Published in final edited form as:

Monogr Soc Res Child Dev. 2016 March ; 81(1): 33–59. doi:10.1111/mono.12225.

THE ROLE OF PHYSICAL CAPITAL ASSETS IN YOUNG GIRLS' AND BOYS' MORTALITY AND GROWTH IN LOW- AND MIDDLE-INCOME COUNTRIES

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States Parties recognize the right of every child to a standard of living adequate for the child's physical, mental, spiritual, moral and social development.

—Article 27.1, Convention on the Rights of the Child
General Assembly resolution 44/25, 20 November 1989.

While the obesity epidemic is raging throughout the developed world, concerns about growth deficiencies and mortality remain paramount in countries where poverty is endemic. This is the reason why two primary Millennium Development Goals (MDGs) established by the United Nations pertain to reduction of undernutrition and child mortality (United Nations, 2000). One analysis indicates that 167,000,000 children in low and middle income countries (LMIC) are stunted; and, even though prevalence rates of stunting decreased from about 40% in 1990 to about 27% in 2010, projections suggest that about 22% of children in developing countries will likely be stunted in 2020 (de Onis, Blossner, & Borghi, 2012). Poor nutrition and unsanitary conditions are presumed to be the major causes of child growth problems, such as wasting and stunting; but links between household-and community-level conditions and children's health remain incompletely characterized. Some research indicates that children's health reflects the general level of resources present in the country, community, and household and the specific sets of resources available to women (De Silva & Harpham, 2007; Else Quest & Grabe, 2012; United Nations Development Program, 2010). A detailed analysis of information from Demographic and Health Surveys conducted throughout Africa led Sahn and Stifel (2000) to conclude that understanding the effects of economic and social policy changes at the country level requires knowledge of household-level wealth or assets. Overall housing quality and access to productive household assets are associated with children's nutritional status, a key contributor to child growth and health (Chowa, Ansog, & Masa, 2010). Ownership of durable assets, such as appliances and automobiles, increases the likelihood that families can access other resources; most importantly for the present study are assets that benefit children's health (e.g., food, medicine, health care services; De Silva & Harpham, 2007). The World Bank (2000) recognized the importance of physical capital assets (good housing, appliances,

modes of transportation) as a means of making decisions and taking actions that are productive toward various ends for oneself, one's family, and one's community. There is general support for the idea that having better quality housing and greater access to durable goods improves health, but the findings are inconsistent as regards how particular assets or their accumulation are implicated in particular health outcomes for particular groups of individuals; this uncertain situation is partly owing to variations in community conditions and cultural values (Herrin, Amaral, & Balihuta, 2013).

In this study, we document similarities and differences between girls and boys in growth (height-for-age and stunting, weight-for-age and underweight, and weight-for-height and wasting) and mortality in 40 LMIC. We also assess associations between physical environmental factors connected with home life and patterns of growth and mortality for young girls and boys. In societies where household facilities and access to material resources are generally low, even small differences in resource availability may loom large in determining parents' decisions pertaining to health care and nutrition thereby affecting children's growth trajectories and their chances of survival (Boyle et al., 2006; Darmon & Drewnowski, 2008; De Silva & Harpham, 2007; Wachs, 2008).

INDICATORS OF CHILD GROWTH AND MORTALITY

According to the World Health Organization (WHO, 1997), low height-for-age or stunting most often reflect prolonged undernutrition. Low weight-for-age and underweight may also reflect poor nutrition and chronic illness, but children who score low on this indicator could either be stunted and of appropriate weight-for-stature, or taller and underweight, making interpretation a challenge. Low weight-for-height, or wasting, is generally indicative of acute recent weight loss, due either to starvation or serious illness.

Only three of nine UN regions appear to be on track to meet the MDGs pertaining to undernutrition (United Nations, 2011b); and even in regions generally on track to meet MDGs (e.g., Latin America and the Caribbean) only 6 of 13 countries are on track as regards stunting (Lutter, Chaparro, & Muñoz, 2010). Similarly, although there has been progress in pursuit of low mortality, the goal has been met in only three of nine UN regions (United Nations, 2011a). In the 60 countries with the highest rates of childhood mortality, only 7 are on track to meet the 2015 targets for child mortality (Lawn, Costello, Mwansambo, & Osrin, 2007).

GENDER DIFFERENCES IN CHILD GROWTH AND MORTALITY

Demographic and Health Surveys from 35 developing countries in the late 1980s and early 1990s revealed that girls were less likely to be stunted and wasted than boys (Hill & Upchurch, 1995). Girls showed better growth than boys in Ethiopia (Medhin et al., 2010), Nigeria (Luke et al., 2007), Pakistan (Mahmood & Mahmood, 1995), and 10 countries in Sub-Saharan Africa (Wamani, Åström, Peterson, Tumwine, & Tylleskär, 2007). That said, there was little gender difference in stunting or in height-for-age in Bangladesh (Moestue et al., 2004).

Overall mortality rates of girls in 35 developing countries were also lower than those for boys (Hill & Upchurch, 1995). In a report on gender differences in under-5 mortality, the United Nations Department of Economic and Social Affairs, Population Division (2011) concluded that in most developing countries (excluding China and India), girls have the advantage over boys. However, trends in 21 countries worldwide, especially in Sub-Saharan Africa and Eastern and Southern Asia, indicate that girls are still at greater risk for childhood mortality than boys. According to Pande (2003), gender discrimination in these countries, especially India and South and East Asia, contributes to disproportionate mortality in young girls.

SOURCES OF GENDER DIFFERENCES IN CHILD GROWTH AND MORTALITY

The greater likelihood boys will have a growth problem or die in early childhood suggests that genetic mechanisms may leave boys more susceptible to ecological adversities (Dercon & Singh, 2013; United Nations, Department of Economic and Social Affairs, Population Division, 2011). Given equivalent exposure to pathogens, boys are more likely to develop diseases and are more severely affected by diseases than girls (Klein, 2007). However, the precise mechanisms responsible for boys' susceptibility are still debated. For example, a study in India showed that boys had slightly higher odds ratios of being stunted, wasted, and underweight, but part reflected girls' greater propensity for catching up after initial problems with low weight (Bisai & Mallick, 2009). The potential complexity of gender differences in conditions associated with malnutrition can be seen in a study conducted in the Philippines. Specifically, stunting was more prevalent among boys at all ages. However, wasting was more prevalent for boys during infancy, shifting to a slightly greater prevalence for girls thereafter (Ricci & Becker, 1996). In effect, children's growth appears to depend on cultural and environmental factors as well as genetic predispositions, with likely different sets of factors applying to different growth outcomes at different ages.

Some of the factors implicated in mortality also remain elusive. Overall rates of mortality, particularly after the neonatal period, have declined owing to better health care and community-level improvements in water and sanitation (Masanja et al., 2008). A differential that favors girls during the first 6 months of life remains (likely owing to genetic factors; Klein, 2007), with some evidence that cultural values can discriminate against girls after that point (e.g., quality of feeding or utilization of health care; Mahmood & Mahmood, 1995). However, findings are inconsistent, leaving unclear how gender is implicated in specific health outcomes (Nuruddin, Hadden, Petersen, & Lim, 2009).

