (1 versus 0 sisters AOR= 1.19, 95% CI= 1.10, 1.28; 2 versus 0 sisters AOR= 1.31, 95% CI= 1.16, 1.47; 3+ versus 0 sisters AOR= 1.32, 95% CI= 1.15, 1.52) increased risk for moderate stunting for the total sample. (See Table 3.) Similar results were seen for severe stunting. Covariates at the household and maternal levels, but not child level, were retained in final models to predict stunting. Unlike with wasting, these included age of mother at birth, with births to youngest mothers being at greatest risk for both moderate and severe stunting.

Sex stratified analyses to predict moderate and severe stunting yielded comparable effects for males and females to that seen for the total sample. However, effect of 3+ sisters on severe stunting was significantly stronger for girls than boys (girls- 3+ versus 0 sisters AOR= 2.25, 95% CI= 1.88, 2.70; boys- 3+ versus 0 sisters AOR= 1.37, 95% CI= 1.13, 1.67), based on magnitude of effect sizes and non-overlapping confidence intervals. Household and maternal level covariates were retained in the models.

Associations between Sibling Effects and Underweight based on Reduced Models

For the total sample, shorter birth spacing (AOR=1.08, 95% CI=1.00, 1.17), having more male siblings (1 versus 0 brothers AOR= 1.09, 95% CI= 1.02, 1.17; 2 versus 0 brothers AOR= 1.21, 95% CI= 1.08, 1.35), and having more female siblings (1 versus 0 sisters AOR= 1.15, 95% CI= 1.07, 1.23; 2 versus 0 sisters AOR= 1.18, 95% CI= 1.06, 1.31) increase risk for moderate underweight for the total sample. (See Table 4.) Similar results were seen for severe underweight, though there was a positive association seen in terms of effects on 3+ versus 0 brothers (AOR= 1.25, 95% CI= 1.05, 1.50) and sisters (AOR= 1.25, 95% CI= 1.05, 1.50), not seen for moderate underweight. Higher birth order (3+ position versus 1st born AOR=1.29, 95% CI= 1.10, 1.50) also was associated with severe, but not moderate, underweight for the total sample. Covariates at the levels of household, maternal, and child (notably diarrhea but not age of child) were retained in final models to predict stunting. Children born to the youngest mothers were again at greatest risk for both moderate and severe underweight.

Sex stratified analyses to predict moderate and severe underweight revealed that, of measured sibling effects, only birth order was associated with moderate underweight for boys (2nd position versus 1st born AOR= 1.22, 95% CI= 1.09, 1.35; 3+ position versus 1st born AOR= 1.46, 95% CI= 1.49, 1.65); comparable findings were seen for severe underweight in boys. For girls, birth spacing (AOR= 1.14, 95% CI= 1.02, 1.28) and effects for number of female siblings were seen on moderate underweight (1 versus 0 sisters AOR=1.19, 95% CI= 1.08, 1.31), as well as severe underweight (birth spacing AOR= 1.24, 95% CI= 1.09, 1.43; 3 versus 0 sisters AOR=1.27, 95% CI= 1.04, 1.57). Also among girls, higher birth order was associated with severe but not moderate underweight (3+ position versus 1st born AOR=1.46, 95% CI= 1.22, 1.75). Notably, for boys, household, maternal and child (again, only diarrhea) level covariates were retained in final models to predict underweight; for girls, only household and maternal level factors were retained as covariates.

Discussion

Findings from this study document the importance of gendered effects of siblings on child malnutrition in South Asia. For wasting, the form of malnutrition most likely to result in child mortality (40), higher birth order heightened risk where low birth spacing was protective, with no effects seen for number or sex of siblings. However, sex stratified analyses revealed that, though similar findings were retained for males, female wasting was more likely among girls with brothers. Such findings may be explained by preferential feeding or better hygiene (i.e., disease protection) of brothers as compared to their sisters, which may indicate lower value placed on girls. Protective aspects of low birth spacing against severe wasting for boys but not girls may also be indicative of preferential care of boys. Prior research in South Asia documents that non-use of contraception and subsequent low birth spacing are more likely in contexts where a boy child is desired (i.e., son preference) (41, 42). Preferential vaccination of boys has also been documented in India (43). Hence, for boys, previous low birth spacing may be a marker for son preference, and this may explain why it is protective against wasting for boys but not girls. Such gendered findings of sibling effects on wasting have not previously been identified, though similar findings have been seen for stunting in India, where boys were protected against stunting if born after girls (17, 29) but more vulnerable if born after boys (29). Notably, these findings did not hold true for stunting in the current analyses.

Stunting, both moderate and severe, is significantly more likely in the context of low birth spacing and greater number of siblings, regardless of sex of the siblings. Similar findings have been well documented in prior research (14–26), providing further support of the likely importance of contraception as a means of not only limiting family size and extending birth spacing, but also reducing child malnutrition in the region. Sex differences in sibling effects on stunting are less clear. As noted above, prior research from India suggests differential effects of number and sex of siblings on stunting (17, 27, 29). While this was largely not observed in current analyses, results did reveal that the effect of having three or more sisters on severe stunting was significantly stronger for girls than boys, and among girls, this effect was also stronger than that seen for having three or more brothers. Hence, being another girl in a household with many daughters poses greater risk for chronic malnutrition than that seen for boys with many sisters or brothers, or girls with many brothers. These findings are again consistent with prior research from India documenting greater desire for multiple sons but not multiple daughters (41).

Results related to underweight reflect similarities with those observed for stunting. Specifically, shorter birth spacing and greater number of brothers and sisters heighten risk for moderate and severe underweight, as does higher overall birth order. However, sex stratified analyses revealed that, for boys, only birth order remains a risk factor for underweight, where for girls, birth spacing and number of sisters heighten risk for this outcome.

As with stunting, girls with three or more sisters are at significantly greater risk for severe underweight, where no effect is seen for girls with brothers or boys with brothers or sisters. Again, similar to stunting, girls with a larger number of sisters are more vulnerable to malnutrition, suggesting that daughter aversion- i.e., the desire not to have daughters, as well as son preference, compromise girl health in South Asia, a finding seen in prior research from India (41, 42). These findings may help explain the higher child survival rates for boys relative to girls in India (13) and, relatedly, the sex ratio imbalance in that country (44). Such findings reinforce the importance of integrating gender empowerment efforts (e.g., improved education and economic opportunity for women and girls) with food security approaches to reduce child malnutrition in South Asia, and highlight the need for efforts to support the girls and increase norms of gender equity across children (5). Altering social norms related to son preference and daughter aversion may be very important to eliminate sex differences in sibling effects on malnutrition observed in the current study.

In addition to the hypothesized findings related to gendered effects of siblings on child malnutrition, they also document the importance of household and maternal equity indicators as contributors of risk. Consistent with prior research (1, 3, 4, 14–26), poverty, rural residence, low or no maternal education, and low maternal BMI were consistent risk factors for boys and girls. Importantly, however, this research clarifies that maternal vulnerabilities around pregnancy, such as young maternal age at pregnancy and, as noted earlier, low spacing between childbirths are a concern for chronic though not acute malnutrition, likely because these effects are markers for persistent nutritional and health risk, rather than short-term food insecurity or infectious disease. Such findings are consistent with prior research on maternal age at marriage and childbirth (45, 46), as well as research on other indicators of maternal and child vulnerability, such as spousal violence (11), which also was associated with stunting but not wasting (47, 48) as well as maternal malnutrition (49).

This study should be considered in light of certain limitations. Malnutrition indicators are subject to identifying individuals who may not malnourished but simply are genetically shorter or lower weight; the variables are none the less based on international definitions that have been linked to poor health outcomes and child mortality (1,2). Sibling variables did not ascertain age or household presence, and effects of non-sibling males in the context of joint families were not assessed as well. Data utilized were the most recent data available for countries of focus, but were not collected in identical timeframes. Covariates were designed to adjust for social inequities but were not able to include indicators of health care access for the child over the course of his/her life. Spousal violence, previously documented to be associated with stunting (47, 48) and survival (11), was unable to be included in analyses as these data were not available for all nations of focus. Data were pooled and cannot be assumed to be consistent with individual nations of focus; small cell sizes inhibit comparable nation-level analyses. All data sources are cross-sectional and observational, and therefore no attributions of causality can be made. Finally, DHS data are susceptible to social desirability and recall bias; the latter should be minimized due use of data on most recent births among births in the past 5 years.