Genes and environments interact to determine growth and health trajectories for young children, but many uncertainties remain as to their precise interplay in most health outcomes (Burgner, Jamieson, & Blackwell, 2006; Cunningham-Rundles, Moon, & McNeeley, 2008; Rushton & Elliott, 2003). In especially adverse circumstances, genetic factors that afford resilience or lead to vulnerability may play a more consequential role in health status given that individuals/parents have little discretion in addressing shortages or potentially damaging exposures. However, as conditions diminish in severity, discretionary behavior on the part of

caregivers is likely to play a greater role (Rendall, 2012). In effect, gender discrimination favoring males may have somewhat greater health consequences in settings where poverty and instability are not overly severe. That said, the relation between societal level gender inequality and child health is unlikely to be straightforward. In their study of factors connected to gender differences in nutrition status, educational aspirations and perceived self-efficacy in Ethiopia, India, Vietnam and Peru, Dercon and Singh (2013, p. 47) found “no common thread that can be used to characterize gender differences across these different countries.” It appears that societal values pertaining to gender are among many cultural values that help determine parental actions regarding to children’s health. Matsumoto and Fletcher (1996) looked at three cross-national differences in value orientation in addition to gender (uncertainty avoidance, individualism/collectivism, and power distance) in an effort to account for country-level differences in six diseases. They found that power distance (i.e., the degree to which society fostered conformity and obedience to authority, used autocratic decision making, and had hierarchical social structures) was more strongly associated with disease prevalence (including infant mortality) than was masculinity orientation. Furthermore, although value orientations inform individual actions, the pathway of household decision-making processes pertaining to health care has multiple steps. It moves from the perception of illness to choices about the type of care needed and the providers to use and then to expenditures of time and money to address any health needs. A study done in Nepal showed that, while gender was implicated in step one (perceptions of illness), it was not implicated in subsequent care seeking (Pokhrel & Sauerborn, 2004). To shed further light on these gender issues, we explore how various environmental conditions relate to growth and mortality differentially for girls and boys as these conditions afford different opportunities and challenges for families: housing quality (water and sanitation, household composition, and cooking and food storage) and household material resources (transportation, electricity, radio, telephone, and television). We also analyze overall wealth in the country (HDI), which conveys the broader level of resources available to a family. Conditions present in different geographic locations interact with genes to affect many aspects of child well-being, including height and weight (Davis, Haworth, Lewis, & Plomin, 2012).

THE HOME ENVIRONMENT’S RELATIONS WITH CHILD GROWTH AND MORTALITY

Inadequate food, poor hygiene practices, and poor quality sanitation contribute to infections and growth problems in children (Grantham-McGregor et al., 2007; Hall, Hewitt, Tuffrey, & de Silva, 2008). In developing countries children who grow up in wealthier households are at lower risk for mortality and stunted growth than children who grow up in households with few assets (Chowa et al., 2010). Because factors contributing to growth problems in early childhood tend to persist and because of collateral damage to other biologic systems, growth retardation in early childhood often augurs difficulties in cognitive processing and school achievement (Berkman, Lescano, Gilman, Lopez, & Black, 2002; Cheung, 2006; Martorell, Rivera, Kaplowitz, & Pollitt, 1992).

Sanitation facilities

Poor hygiene and sanitation contribute to diarrhea and growth problems for children (Hong, Banta, & Betancourt, 2006; Podewils, Mintz, Nataro, & Parashar, 2004; Ricci & Becker, 1996). There is a higher incidence of intestinal parasites in children who share toilets or use toilets that lack connection to a city sewer system (Ludwig, Fernando, Firmino, & Joao Tadeu, 1999; Mahfouz, El-Morshedy, Fargaly, & Khalil, 1997). Fecal-oral spread of bacterial pathogens, resulting from lack of access to appropriate toilets, contributes to diarrheal illness. Inadequate facilities to deal with waste increase risk for childhood illness and mortality in poor countries (Agha, 2000; Podewils et al., 2004).

Food storage and refrigeration

Contamination resulting from poor food storage facilities is a major problem for health and growth in children (Hong et al., 2006). Contamination of foods used to wean children from the breast is a leading cause of diarrhea and malnutrition (Motarjemi, Käferstein, Moy, & Quevedo, 1993). Because young children can hold limited quantities of food in their stomachs, they often need several small meals a day to obtain the necessary nutrients. When homes contain inadequate facilities for food storage, food is often left out for later consumption, increasing the likelihood of food contamination (Bartlett, 2005).

Provisions for water

WHO estimates that water contaminants account for 4% of all deaths and 6% of all disease burden for young children. When water does not come into the house, storage of water becomes a major issue as regards contamination. Young children may dip their hands into water or drop water scoops on the floor, which then become a source of disease that can lead to growth retardation and even death (Abou-Ali, 2003; Halpenny, Koski, Valdes, & Scott, 2012; Lindskog & Lundqvist, 1998; Ouattara, N'Guéssean, Yapi, & N'Goran, 2010). A study done in Malawi showed that diarrhea in children could be significantly reduced by measures as simple as an improved bucket for carrying water (Roberts et al., 2001). Having piped water can reduce wasting and stunting (e.g., in the Philippines; Ricci & Becker, 1996). Child survival rates have improved in Latin America and the Caribbean as sanitation and access to clean water have improved along with greater access to health services (Mitra & Rodriguez-Fernandez, 2010).

Cooking facilities

An open stove with no chimney in the household increases indoor pollutants that can pose health risks (Awasthi, Glick, & Fletcher, 1996; Collins, Sithole, & Martin, 1990). In poor nations, acute respiratory illness associated with exposure to indoor air pollution is a leading cause of death among young children (Gauderman et al., 2004). Having a stove that used wood for fuel is associated with stunting among children in the Philippines and in Bangladesh (Hong et al., 2006; Ricci & Becker, 1996).

Quality of housing and access to durable goods

Having access to physical and social assets at home is critical for health maintenance and survival of family members. Under general conditions of economic hardship, having such

access can be particularly important as it enables adults in the household to avoid disease (Obrist et al., 2007). In developing countries, gaining access to electricity helps reduce mortality (Wagstaff, Bustreo, Bryce, Claeson, & the WHO-World Bank Child Health and Poverty Working Group, 2004; Wang, 2003). Child survival seems especially sensitive to improvements in material conditions present in the home; albeit, details on how particular components of home conditions are implicated in child health remain unclear and may vary from region to region (Chalasani, 2010; Marmot, 2005). A high percentage of homes in developing countries are small, poorly constructed, and lack basic amenities (Aribigbola, 2008; Fiadzo, 2004). Such conditions increase the likelihood of contracting diseases, sustaining a serious injury, stunting, and death among young children (Gielen, Wilson, Faden, Wissow, & Harvilchuck, 1995; Leventhal & Newman, 2010), with variations both within and across countries.

There has been an increasing effort to look at relations between household quality and children's well-being in a more holistic fashion. Researchers have composed household wealth indices that include indicators of specific durable assets (e.g., appliances, automobiles, electricity, telephones, disposable drinking water, bathing facilities, bicycles) and types of construction materials used for dwellings (e.g., type of flooring, material used for roofing, materials used for the walls). For parents living in developing countries there are often many challenges in gaining access to household and community assets, constraining their capacities to promote health and cope with disease (De Silva & Harpham, 2007; Obrist et al., 2007). Studies done across Asia, Africa, Latin America, and the Pacific Islands reveal relations between these household wealth indices and a diversity of health markers, including receipt of immunizations and vitamins, growth, and survival (Aerts, Drachler, & Giugliani, 2004; Boyle et al., 2006; Choi, Bishai, & Hill, 2005; De Silva & Harpham, 2007; Larrea & Freire, 2002; Larrea & Kawachi, 2005; Xie & Dow, 2005). Some studies indicate gender differences, usually favoring girls (Wamani et al., 2007). Some studies indicate that household wealth predicts child health net of factors such as country level GDP and maternal education (Boyle et al., 2006); but cultural and geographic factors play into the equation as well (Matsumoto & Fletcher, 1996; Pascual, Bouma, & Dobson, 2002).

This Study

This study attempts to increase understanding about child growth and mortality in LMIC. Using data from 40 LMIC, we compare girls and boys on 7 indicators of growth and mortality. We also explore how environmental conditions relate to growth and mortality with a focus on gender and country-level resource differences in these patterns. Finally, we explore how gender differences in growth and mortality relate to international indicators of gender equality and sociodemographic development.