Conclusion

Findings from this study document differential effects of siblings on child malnutrition for boys and girls in South Asia. Brothers confer increased risk for acute malnutrition of girls, and multiple sisters confer increased risk for girls being underweight and severe stunting. Presence of siblings had no effect on wasting or underweight for boys, and while more siblings increased risk for stunting among boys, sex of siblings did not produce differential effects. Sex differences in effects were also seen for inadequate spacing between births, with this factor being protective against wasting for boys but not girls, and heightening risk for underweight for girls but not boys. Results of this study suggest differential treatment and nutritional access for girls relative to boys based on number and sex of siblings may be occurring in South Asia, advantaging boys over girls. Programs to improve nutritional access may need to account for these gendered concerns to better address child malnutrition in the region.

References

1. United Nations Children's Fund WHO, The World Bank. UNICEF-WHO-World Bank Joint Child Malnutrition Estimates: Levels & Trends in Child Malnutrition. New York, Geneva, Washington DC: UNICEF, WHO, World Bank; 2012.
2. Liu L, Johnson HL, Cousens S, Perin J, Scott S, Lawn JE, et al. Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. Lancet. Jun 9; 2012 379(9832):2151–2161. [PubMed: 22579125]
3. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. Jun 6.2013
4. Bhutta ZA, Salam RA. Global nutrition epidemiology and trends. Ann Nutr Metab. 2012; (61 Suppl 1):19–27. [PubMed: 23343944]
5. World Health Assembly. Maternal, infant and young child nutrition: draft comprehensive implementation plan. Geneva: WHA; 2012.
6. Baqui AH, Sabir AA, Begum N, Arifeen SE, Mitra SN, Black RE. Causes of childhood deaths in Bangladesh: an update. Acta Paediatr. Jun; 2001 90(6):682–690. [PubMed: 11440104]
7. Silverman JG, Gupta J, Decker MR, Kapur N, Raj A. Intimate partner violence and unwanted pregnancy, miscarriage, induced abortion, and stillbirth among a national sample of Bangladeshi women. Bjog. Oct; 2007 114(10):1246–1252. [PubMed: 17877676]
8. Bates LM, Schuler SR, Islam F, Islam K. Socioeconomic factors and processes associated with domestic violence in rural Bangladesh. Int Fam Plan Perspect. Dec; 2004 30(4):190–199. [PubMed: 15590385]
9. Bhuiya A, Sharmin T, Hanifi SM. Nature of domestic violence against women in a rural area of Bangladesh: implication for preventive interventions. J Health Popul Nutr. Mar; 2003 21(1):48–54. [PubMed: 12751674]
10. Jain D, Sanon S, Sadowski L, Hunter W. Violence against women in India: evidence from rural Maharashtra, India. Rural and remote health. Oct-Dec;2004 4(4):304. [PubMed: 15887989]
11. Silverman JG, Decker MR, Cheng DM, Wirth K, Saggurti N, McCauley HL, et al. Gender-based disparities in infant and child mortality based on maternal exposure to spousal violence: the heavy burden borne by Indian girls. Arch Pediatr Adolesc Med. Jan; 2011 165(1):22–27. [PubMed: 21199976]

12. Koenig MA, Stephenson R, Ahmed S, Jejeebhoy SJ, Campbell J. Individual and contextual determinants of domestic violence in North India. Am J Public Health. Jan; 2006 96(1):132–138. [PubMed: 16317213]
13. UNICEF, World Health Organization, The World Bank, United Nations. Levels & Trends in Child Mortality: Report 2012. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. New York: UNICEF; 2012.
14. Mushtaq MU, Gull S, Khurshid U, Shahid U, Shad MA, Siddiqui AM. Prevalence and socio-demographic correlates of stunting and thinness among Pakistani primary school children. BMC Public Health. 2011; 11:790. [PubMed: 21988799]
15. Mondal N, Sen J. Prevalence of undernutrition among children (5–12 years) belonging to three communities residing in a similar habitat in North Bengal, India. Ann Hum Biol. Apr; 2010 37(2): 198–216. [PubMed: 19961351]
16. Zottarelli LK, Sunil TS, Rajaram S. Influence of parental and socioeconomic factors on stunting in children under 5 years in Egypt. Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit. Nov-Dec;2007 13(6): 1330–1342.
17. Pande RP. Selective gender differences in childhood nutrition and immunization in rural India: the role of siblings. Demography. Aug; 2003 40(3):395–418. [PubMed: 12962055]
18. Pathak P, Kapil U, Kapoor SK, Saxena R, Kumar A, Gupta N, et al. Prevalence of multiple micronutrient deficiencies amongst pregnant women in a rural area of Haryana. Indian J Pediatr. Nov; 2004 71(11):1007–1014. [PubMed: 15572822]
19. Dewey KG, Cohen RJ. Does birth spacing affect maternal or child nutritional status? A systematic literature review. Maternal & child nutrition. Jul; 2007 3(3):151–173. [PubMed: 17539885]
20. Basit A, Nair S, Chakraborthy K, Darshan B, Kamath A. Risk factors for under-nutrition among children aged one to five years in Udupi taluk of Karnataka, India: A case control study. The Australasian medical journal. 2012; 5(3):163–167. [PubMed: 22952561]
21. Kanani S, Popat K. Growing normally in an urban environment: positive deviance among slum children of Vadodara, India. Indian J Pediatr. May; 2012 79(5):606–611. [PubMed: 22218805]
22. Das S, Rahman RM. Application of ordinal logistic regression analysis in determining risk factors of child malnutrition in Bangladesh. Nutrition journal. 2011; 10:124. [PubMed: 22082256]
23. Gribble JN, Murray NJ, Menotti EP. Reconsidering childhood undernutrition: can birth spacing make a difference? An analysis of the 2002–2003 El Salvador National Family Health Survey. Maternal & child nutrition. Jan; 2009 5(1):49–63. [PubMed: 19161544]
24. Rutstein SO. Effects of preceding birth intervals on neonatal, infant and under-five years mortality and nutritional status in developing countries: evidence from the demographic and health surveys. Int JGynaecol Obstet. Apr.2005 (89 Suppl 1):S7–S24. [PubMed: 15820369]
25. Mostafa KS. Socio-economic determinants of severe and moderate stunting among under-five children of rural Bangladesh. Malaysian journal of nutrition. Apr; 2011 17(1):105–118. [PubMed: 22135870]
26. Subramanyam MA, Kawachi I, Berkman LF, Subramanian SV. Socioeconomic inequalities in childhood undernutrition in India: analyzing trends between 1992 and 2005. PLoS One. 2010; 5(6):e11392. [PubMed: 20617192]
27. Biswas S, Bose K. Effect of number of rooms and sibs on nutritional status among rural Bengalee preschool children from eastern India. Coll Antropol. Apr; 2011 35(4):1017–1022. [PubMed: 22397232]
28. Arnold, F. Gender Preferences for Children. Calverton, Maryland USA: Macro International Inc; 1997.
29. Mishra, V.; Roy, TK.; Retherford, RD. Honolulu, HI USA: Health Care and Nutritional Status in India; 2004.
30. ICF (Inner City Fund) International Inc. MEASURE DHS STATcompiler. [cited 2013 1 July]; Available from: www.statcompiler.com
31. ICF (Inner City Fund) International. Survey Organization Manual for Demographic and Health Surveys. Calverton, MD: 2012.