METHOD

Participants

Forty of the 41 LMIC from which we had data asked questions about child growth and/or child mortality. Child growth data were available from 139,614 children under age 5 in 34 LMIC, and child mortality data were available from 226,798 women between the ages of 15

and 49 who had ever given birth (henceforth called mothers) in an overlapping but different set of 34 LMIC. Characteristics of the samples are presented in Table 3.1.

Procedures

We used the Multiple Indicator Cluster Survey (MICS3), the Human Development Index (HDI; UNDP, 2008), the Gender Relative Status Index (GRS; Beneria & Permanyer, 2010; Permanyer, 2010), and the Gender Inequality Index (GII; UNDP, 2011); additional information about the MICS3 and country-level indices are available in Chapter II.

Growth data—As part of the MICS administration, trained administrators weighed and measured every child under 5 who was present in the home using standard equipment and a common WHO protocol provided by UNICEF (2012). Using the resulting weight and height data, we adapted and implemented the World Health Organization's (WHO, 2011) Child Growth Standards SPSS macro for the MICS data. This macro uses standard data files to calculate z-scores for height-for-age, weight-for-age, and weight-for-height, based on the WHO (2006; WHO & UNICEF, 2009) Child Growth Standards. We then used predefined cut-off values of 2 *SD* below the mean to identify children who were stunted (<-2.00 on height-for-age), underweight (<-2.00 on weight-for-age), and wasting (<-2.00 on weight-for-height). As a basis for comparison, the percentages of children who are stunted, underweight, and wasting in a particular country can be compared with 2.3%, which is the expected percentage of children below -2 *SD* in a normal population (i.e., based on the standardization sample of typically developing, singleton children in the U.S.A., Oman, Norway, Brazil, and affluent neighborhoods of Ghana and India with no known environmental growth constraints; WHO, 1997, p. 50).

Child mortality data—Each woman aged 15 to 49 in a household was asked if she had ever given birth to a live baby, even if the newborn had only lived for a few minutes. If the woman answered yes, she was then asked a series of questions designed to ascertain the total number of live births of girls and boys and the total number of girls and boys who were born alive but later died. From these questions, for each woman who had given birth we calculated the percentage of girls and boys born alive who subsequently died.

Home environment data—The home environment questions pertaining to quality of housing and material resources were taken from the water and sanitation and household characteristics modules of the MICS3 Household Questionnaire.

Quality of housing indicators—Following the WHO and UNICEF's (2008) drinking water ladder, we coded drinking water into three categories: unimproved (1; unprotected springs or wells, tanker-trucks or carts with a small tank/drum, surface water, or bottled water), improved (2; public taps or standpipes, tube wells or boreholes, protected wells or springs, or rainwater collection), and piped (3; piped directly to the household dwelling, plot, or yard). Following the sanitation ladder recommended by WHO and UNICEF (2008), we coded toilet facilities into four categories: open defecation (1; no facilities or toileting in the bush or field), unimproved (2; pit latrines without a slab or platform, hanging latrines, and bucket latrines), shared improved (3), and unshared improved (4). Improved facilities

included flush or pour-flush latrines, ventilated improved pit (VIP) latrines, pit latrines with slabs, and composting toilets. The main material of the dwelling floor was recoded into the three existing superordinate categories of natural (1), rudimentary (2), and finished (3) flooring. Cooking was recoded to indicate whether household cooking was done on an open fire or stove (0) or in a closed stove (1).

Household materials indicators—Nine household items (radio, TV, mobile telephone, non-mobile telephone, refrigerator, motorcycle or scooter, animal-drawn cart, car or truck, and boat with motor) were coded as absent (0), present (1). Mobile and non-mobile telephone were recoded into a single item to indicate the absence (0) or presence (1) of either type of telephone in the household. Finally, the four items about household transportation - motorcycle or scooter, animal-drawn cart, car or truck, and boat with a motor - were recoded into a single item to indicate the absence (0) or presence (1) of any kind of transportation not powered by humans.

Quality of housing and household materials summary indices—Following Bradley and Putnick (2012), we organized the quality of housing and household materials into summary indices. Summary scores were computed for each index, allowing one item to be missing and prorating the total based on the remaining items. We consider these aggregates to be indices and not scales because they are conceptually related as indicators of child development, but they are not necessarily statistically related (see Bradley, 2004; Streiner, 2003). The Quality of Housing Index was computed as the standardized average of drinking water, toilet facilities, household flooring, cooking, and refrigeration. Higher scores on these 5 items indicated a healthier and safer home environment for children under 5. The Household Materials Index was computed as the sum of the presence of a radio, television, telephone, non-human-powered transportation, and electricity in the household. Higher scores on these 5 items indicated the availability of a broader range of experiences for children under 5.

Analytic Plan

First, we explored whether girls and boys differed on height-for-age, stunting, weight-for-age, underweight, weight-for-height, wasting, and mortality. For child growth z-scores, we performed Child gender by Country analyses of variance (ANOVAs); for stunting, underweight, and wasting, Child gender by Country binary logistic regressions; and for child mortality, Child gender by Country repeated-measures analyses of variance (RM-ANOVAs) with child gender as a within-subjects factor. If the interaction between Child gender and Country was significant, we reanalyzed the child gender models within country. Next, we performed explanatory models designed to assess whether quality of housing and household materials were associated with growth and mortality and whether they interacted with gender.

In the explanatory models, we used maternal education as a covariate. Maternal education was associated with child growth z-scores, $r_s(129,282-134,720) = .16-.30$, $p_s < .001$, and child mortality for girls and boys, $r_s(226,512) = -.19$, $p_s < .001$. There were also large differences in education across countries, $F(33, 139,401) = 3,173.37$, $p < .001$, $\eta^2 = .429$, for

the child growth sample, and $F(33, 226,572) = 5,886.02, p < .001, \eta^2 = .462$, for the child mortality sample, and controlling for maternal education has the advantage of accounting for across-country differences as well as within-country differences.

To assess whether the country's overall level of human development was associated with the gender differences we found in growth and mortality, the effect sizes for child gender for each country were correlated with the country's HDI and its constituent indicators. The effect sizes we used were Cohen's (1988) d for z-scores and mortality and odds ratios (OR) for stunting, underweight, and wasting status, based on the Child gender by Country models.

Finally, to determine whether country-level gender equality was associated with markers of child growth and mortality net of HDI, we computed partial correlations between two country-level indices of gender equality (GRS and GII) and gender differences in each child outcome, controlling for HDI.

RESULTS

Overall, findings indicated that boys were disadvantaged relative to girls in growth and mortality, especially in lower-HDI countries. Quality of housing and material resources were generally related to growth and mortality for both genders, and there were only small differences in the relative relations of quality of housing and material resources with growth and mortality in girls and boys.

Growth and Mortality by Gender and Country

Height-for-age and stunting—The Gender by Country interaction for height-for-age was significant, $F(33, 131,398) = 1.81, p < .01, \eta_p^2 = .000$, as were the main effects for gender, $F(1, 131,398) = 110.83, p < .001, \eta_p^2 = .001$, and country, $F(33, 131,398) = 298.88, p < .001, \eta_p^2 = .070$. To decompose the interaction of Gender and Country, we computed the ANOVA by gender within countries. Boys had lower height-for-age z-scores than girls in 9 of 16 medium-HDI countries, 8 of 9 low-HDI countries, and both HDI-N/A countries, but girls and boys did not differ in any of the 7 High-HDI countries. Effect sizes were all small.