32. Jayaraman A, Mishra V, Arnold F. The relationship of family size and composition to fertility desires, contraceptive adoption and method choice in South Asia. International perspectives on sexual and reproductive health. Mar; 2009 35(1):29–38. [PubMed: 19465346]
33. Ministry of Health and Population (MOHP) [Nepal], New ERA, and ICF International Inc. Nepal Demographic and Health Survey 2011. Kathmandu, Nepal and Calverton, Maryland: Ministry of Health and Population, New ERA, and ICF International; 2012.
34. International Institute for Population Sciences (IIPS) and Macro International. National Family Health Survey (NFHS-3), 2005–06. Vol. Volume I. India: 2007. Mumbai: IIPS
35. National Institute of Population Research and Training (NIPORT), Mitra and Associates, ICF International. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and ICF International; 2013.
36. World Health Organization. WHO Child Growth Standards: length/height-for-age, weight-for-age, weight-for-length, weight-for height and body mass index-for-age : methods and development. Geneva: WHO; 2006.
37. Rutstein, S.; Johnson, K. The DHS Wealth Index. Calverton, Maryland: ORC Macro; 2004.
38. World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Geneva: WHO; 1995.
39. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2012 Revision. 2013
40. McDonald CM, Olofin I, Flaxman S, Fawzi WW, Spiegelman D, Caulfield LE, et al. The effect of multiple anthropometric deficits on child mortality: meta-analysis of individual data in 10 prospective studies from developing countries. Am J Clin Nutr. Apr; 2013 97(4):896–901. [PubMed: 23426036]
41. Edmeades J, Pande R, Macquarrie K, Falle T, Malhotra A. Two sons and a daughter: sex composition and women's reproductive behaviour in Madhya Pradesh, India. J Biosoc Sci. Nov; 2012 44(6):749–764. [PubMed: 22459354]
42. Raj A, Vilms RJ, McDougal L, Silverman JG. Association between having no sons and using no contraception among a nationally representative sample of young wives in Nepal. Int JGynaecol Obstet. May; 2013 121(2):162–165. [PubMed: 23474019]
43. Hilber, AM.; Bosch-Capblanch, X.; Schindler, C.; Beck, L.; Sécula, F.; McKenzie, O., et al. Gender and Immunisation: Summary report for SAGE. Swiss Tropical and Public Health Institute; 2010.
44. Guilmoto, C. Sex-ratio imbalance in Asia: Trends, consequences and policy responses. Hyderabad, India: LPED/IRD; 2007.
45. Finlay JE, Ozaltin E, Canning D. The association of maternal age with infant mortality, child anthropometric failure, diarrhoea and anaemia for first births: evidence from 55 low- and middle-income countries. BMJ open. Jan 1.2011 1(2):e000226.
46. Raj A, Saggurti N, Winter M, Labonte A, Decker MR, Balaiah D, et al. The effect of maternal child marriage on morbidity and mortality of children under 5 in India: cross sectional study of a nationally representative sample. BMJ. 2010; 340:b4258. [PubMed: 20093277]
47. Rico E, Fenn B, Abramsky T, Watts C. Associations between maternal experiences of intimate partner violence and child nutrition and mortality: findings from Demographic and Health Surveys in Egypt, Honduras, Kenya, Malawi and Rwanda. J Epidemiol Community Health. Apr; 2011 65(4):360–367. [PubMed: 20841374]
48. Ziaei S, Naved RT, Ekstrom EC. Women's exposure to intimate partner violence and child malnutrition: findings from demographic and health surveys in Bangladesh. Maternal & child nutrition. Aug 20.2012
49. Ackerson LK, Subramanian SV. Intimate partner violence and death among infants and children in India. Pediatrics. Nov; 2009 124(5):e878–e889. [PubMed: 19822588]

Table 1

Prevalence of wasting, stunting and underweight among children under 5 years of age in Bangladesh (2011), India (2005–06) and Nepal (2011).*

	Bangladesh (unwtd n=7639)	**India (unwtd n=41265)**	**Nepal (unwtd n=2335)**
	Weighted %(95% CI)	**Weighted %(95% CI)**	**Weighted %(95% CI)**
Wasting			
No wasting	84.5% (83.4, 85.6)	80.2% (79.6, 80.8)	89.1% (87.4, 90.7)
Moderate wasting	11.6% (10.8, 12.5)	13.4% (12.9, 13.9)	8.4% (7.0, 9.8)
Severe wasting	3.9% (3.2, 4.5)	6.4% (6.1, 6.8)	2.5% (1.8, 3.3)
Male child wasting			
No wasting	84.1% (82.7, 85.5)	79.5% (78.8, 80.3)	88.1% (85.9, 90.3)
Moderate wasting	11.8% (10.7, 13.0)	13.7% (13.0, 14.3)	8.8% (6.8, 10.7)
Severe wasting	4.1% (3.2, 4.9)	6.8% (6.3, 7.2)	3.1% (1.9, 4.4)
Female child wasting			
No wasting	84.9% (83.6, 86.2)	80.9% (80.1, 81.7)	90.0% (87.8, 92.3)
Moderate wasting	11.4% (10.3, 12.6)	13.1% (12.4, 13.7)	8.1% (6.0, 10.1)
Severe wasting	3.7% (2.9, 4.4)	6.0% (5.6, 6.5)	1.9% (1.0, 2.8)
Stunting			
No stunting	58.8% (57.2, 60.5)	52.0% (51.2, 52.8)	59.7% (56.9, 62.6)
Moderate stunting	26.0% (24.8, 27.2)	24.3% (23.8, 24.9)	24.3% (22.4, 26.2)
Severe stunting	15.2% (13.9, 16.4)	23.7% (23.0, 24.4)	15.9% (13.8, 18.1)
Male child stunting			
No stunting	59.6% (57.6, 61.6)	51.9% (50.9, 52.9)	58.8% (55.4, 62.3)
Moderate stunting	25.8% (24.2, 27.4)	24.1% (23.4, 24.9)	24.9% (22.2, 27.5)
Severe stunting	14.6% (13.0, 16.2)	24.0% (23.1, 24.8)	16.3% (13.6, 19.0)
Female child stunting			
No stunting	58.0% (55.8, 60.3)	52.1% (51.0, 53.1)	60.7% (57.1, 64.3)
Moderate stunting	26.2% (24.5, 28.0)	24.6% (23.8, 25.3)	23.7% (20.7, 26.8)
Severe stunting	15.7% (14.3, 17.2)	23.4% (22.5, 24.3)	15.6% (12.6, 18.5)
Underweight			
Not underweight	63.8% (62.2, 65.5)	57.5% (56.7, 58.3)	71.5% (68.9, 74.0)
Moderately underweight	26.0% (24.8, 27.2)	26.7% (26.0, 27.3)	20.9% (18.9, 22.9)
Severely underweight	10.2% (9.1, 11.3)	15.8% (15.2, 16.4)	7.6% (6.1, 9.2)
Male child underweight			
Not underweight	65.8% (63.7, 68.0)	58.0% (57.0, 59.0)	70.8% (67.6, 74.1)
Moderately underweight	24.9% (23.2, 26.6)	26.6% (25.8, 27.4)	21.2% (18.3, 24.1)
Severely underweight	9.3% (7.9, 10.6)	15.4% (14.7, 16.1)	7.9% (6.2, 9.7)
Female child underweight			