The Gender by Country interaction for stunting was nonsignificant, Wald $\chi^2(33) = 40.27, ns$. Main effects of gender, Wald $\chi^2(1) = 189.57, p < .001, OR = .84$, and country, Wald $\chi^2(33) = 7614.11, p < .001$, were significant. Across all countries, higher percentages of boys than girls were stunted. Despite the nonsignificant interaction between gender and country, we computed logistic regressions within country to parallel the analyses for height-for-age. Higher percentages of boys than girls were stunted in 1 of the 7 high-HDI countries (Bosnia & Herzegovina), 10 of the 16 medium-HDI countries, 7 of the 9 low-HDI countries, and 1 of the 2 HDI-N/A countries (Iraq), and girls and boys did not differ in the other 15 countries. See Supplemental Table 3.1.

Weight-for-age and underweight—The Gender by Country interaction for weight-for-age was significant, $F(33, 134,821) = 4.18, p < .001, \eta_p^2 = .001$, as were the main effects for gender, $F(1, 134,821) = 55.69, p < .001, \eta_p^2 = .000$, and country, $F(33, 134,821) = 724.87, p < .001, \eta_p^2 = .151$. To decompose the interaction of Gender and Country, we computed the

ANOVA by gender within countries. Boys had lower weight-for-age z-scores than girls in 7 of 16 medium-HDI countries, 8 of 9 low-HDI countries, and 1 of the 2 HDI-N/A countries (Somalia), but girls and boys did not differ in any of the 7 high-HDI countries. Effect sizes were all small.

The Gender by Country interaction for underweight was nonsignificant, Wald $\chi^2(33) = 36.93$, *ns*. Main effects of gender, Wald $\chi^2(1) = 164.65$, $p < .001$, OR = .82, and country, Wald $\chi^2(33) = 8633.50$, $p < .001$, were significant. Higher percentages of boys than girls were underweight. Despite the nonsignificant interaction between Gender and Country, we computed regressions within country to parallel the analyses for weight-for-age. Higher percentages of boys than girls were underweight in 1 of the 7 high-HDI countries (Serbia), 7 of the 16 medium-HDI countries, 6 of the 9 low-HDI countries, and 1 of the 2 HDI-N/A countries (Somalia). See Supplemental Table 3.2.

Weight-for-height and wasting—The Gender by Country interaction for weight-for-height was significant, $F(33, 129,374) = 1.56$, $p < .05$, $\eta_p^2 = .001$, as was the main effect of country, $F(33, 129,374) = 349.23$, $p < .001$, $\eta_p^2 = .082$, but not gender, $F(1, 129,374) = .46$, *ns*, $\eta_p^2 = .000$. To decompose the interaction of Gender and Country, we computed the ANOVA by gender within countries. Boys had lower weight-for-height z-scores than girls in 2 countries (Laos and Somalia), girls had lower weight-for-height than boys in 3 countries (Thailand, Mongolia, and Iraq), and girls and boys did not differ in the other 29 countries. Effect sizes were all small.

The Gender by Country interaction for wasting was nonsignificant, Wald $\chi^2(33) = 42.57$, *ns*. Main effects of gender, Wald $\chi^2(1) = 51.23$, $p < .001$, OR = .87, and country, Wald $\chi^2(33) = 3845.62$, $p < .001$, were significant. Across all countries, higher percentages of boys than girls were wasting. Despite the nonsignificant interaction between gender and country, we computed logistic regressions within country to parallel the analyses for weight-for-height. Higher percentages of boys than girls were wasting in 1 of the 7 high-HDI countries (Serbia), 3 of the 16 medium-HDI countries (Laos, Mauritania, and the Syrian Arab Republic), 4 of the 9 low-HDI countries (Burkina Faso, Côte d'Ivoire, Mozambique, and Sierra Leone), 1 of the 2 HDI-N/A countries (Somalia), and girls and boys did not differ in the other 25 countries. See Supplemental Table 3.3.

Mortality—The Gender by Country interaction for child mortality was significant, $F(33, 226,672) = 5.38$, $p < .001$, $\eta_p^2 = .001$, as were the main effects for gender, $F(1, 226,672) = 402.26$, $p < .001$, $\eta_p^2 = .002$, and country, $F(33, 226,672) = 936.36$, $p < .001$, $\eta_p^2 = .120$. To decompose the interaction of Gender and Country, we computed the RM-ANOVA by gender within countries. Higher percentages of boys than girls had died in all 5 high-HDI countries, 14 of 18 medium-HDI countries, all 9 low-HDI countries, and both HDI-N/A countries. The percentages of girls and boys who had died did not differ in Belize, Vanuatu, Yemen, and Djibouti. Effect sizes were all small. See Supplemental Table 3.4.

Explanatory Models

We next explored whether quality of housing and household material resources were associated with child growth and mortality; and we explored interactions of gender with

housing quality and household material resources to determine whether they might help to explain any observed gender differences in growth and mortality controlling for maternal education. Finally, we included interactions with country in case there was a country-specific effect.

Quality of housing—The 3-way interactions for Country, Gender, and Housing Quality were nonsignificant for all dependent variables: height-for-age, $F(33, 129,565) = 1.01$, *ns*, $\eta_p^2 = .000$, stunting, Wald $\chi^2(33) = 25.30$, *ns*, weight-for-age, $F(33, 132,943) = 1.24$, *ns*, $\eta_p^2 = .000$, underweight, Wald $\chi^2(33) = 44.82$, *ns*, weight-for-height, $F(33, 127,562) = .94$, *ns*, $\eta_p^2 = .000$, wasting, Wald $\chi^2(33) = 19.86$, *ns*, and child mortality, $F(32, 221,341) = .80$, *ns*, $\eta_p^2 = .000$.

Country by Housing Quality interactions were significant for all outcomes: height-for-age, $F(33, 129,565) = 10.40$, $p < .001$, $\eta_p^2 = .003$, stunting, Wald $\chi^2(33) = 345.15$, $p < .001$, weight-for-age, $F(33, 132,943) = 13.57$, $p < .001$, $\eta_p^2 = .003$, underweight, Wald $\chi^2(33) = 229.57$, $p < .001$, weight-for-height, $F(33, 127,562) = 9.55$, $p < .001$, $\eta_p^2 = .002$, wasting, Wald $\chi^2(33) = 117.98$, $p < .001$, and child mortality, $F(32, 221,341) = 27.23$, $p < .001$, $\eta_p^2 = .004$.

Better housing quality was associated with taller height-for-age in 6 of 7 high-HDI countries ($\eta_p^2 = .003-.017$), 14 of 16 medium-HDI countries ($\eta_p^2 = .003-.022$), 8 of 9 low-HDI countries ($\eta_p^2 = .003-.036$), and both HDI-N/A countries ($\eta_p^2 = .001-.046$), but the effects were not significant in the other 4 countries (Albania, Georgia, Vanuatu, and Guinea-Bissau). Similarly, better housing quality was associated with a lower probability of stunting in 6 of 7 high-HDI countries (OR = .11-.65), 14 of 16 medium-HDI countries (OR = .49-.78), all 9 low-HDI countries (OR = .44-.85), and both HDI-N/A countries (OR = .34-.81), but relations were not significant in the remaining 3 countries (Albania, Georgia, and Vanuatu). See Supplemental Table 3.5.

Better housing quality was associated with greater weight-for-age in 5 of 7 high-HDI countries ($\eta_p^2 = .002-.013$), 15 of 16 medium-HDI countries ($\eta_p^2 = .001-.042$), all 9 low-HDI countries ($\eta_p^2 = .001-.045$), and both HDI-N/A countries ($\eta_p^2 = .002-.060$), and was unrelated in the remaining 3 countries (Albania, Bosnia and Herzegovina, and Vanuatu). Better housing quality was associated with a lower probability of being underweight in 1 of 7 high-HDI countries (OR = .23), 8 of 16 medium-HDI countries (OR = .50-.70), 8 of 9 low-HDI countries (OR = .36-.81), and both HDI-N/A countries (OR = .32-.79). See Supplemental Table 3.6.