NIH-PA Author Manuscript

NIH-PA Author Manuscript

	Bangladesh (unwtd n=7639)	**India (unwtd n=41265)**	**Nepal (unwtd n=2335)**
	Weighted %(95% CI)	**Weighted %(95% CI)**	**Weighted %(95% CI)**
Not underweight	61.8% (59.7, 63.8)	57.0% (55.9, 58.0)	72.1% (69.0, 75.2)
Moderately underweight	27.1% (25.4, 28.7)	26.7% (25.9, 27.6)	20.6% (17.9, 23.2)
Severely underweight	11.2% (9.9, 12.5)	16.3% (15.5, 17.1)	7.3% (5.2, 9.5)

[*] n is not reported as unweighted n do not correspond to the weighted N provided. Nation-specific DHS weights were used for the current analyses to provide more representative estimates of the population (31).

Table 2

Multivariate models showing associations with wasting among children under 5 years of age in Bangladesh (2011), India (2005–06) and Nepal (2011).

	Total[1] (unwtd N=51,239)		**Male[2] (unwtd n=26,559)**		**Female[3] (unwtd n=24,680)**	
	Moderate AOR (95% CI)	**Severe AOR (95% CI)**	**Moderate AOR (95% CI)**	**Severe AOR (95% CI)**	**Moderate AOR (95% CI)**	**Severe AOR (95% CI)**
Maternal Age at Birth						
≤17 vs 35–49	-	-	-	-	-	-
18–19 vs 35–49	-	-	-	-	-	-
20–24 vs 35–49	-	-	-	-	-	-
25–34 vs 35–49	-	-	-	-	-	-
Sex						
Female vs male	**0.92 (0.86, 0.99)**	**0.85 (0.77, 0.94)**				
SIBLING EFFECTS						
Birth Order						
2 vs 1	1.07 (0.98, 1.17)	**1.15 (1.01, 1.32)**	1.09 (0.96, 1.24)	1.20 (0.996, 1.44)	-	-
3+ vs 1	**1.14 (1.04, 1.25)**	**1.27 (1.11, 1.45)**	1.12 (0.99, 1.27)	**1.28 (1.07, 1.52)**	-	-
Birth Spacing						
<24 months vs. ≥24 months/firstborn	**0.90 (0.81, 0.99)**	0.88 (0.77, 1.02)	0.91 (0.79, 1.04)	**0.80 (0.66, 0.96)**	-	-
Brothers						
1 vs 0	-	-	-	-	1.04 (0.93, 1.17)	**1.31 (1.11, 1.55)**
2 vs 0	-	-	-	-	1.12 (0.95, 1.32)	**1.36 (1.07, 1.73)**
3+ vs 0	-	-	-	-	1.08 (0.87, 1.33)	1.27 (0.90, 1.80)
Sisters						
1 vs 0	-	-	-	-	-	-
2 vs 0	-	-	-	-	-	-
3+ vs 0	-	-	-	-	-	-

[1] Total AOR model was adjusted for wealth, maternal education, age of child, sex of child, recent diarrhea, maternal BMI, and country

NIH-PA Author Manuscript
NIH-PA Author Manuscript

[2]Male AOR model was adjusted for wealth, urban/rural residence, maternal education, age of child, recent diarrhea, maternal BMI, country

[3]Female AOR model was adjusted for wealth, maternal education, age of child, recent diarrhea, maternal BMI, country

NOTE: Cells in which there is a “-” indicate that these variables were not included in reduced models. Please see data analysis section for more details.