Results were less consistent for weight-for-height and wasting. Better housing quality was significantly associated with lower weight-for-height in 2 of 7 high-HDI countries (Belarus and Bosnia and Herzegovina; $\eta_p^2 = .002-.009$), greater weight-for-height in 1 of 7 high-HDI countries (Macendonia; $\eta_p^2 = .002$), 6 of 16 medium-HDI countries ($\eta_p^2 = .002-.031$), 5 of 9 low-HDI countries ($\eta_p^2 = .001-.011$), and both HDI-N/A countries ($\eta_p^2 = .001-.013$), and was unrelated in the remaining 18 countries. Better quality of housing was significantly associated with a higher probability of wasting in 1 of 16 medium-HDI countries (Vanuatu; OR = 1.78), a lower probability of wasting in 4 of 16 medium-HDI countries (OR = .63-.75),

5 of 9 low-HDI countries ($OR = .48-.72$), both HDI-N/A countries ($OR = .63-.85$), and was unrelated in the remaining 22 countries (including all high-HDI countries) See Supplemental Table 3.7. Finally, better housing quality was associated with lower mortality in 1 of 5 high-HDI countries, 9 of 15 medium-HDI countries, all 9 low-HDI countries, and 1 of 2 HDI-N/A countries. See Supplemental Table 3.8

Housing quality did not significantly interact with gender for height-for-age, $F(1, 129,565) = 1.83$, ns , $\eta_p^2 = .000$, stunting, Wald $\chi^2(1) = .24$, ns , $OR = 1.01$, weight-for-age, $F(1, 132,943) = 2.18$, ns , $\eta_p^2 = .000$, underweight, Wald $\chi^2(1) = .08$, ns , $OR = 1.01$, or child mortality, $F(1, 221,341) = .16$, ns , $\eta_p^2 = .000$. However, the interaction between housing quality and gender was significant for weight-for-height, $F(1, 127,562) = 6.01$, $p < .05$, $\eta_p^2 = .000$, and wasting, Wald $\chi^2(1) = 5.99$, $p < .05$, $OR = 1.07$. Follow-up tests indicated that better quality of housing was associated with greater weight-for-height in boys, $F(1, 65,152) = 21.66$, $p < .001$, $\eta_p^2 = .000$, but not girls, $F(1, 62,409) = 3.07$, ns , $\eta_p^2 = .000$ (although with tiny effect sizes in both groups). Similarly, the effect of quality of housing on wasting was slightly stronger for boys, Wald $\chi^2(1) = 79.99$, $p < .001$, $OR = .76$, than for girls, Wald $\chi^2(1) = 32.78$, $p < .001$, $OR = .83$, but for both girls and boys having better housing quality was still significantly associated with a lower probability of wasting.

Overall, quality of housing was associated with better growth and less mortality, but results varied by country. Housing quality was related to height-for-age and stunting in most countries, was more often related to weight-for-age, underweight, and mortality in low- and medium-HDI countries than high-HDI countries, and was less consistently related to weight-for-height and wasting by HDI. Quality of housing had slightly stronger relations with the weight-for-height and wasting status of boys than girls across countries, but there were no gender differences in relations between housing quality and mortality or the other growth problems.

Household material resources—The 3-way interactions for Country, Gender, and Material resources were nonsignificant for height-for-age, $F(32, 130,190) = .91$, ns , $\eta_p^2 = .000$, stunting, Wald $\chi^2(32) = 35.06$, ns , weight-for-height, $F(32, 128,169) = 1.01$, ns , $\eta_p^2 = .000$, underweight, Wald $\chi^2(32) = 40.69$, ns , wasting, Wald $\chi^2(32) = 30.53$, ns , and child mortality, $F(31, 220,597) = 1.19$, ns , $\eta_p^2 = .000$. The 3-way interaction was significant for weight-for-age, $F(32, 133,594) = 1.49$, $p < .05$, $\eta_p^2 = .000$. Follow-up tests indicated that the interaction between gender and material resources was significant for Cameroon, $F(1, 4,310) = 7.99$, $p < .01$, $\eta_p^2 = .002$, Kyrgyzstan, $F(1, 2,289) = 4.82$, $p < .05$, $\eta_p^2 = .002$, and Nigeria, $F(1, 11,944) = 6.36$, $p < .05$, $\eta_p^2 = .001$, only. In Cameroon, having more material resources was associated with greater weight-for-age for both girls, $F(1, 2,180) = 27.86$, $p < .001$, $\eta_p^2 = .013$, and boys, $F(1, 2,129) = 77.68$, $p < .001$, $\eta_p^2 = .035$. In Kyrgyzstan, having more material resources was associated with greater weight-for-age for boys, $F(1, 1,183) = 8.09$, $p < .01$, $\eta_p^2 = .007$, but not girls, $F(1, 1,105) = .45$, ns , $\eta_p^2 = .000$. In Nigeria, material resources was not associated with weight-for-age for girls, $F(1, 5,874) = .81$, ns , $\eta_p^2 = .000$, or boys, $F(1, 6,069) = 3.36$, ns , $\eta_p^2 = .001$.

Significant Country by Household Materials interactions emerged for all outcomes: height-for-age, $F(32, 130,190) = 7.93$, $p < .001$, $\eta_p^2 = .002$, stunting, Wald $\chi^2(32) = 260.08$, $p < .$

001, weight-for-age, $F(32, 133,594) = 13.11, p < .001, \eta_p^2 = .003$, underweight, Wald $\chi^2(32) = 182.14, p < .001$, weight-for-height, $F(32, 128,169) = 9.07, p < .001, \eta_p^2 = .002$, wasting, Wald $\chi^2(32) = 106.81, p < .001$, and mortality, $F(31, 220,597) = 24.01, p < .001, \eta_p^2 = .003$.

Having more material resources was associated with taller height-for-age in all 6 high-HDI countries ($\eta_p^2 = .007-.017$), 14 of 16 medium-HDI countries ($\eta_p^2 = .005-.038$), 8 of 9 low-HDI countries ($\eta_p^2 = .002-.030$), and both HDI-N/A countries ($\eta_p^2 = .002-.014$), and was unrelated in the Syrian Arab Republic, Kyrgyzstan, and Nigeria. Having more material resources was associated with a lower probability of stunting in 5 of 6 high-HDI countries (OR = .58-.83), 13 of 16 medium-HDI countries (OR = .64-.86), all 9 low-HDI countries (OR = .75-.95), and both HDI-N/A countries (OR = .78-.91), and was unrelated in Montenegro, the Syrian Arab Republic, Kyrgyzstan, and Vanuatu. See Supplemental Table 3.9.

Having more material resources was associated with greater weight-for-age in 5 of 6 high-HDI countries ($\eta_p^2 = .002-.013$), 13 of 16 medium-HDI countries ($\eta_p^2 = .002-.052$), 8 of 9 low-HDI countries ($\eta_p^2 = .001-.021$), both HDI-N/A countries ($\eta_p^2 = .001-.024$), and was unrelated in Montenegro, Suriname, Georgia, Kyrgyzstan, and Nigeria. Having more material resources was associated with a lower probability of being underweight in 2 of 6 high-HDI countries (OR = .53-.65), 10 of 16 medium-HDI countries (OR = .77-.89), all 9 low-HDI countries (OR = .72-.94), 1 of the 2 HDI-N/A countries (OR = .74), and was unrelated in the remaining 11 countries. See Supplemental Table 3.10.

Having more material resources was associated with greater weight-for-height in 1 of 6 high-HDI countries (Macedonia; $\eta_p^2 = .002$), 6 of 16 medium-HDI countries ($\eta_p^2 = .002-.017$), 5 of 9 low-HDI countries ($\eta_p^2 = .001-.010$), and 1 of the 2 HDI-N/A countries (Somalia; $\eta_p^2 = .011$), and was unrelated in the remaining 20 countries. Having more material resources was associated with a higher probability of wasting in 1 medium-HDI country (Guyana; OR = 1.19), a lower probability of wasting in 3 medium-HDI countries (Syrian Arab Republic, Mauritania, and Cameroon; OR = .85-.91), 3 low-HDI countries (Burkina Faso, Mozambique, and Togo; OR = .81-.92), 1 of the 2 HDI-N/A countries (Somalia; OR = .84), and was unrelated in 25 countries. See Supplemental Table 3.11. Finally, for mortality, having more material resources was associated with lower mortality in 2 of 6 high-HDI countries, 10 of 16 medium-HDI countries, 8 of 9 low-HDI countries, neither of the HDI-N/A countries, and was unrelated to mortality in 12 countries. See Supplemental Table 3.8

Material resources did not significantly interact with gender for height-for-age, $F(1, 130,190) = .04, ns, \eta_p^2 = .000$, stunting, Wald $\chi^2(1) = .58, ns, OR = 1.01$, weight-for-age, $F(1, 133,594) = .65, ns, \eta_p^2 = .000$, underweight, Wald $\chi^2(1) = .78, ns, OR = 1.01$, weight-for-height, $F(1, 128,169) = 1.94, ns, \eta_p^2 = .000$, or child mortality, $F(1, 220,597) = .07, ns, \eta_p^2 = .000$. The interaction between Child gender and Material resources was significant for wasting, Wald $\chi^2(1) = 5.43, p < .05, OR = 1.03$. Follow-up tests by gender indicated that the effect of material resources on wasting was slightly stronger for boys, Wald $\chi^2(1) = 49.80, p < .001, OR = .92$, than girls, Wald $\chi^2(1) = 17.36, p < .001, OR = .95$, but for both girls and boys having more material resources was still associated with a lower probability of wasting.

Overall, having more material resources in the house was associated with better growth and reduced mortality, but the strength and significance of the effects varied by country. Material resources were almost uniformly related to height-for-age and stunting, were more related to weight-for-age, underweight, and mortality in low- and medium-HDI countries than high-HDI countries, and were less consistently related to weight-for-height and wasting by HDI. Material resources had a slightly stronger relation with weight-for-age in boys than girls in Cameroon and Kyrgyzstan and with the wasting status of boys than girls across countries.

Relations between Gender Effect Sizes and the HDI

Table 3.2 displays correlations between effect sizes for the gender difference in growth and mortality (Cohen's d or ORs) and the country HDI and its constituent indices. A positive correlation means that as HDI increases, the difference between boys and girls increasingly favors boys. In other words, in low-HDI countries boys are at a disadvantage compared to girls; but in high-HDI countries, the gap between girls and boys is smaller, or even reverses. Large positive correlations emerged for the effect sizes for all z-scores with the HDI and all of its indices. However, the effect sizes for stunting, underweight, wasting, and mortality were unrelated to the HDI, life expectancy index, and GDP index. Effect sizes for stunting and underweight were modestly related to the education index and literacy, and the effect size for stunting was also modestly related to schooling. As an example, Figure 3.1 displays the scatterplot of gender effect size (Cohen's d) for weight-for-age by HDI. Effect sizes < 0 indicate that boys had lower weight-for-age than girls, and effect sizes > 0 indicate that girls had lower weight-for-age than boys. Boys were at a disadvantage compared to girls in all low-HDI countries ($< .50$), and some medium-HDI countries (.51-.70). Although we only show one figure, there were two visible groupings of countries for all three z-scores (height-for-age, weight-for-age, and weight-for-height): (1) low-medium-HDI countries where boys are at a disadvantage and (2) medium-high-HDI countries where boys are at less of a disadvantage, or even gain the advantage over girls (see Figure 3.1).

Relations between Gender Equality Indices and Gender Differences in Markers of Child Health

As shown in Table 3.2, GRS was a significant predictor for only one child outcome (weight-for-age) controlling for HDI ($r = .50, p < .01$), indicating that in countries with better national gender equality boys were at less of a disadvantage compared to girls on weight-for-age. Likewise, GII was a significant predictor for only one child outcome (wasting) controlling for HDI ($r = -.68, p < .01$), indicating that in countries with better national gender quality (low score) boys were at less of a disadvantage compared to girls.

DISCUSSION

Malnutrition and exposure to various pathogens present serious risks to children growing up in poverty. Consequently, it is important to further delineate how specific resources at home and in the broader community contribute to growth difficulties and mortality in young children. Our results show that family-level physical capital assets, in the form of household quality and material resources, are differentially associated with some indicators of growth in girls and boys; but relations differed by country and all gender effects were quite small.

Across all countries, weight-for-height and wasting were more strongly related to housing quality for boys. Wasting was also more strongly related to material resources for boys than girls. Gender disparities, favoring girls, were most prevalent in countries where socioeconomic capital is scarce, consistent with the idea that genes that promote resilience may play a relatively larger role in adverse environments. As countries are able to improve infrastructure pertaining to water, sanitation, and health care, severe malnutrition and childhood mortality subside, at which point gender differences attenuate (Pelletier, 1994). However, when resources in a country remain low, growth problems and mortality for both girls and boys continue to be prevalent, consistent with the broader literature on malnutrition and disease exposure (Cunningham-Rundles et al., 2008). In general, the disparate pattern of findings for child gender across countries appears to attest to the value of considering the resources available at household, community, and societal levels when trying to determine influences on children's health status (Sahn & Stifel, 2000). Results from this study also indicate that country-level gender equality may be a minor factor in determining the likelihood young children will present with growth problems, albeit significant results emerged for only two of the seven health indicators we examined once the overall socioeconomic level of the country was controlled.

Micronutrient deficiencies coincident with frequent diarrhea can lead to malabsorption and significant weight loss for young children. The combination of poor nutrition and diarrhea can become a vicious cycle leading to serious growth problems, even death (Podewils et al., 2004). Genetic differences between girls and boys generally result in fewer serious growth problems and lower rates of mortality for girls (Klein, 2007). Our findings confirm that stunting is more prevalent in boys than girls who live in the countries sampled in the MICS. In just more than half of the countries sampled, girls fared better than boys (albeit, all effect sizes were small). In the remainder of the countries there was no difference. Notably, gender differences for height-for-age and stunting were nonsignificant in almost all high-HDI countries.

Our findings pertaining to weight-for-age were similar to our findings pertaining to height-for-age. That is not surprising in that being underweight also tends to reflect multiplicative effects of poor nutrition and poor health circumstances over time (Ricci & Becker, 1996). There was a higher prevalence of low weight-for-age among boys in 16 countries (again, the effect sizes were small). Technically the interaction between gender and country was nonsignificant, but greater percentages of boys were underweight in 15 LMIC. Like the results of height-for-age and stunting, gender differences for weight-for-age and underweight were nonsignificant in almost all high-HDI countries.

The basic genetic advantage present for girls tends to be less protective with respect to health conditions such as weight-for-height that reflect transient circumstances and parents' discretionary behaviors (Hill & Upchurch, 1995). Thus, it was not surprising to find fewer gender differences in weight-for-height. Relatedly, even though there was a significant overall difference in wasting, favoring girls, the gender difference was only observed in 9 countries. GII predicted the likelihood of wasting net of HDI, showing that boys were at less of a disadvantage relative to girls in countries with better national gender equality. Had we separated children by age, we may have found that gender differences pertaining to wasting

favoring girls only obtained for infants because early infancy is the most vulnerable period of development.