Table 3

Multivariate models showing associations with stunting among children under 5 years of age in Bangladesh (2011), India (2005–06) and Nepal (2011).

	Total[1] (unwtd N=51,239)		**Male[2] (unwtd n=26,559)**		**Female[3] (unwtd n=24,680)**	
	Moderate AOR (95% CI)	**Severe AOR (95% CI)**	**Moderate AOR (95% CI)**	**Severe AOR (95% CI)**	**Moderate AOR (95% CI)**	**Severe AOR (95% CI)**
Maternal Age at Birth						
≤17 vs 35–49	**1.70 (1.40, 2.05)**	**2.25 (1.84, 2.76)**	**1.74 (1.34, 2.26)**	**1.96 (1.50, 2.56)**	**1.67 (1.28, 2.19)**	**2.54 (1.89, 3.43)**
18–19 vs 35–49	**1.48 (1.24, 1.77)**	**1.65 (1.37, 1.99)**	**1.57 (1.23, 1.99)**	**1.53 (1.19, 1.97)**	**1.41 (1.09, 1.81)**	**1.75 (1.32, 2.31)**
20–24 vs 35–49	**1.25 (1.06, 1.47)**	**1.33 (1.13, 1.56)**	**1.28 (1.03, 1.59)**	**1.25 (1.01, 1.55)**	1.22 (0.97, 1.53)	**1.40 (1.08, 1.81)**
25–34 vs 35–49	1.05 (0.90, 1.22)	1.05 (0.90, 1.22)	1.01 (0.82, 1.25)	0.93 (0.76, 1.14)	1.07 (0.87, 1.33)	1.21 (0.95, 1.53)
Sex						
Female vs male	-	-				
SIBLING EFFECTS						
Birth Order						
2 vs 1	1.08 (0.98, 1.18)	1.03 (0.93, 1.13)	1.12 (0.99, 1.27)	1.01 (0.88, 1.16)	-	-
3+ vs 1	0.96 (0.85, 1.09)	1.07 (0.94, 1.22)	0.99 (0.83, 1.18)	1.06 (0.88, 1.26)	-	-
Birth Spacing						
<24 months vs. ≥24 months/firstborn	**1.10 (1.01, 1.20)**	**1.35 (1.24, 1.46)**	1.06 (0.95, 1.18)	**1.28 (1.14, 1.43)**	**1.16 (1.03, 1.30)**	**1.45 (1.29, 1.63)**
Brothers						
1 vs 0	**1.25 (1.16, 1.35)**	**1.25 (1.15, 1.35)**	**1.27 (1.15, 1.41)**	**1.25 (1.12, 1.40)**	**1.22 (1.10, 1.35)**	**1.28 (1.15, 1.42)**
2 vs 0	**1.32 (1.17, 1.49)**	**1.62 (1.44, 1.83)**	**1.44 (1.21, 1.70)**	**1.80 (1.52, 2.13)**	**1.17 (1.01, 1.35)**	**1.51 (1.30, 1.76)**
3+ vs 0	**1.51 (1.28, 1.79)**	**1.80 (1.54, 2.12)**	**1.57 (1.26, 1.95)**	**1.75 (1.41, 2.18)**	**1.40 (1.12, 1.73)**	**1.92 (1.55, 2.39)**
Sisters						
1 vs 0	**1.19 (1.10, 1.28)**	**1.34 (1.24, 1.45)**	**1.18 (1.06, 1.31)**	**1.28 (1.14, 1.43)**	**1.19 (1.07, 1.31)**	**1.44 (1.29, 1.60)**
2 vs 0	**1.31 (1.16, 1.47)**	**1.48 (1.31, 1.67)**	**1.28 (1.09, 1.50)**	**1.42 (1.21, 1.66)**	**1.29 (1.12, 1.48)**	**1.60 (1.37, 1.87)**
3+ vs 0	**1.32 (1.15, 1.52)**	**1.73 (1.50, 2.00)**	**1.26 (1.03, 1.55)**	**1.37 (1.13, 1.67)**	**1.32 (1.12, 1.57)**	**2.25 (1.88, 2.70)**

[1] Total AOR model was adjusted for wealth, urban/rural residence, maternal education, maternal BMI, maternal age at birth, and country

[2]Male AOR model was adjusted for wealth, urban/rural residence, maternal education, maternal BMI, maternal age at birth, and country

[3]Female AOR model was adjusted for wealth, urban/rural residence, maternal education, maternal BMI, maternal age at birth, and country

NOTE: Cells in which there is a "-" indicate that these variables were not included in reduced models. Please see data analysis section for more details.