The United Nations, Department of Economic and Social Affairs (2011) reported a very complex pattern pertaining to gender differences in mortality for children under age 5. Girls from 122 countries showed a slight advantage over boys in rates of mortality. However, there was little gender variation in India and China, where there remain strong preferences for male offspring, and there is evidence for differential treatment surrounding childhood illnesses (Hesketh & Xing, 2006). In large measure, our findings are consistent with that report. Specifically, we observed a main effect of gender (favoring girls) as well as a Gender by Country interaction. In our study, boys died at higher rates than girls in 30 countries. However, consistent with prior studies, the effect sizes were small. In overview, research on child mortality suggests that there is interplay between various genetic factors and multiple environmental conditions, including cultural values (both those connected with gender equality and those that treat other social and emotional issues). The interplay becomes more complicated given that there have been rapid changes in both policy and infra-structure in many LMIC. In Tanzania, for example, rapid improvements in the health system between 2000 and 2004 resulted in a reduction of mortality in infancy from 141 per 1000 to 83 per 1000 (Masanja et al., 2008). These shifts, sometimes complemented by changes in the education infrastructure (especially for women), can change the pathway of household decision making pertaining to nutrition and health care dramatically such that all children are given better health care (Pokhrel & Sauerborn, 2004).

When we looked at overall housing quality (including construction materials and facilities therein), we found fairly consistent effects on height-for-age and stunting, weight-for-age and overweight, and mortality, but the relations were inconsistent for weight-for-height and wasting. The effects of housing quality on weight-for-height and wasting were a little stronger for boys than girls. The observed modest impacts on growth and mortality may reflect generally improved access to clean water and sanitation facilities as well as improved maternal literacy and access to certain forms of health care. Thus, even though poor housing construction can increase the likelihood of respiratory problems and poor household facilities can increase the likelihood of infections leading to diarrhea (Wagstaff et al., 2004), improvements in these areas may have reduced the likelihood of mortality and the most consequential types of growth problems in many countries (Mitra & Rodriguez-Fernandez, 2010; Nuruddin et al., 2009).

Our findings pertaining to material resources parallel those observed for household quality. Having more material resources in the home was related to better height-for-age and stunting, weight-for-age and underweight, and less mortality in most countries. The pattern for weight-for-height was consistent, with positive associations between material resources and weight-for-height in 13 countries, but the pattern was less consistent for wasting, with a positive association in 1 county, negative associations in 7 countries, and no relations in 25 countries. Material resources showed slightly stronger relations with weight-for-age in boys than girls in Cameroon and Kyrgyzstan, and material resources were more strongly related to the wasting status of boys across countries. The fact that owning goods, such as TVs, radios, telephones, and automobiles, showed varying relations to growth problems and

mortality in our study comports with other research. Past studies have implicated household assets as a major contributor to growth, injury, and mortality (Howe et al., 2006; Ricci & Becker, 1996), but in a study conducted in Uganda, a household assets index that included both quality of housing and material resources available did not predict stunting once maternal education was included in the model (Wamani, Tylleskär, Åström, Tumine, & Peterson, 2004). Bakeera and colleagues (2009) conducted another study in Uganda that would seem to bear on how having material resources influence utilization of health care and ultimately health status. Specifically, they conducted a series of focus groups, using the health access livelihood framework as a guide. Individual material resources and the availability of public resources were critical to decisions about using health care, but social resources sometimes compensated for lack of individual resources (e.g., others provided information, financial help, transportation, and the like). In effect, although household assets continue to matter, their role may vary as a consequence of other resources available to the household – a particularly difficult interplay to track in an era of improvements in health and education policies and infrastructure in many developing countries.

Our study reveals that gender differences favoring girls in certain critical markers of child well-being are more pronounced in countries low in wealth per capita. A review of studies conducted in Sub-Saharan Africa revealed a similar pattern (Svedberg, 1990), as did a study of older children in Ethiopia (Dercon & Singh, 2013). In low-HDI countries, boys were more likely to show low height- and weight-for-age and low weight-for-height. The same pattern emerged for GDP, the life expectancy index, and the education index. The education index was also related to wasting and stunting. In general, such findings are consistent with the idea that severe shortages of resources and chronic exposure to potentially damaging conditions leave parents with little discretion as regards treatment of their offspring; thus, giving more precedence to genetic factors that increase resilience or vulnerability. Figure 3.1 reveals two distinct groupings of countries. The lower- to middle-HDI group ($HDI < .65$) all scored below 0, indicating a disadvantage for boys. However, because all but one country in this lower-scoring group were African, it may be that geography rather than HDI is the relevant factor, given that geographic conditions appear to play a consequential role in many aspects of child well-being (Davis et al., 2012). Different climatic conditions are associated with different geographic regions; and it is well known that climate is a major contributor to infectious diseases (Dunn, Davies, Harris, & Gavin, 2010). More specifically, individual infectious agents (protozoa, bacteria, viruses, etc.) tend to concentrate in regions with particular climatic conditions because their host organisms can only thrive in those conditions (Patz et al., 2004). Tropical areas, such as are present in much of Africa, are dense with pathogens that lead to the types of infections implicated in poor growth and mortality (Dunn et al., 2010). High levels of pathogens, in combination with low HDI, may make it very difficult for parents to cope with disease generally (their own or their children's). This combination of conditions may reduce the influence of gender-based values on children's health status, such as our limited findings pertaining to GRS and GII suggest. That possibility granted, given that we had no detailed information on the social and physical conditions present in particular geographic locales, it would be useful to conduct additional studies that included more detailed information about community and household conditions and levels of exposure to key pathogens to determine particular conditions

relevant to specific growth and health problems. It is likely that some of these conditions will be targeted as part of the newly released Sustainable Development Goals (SDGs; United Nations General Assembly, 2015).

Limitations

This study has limitations that raise additional questions about gender in LMIC. Some general and specific limitations associated with the MICS are addressed in Chapter VII. We were limited by not having more information on the assets available to families at country, community, and household levels and by not having more detailed information on gender equity at multiple levels as well (Else-Quest & Grabe, 2012; Sahn & Stifel, 2000). In general we were limited by the items contained in MICS3. The environment questions were all close-ended and specific. The mortality questions did not include information about the circumstances surrounding child death, the date of birth, date of death, or age of the child who died. Consequently, we do not know how many of the children who died were under 5. We only know that a woman in the household aged 15 to 49 lost the child. This limitation acknowledged, MICS3 data were collected in large numbers in 40 countries using a standard protocol that allowed us to make critical cross-country comparisons that are almost completely lacking in the literature.

Conclusions and Implications

Improvements in infrastructure and access to health care over the past two decades have decreased the likelihood children will die or suffer growth deficiencies. These movements toward fulfillment of the UN MDGs have advantaged both girls and boys. However, the improvements have not been uniform within or across countries. To some extent those improvements have shifted what matters as regards community resources, parenting practices, and household accoutrements; but certain factors (e.g., genetic predispositions favoring girls, cultural values favoring boys, social and physical conditions in the surrounding area that may favor boys in some cases and girls in others) continue to play a role in who will survive and who will grow normally. Whether one has access to supportive social networks also matters – an issue of significance given rapid urbanization in some areas, together with immigration and forced evacuations connected with war. Our findings suggest that achievement of MDGs pertaining to child health and equity requires continued efforts to modernize community infrastructure and health services and to increase economic well-being. That said, to provide the kind of precise information health officials and policy makers need to further improve life prospects for children, our findings need to be placed in broader context. It is well known that poor people and poor houses tend to cluster. It is also well known that diseases tend to cluster (Ouattara et al., 2010). Montgomery and Hewitt (2004), using data from 73 Demographic and Health Surveys, found that, when the quality of the neighborhood was included in a model that also included housing quality, neighborhood cluster predicted height-for-age in 22 samples, whereas housing quality was a significant predictor in 45. However, ratios varied depending on geography. In effect, the quality of a child's living conditions matters, but (consistent with ecological theories of development) how much it matters varies depending on other aspects of the child's ecology.