Table 4

Multivariate models showing associations with underweight among children under 5 years of age in Bangladesh (2011), India (2005–06) and Nepal (2011).

	Total[1] (unwtd N=51,239)		**Male[2] (unwtd n=26,559)**		**Female[3] (unwtd n=24,680)**	
	Moderate AOR (95% CI)	**Severe AOR (95% CI)**	**Moderate AOR (95% CI)**	**Severe AOR (95% CI)**	**Moderate AOR (95% CI)**	**Severe AOR (95% CI)**
Maternal Age at Birth						
≤17 vs 35–49	**1.39 (1.13, 1.70)**	**1.51 (1.21, 1.88)**	**1.57 (1.20, 2.05)**	**1.51 (1.14, 2.00)**	1.15 (0.89, 1.48)	**1.41 (1.03, 1.92)**
18–19 vs 35–49	**1.21 (1.001, 1.45)**	1.16 (0.94, 1.42)	**1.34 (1.04, 1.73)**	1.16 (0.90, 1.49)	1.00 (0.79, 1.26)	1.04 (0.78, 1.39)
20–24 vs 35–49	1.06 (0.90, 1.26)	0.99 (0.83, 1.18)	1.09 (0.87, 1.36)	0.92 (0.74, 1.14)	0.96 (0.78, 1.18)	0.96 (0.74, 1.23)
25–34 vs 35–49	0.99 (0.85, 1.16)	0.90 (0.76, 1.07)	0.97 (0.78, 1.21)	0.79 (0.64, 0.98)	0.96 (0.79, 1.17)	0.96 (0.75, 1.22)
Sex						
Female vs male	1.03 (0.97, 1.09)	**1.08 (1.01, 1.16)**				
SIBLING EFFECTS						
Birth Order						
2 vs 1	1.03 (0.94, 1.12)	1.09 (0.98, 1.22)	**1.22 (1.09, 1.35)**	**1.25 (1.08, 1.44)**	0.97 (0.87, 1.09)	1.14 (0.98, 1.33)
3+ vs 1	1.11 (0.99, 1.26)	**1.29 (1.10, 1.50)**	**1.46 (1.29, 1.65)**	**1.59 (1.35, 1.86)**	1.12 (0.97, 1.30)	**1.46 (1.22, 1.75)**
Birth Spacing						
<24 months vs. ≥24 months/firstborn	**1.08 (1.00, 1.17)**	**1.17 (1.07, 1.28)**	-	-	**1.14 (1.02, 1.28)**	**1.24 (1.09, 1.43)**
Brothers						
1 vs 0	**1.09 (1.02, 1.17)**	**1.12 (1.02, 1.23)**	-	-	-	-
2 vs 0	**1.21 (1.08, 1.35)**	**1.17 (1.03, 1.34)**	-	-	-	-
3+ vs 0	1.14 (0.98, 1.33)	**1.25 (1.05, 1.50)**	-	-	-	-
Sisters						
1 vs 0	**1.15 (1.07, 1.23)**	**1.18 (1.07, 1.29)**	-	-	**1.19 (1.08, 1.31)**	1.13 (0.99, 1.29)
2 vs 0	**1.18 (1.06, 1.31)**	1.13 (0.98, 1.30)	-	-	1.10 (0.95, 1.27)	1.04 (0.86, 1.26)
3+ vs 0	1.12 (0.98, 1.27)	**1.27 (1.08, 1.50)**	-	-	0.99 (0.83, 1.19)	**1.27 (1.04, 1.57)**

NIH-PA Author Manuscript

NIH-PA Author Manuscript

[1]Total AOR model was adjusted for wealth, urban/rural residence, maternal education, recent diarrhea, maternal BMI, country

[2]Male AOR model was adjusted for wealth, urban/rural residence, maternal education, recent diarrhea, maternal BMI, country

[3]Female AOR model was adjusted for wealth, maternal education, maternal BMI, country

NOTE: Cells in which there is a "-" indicate that these variables were not included in reduced models. Please see data analysis section for more details.