Not to be forgotten is the need to educate both adults and children. As Wachs (2008; see also Gakidou, Cowling, Lozano, & Murray, 2010) aptly noted, having parents (especially mothers) who are better educated contributes to the likelihood that children will be better nourished, gain greater access to needed health care, and have better access to educational opportunities. Better-educated parents are likely to make more productive decisions at each step along the pathway of choices leading to child health promotion (Pokhrel & Sauerborn, 2004).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was supported by the Intramural Research Program of the NIH, NICHD. We thank UNICEF and participating countries for collecting the data.

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Figure 3.1.

Scatterplot between the HDI and the effect size for gender difference in weight-for-age

TABLE 3.1
DESCRIPTIVE STATISTICS FOR THE CHILD GROWTH AND CHILD MORTALITY SAMPLES

Country	Child Growth Sample						Child Mortality Sample											
	Child age (months)			Mother education ^a			# Children under 5			Mother age (years)			Mother education ^a			# Children born alive		
	n	M	SD	M	SD	M	SD	M	SD	n	M	SD	M	SD	M	SD	M	SD
Albania	948	32.16	17.33	2.43	.57	1.15	.39	3237	36.96	7.53	.54	2.45	.54	2.48	1.15			
Belarus	2812	30.58	16.50	2.28	.45	1.08	.29	4872	33.51	8.40	.43	2.24	.43	1.73	.85			
Belize	593	30.02	17.38	1.38	.72	1.34	.56	1145	33.60	8.42	.73	1.41	.73	3.67	2.55			
Bosnia and Herzegovina	2711	31.22	16.38	1.76	.61	1.18	.40	—	—	—	—	—	—	—	—			
Burkina Faso	4168	27.08	15.94	.17	.47	1.27	.47	5637	32.33	8.46	.18	.50	.50	4.53	2.72			
Burundi	—	—	—	—	—	—	—	5819	32.57	8.24	.80	.54	.54	4.43	2.75			
Cameroon	4490	27.67	16.48	1.05	.78	1.42	.59	—	—	—	—	—	—	—	—			
Central African Republic	6706	26.95	16.90	.68	.70	1.41	.59	9039	29.90	8.77	.68	.70	.70	3.98	2.82			
Côte d'Ivoire	6604	27.26	16.64	.47	.69	1.30	.52	—	—	—	—	—	—	—	—			
Djibouti	1549	29.63	15.73	.52	.78	1.45	.64	2620	34.09	7.36	.45	.75	.75	4.00	2.55			
Gambia	4909	25.62	15.94	.51	.77	1.33	.52	6774	30.97	8.03	.52	.79	.79	4.06	2.61			
Georgia	1684	30.13	17.26	2.18	.73	1.21	.42	6395	36.21	8.08	.75	2.02	.75	2.16	.94			
Ghana	2661	28.86	16.75	.86	.90	1.30	.52	4038	33.52	8.30	.92	.91	.91	3.89	2.37			
Guinea-Bissau	4532	27.21	16.22	.40	.66	1.29	.51	5979	30.49	8.53	.47	.72	.72	4.02	2.68			
Guyana	1839	30.21	17.21	1.73	.60	1.36	.56	3583	33.68	8.63	1.74	.58	.58	3.39	2.24			
Iraq	10594	28.09	17.01	1.11	.72	1.55	.69	14546	32.87	8.21	1.10	.74	.74	4.29	2.73			
Jamaica	—	—	—	—	—	—	—	2542	34.56	8.52	2.08	.43	.43	2.83	1.80			
Kazakhstan	3543	28.87	16.81	2.24	.45	1.25	.48	9595	36.26	8.05	2.23	.43	.43	2.43	1.36			
Kyrgyzstan	2358	29.93	17.60	2.22	.43	1.27	.48	4478	34.62	8.28	2.20	.42	.42	2.86	1.58			
Laos	3044	28.51	16.62	.80	.71	1.36	.55	—	—	—	—	—	—	—	—			
Macedonia	3230	33.04	16.02	1.27	.75	1.41	.56	5195	32.78	8.39	1.23	.73	.73	2.51	1.30			
Mauritania	5983	26.91	16.08	.82	.67	1.45	.61	8033	32.30	8.64	.83	.67	.67	4.45	2.84			
Mongolia	3053	28.32	17.05	2.19	.60	1.16	.39	5576	33.77	7.97	2.21	.59	.59	2.76	1.71			
Montenegro	817	31.97	17.15	1.93	.65	1.30	.55	—	—	—	—	—	—	—	—			
Mozambique	8246	27.81	16.76	.84	.63	1.39	.56	11288	30.69	8.66	.86	.64	.64	3.75	2.49			
Nigeria	12292	27.59	16.14	.75	.91	1.35	.56	16472	31.75	8.01	.79	.93	.93	4.17	2.53			

Country	Child Growth Sample						Child Mortality Sample											
	Child age (months)			Mother education ^a			# Children under 5			Mother age (years)			Mother education ^a			# Children born alive		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Serbia	2898	30.09	16.89	1.65	.82	1.30	.54	—	—	—	—	—	—	—	—	—	—	—
Sierra Leone	4258	28.59	16.45	.32	.67	1.23	.46	6365		30.90	7.77	.37	.73		4.44		2.82	
Somalia	3889	28.69	17.14	.41	.56	1.62	.71	4581		30.69	8.07	.43	.58		4.45		2.84	
Suriname	1750	30.80	17.18	1.49	.79	1.29	.52	3537		34.66	8.28	1.57	.73		2.97		1.98	
Syrian Arab Republic	7562	28.85	15.83	1.32	.79	1.46	.62	12899		33.86	7.96	1.29	.83		4.27		2.53	
Tajikistan	3139	29.92	17.01	2.05	.37	1.36	.55	6058		34.58	8.01	2.06	.37		3.82		2.12	
Thailand	8419	29.41	17.05	1.58	.79	1.12	.34	24018		36.77	7.79	1.50	.77		2.02		1.03	
Togo	3169	27.39	16.32	.61	.74	1.29	.49	4549		32.36	8.10	.62	.74		3.92		2.52	
Trinidad & Tobago	—	—	—	—	—	—	—	2608		36.51	8.30	1.81	.56		2.51		1.54	
Ukraine	—	—	—	—	—	—	—	4863		33.08	8.74	2.31	.68		1.62		.85	
Uzbekistan	3881	29.05	16.93	2.09	.29	1.28	.49	8897		34.51	8.12	2.11	.32		3.01		1.57	
Vanuatu	1283	27.91	16.68	1.29	.65	1.27	.50	1969		32.45	8.08	1.28	.64		3.21		1.91	
Viet Nam	—	—	—	—	—	—	—	6283		35.99	8.04	1.60	.72		2.62		1.46	
Yemen	—	—	—	—	—	—	—	3308		32.16	8.56	.44	.71		5.20		3.27	
TOTAL	139614	28.44	16.66	1.11	.93	1.34	.56	226798		33.44	8.45	1.28	.94		3.43		2.39	

Note. – = Data not collected.

^a Education is rated as 0 = none or preschool, 1 = primary school, nonstandard curriculum, religious school, 2 = secondary, vocational, tertiary school, and 3 = higher education.

TABLE 3.2

CORRELATIONS BETWEEN THE HDI AND ITS CONSTITUENT INDICES, GRS, AND GII WITH EFFECT SIZES FOR GENDER DIFFERENCES IN GROWTH AND MORTALITY

	Height-for-age	Stunting	Weight-for-age	Underweight	Weight-for-height	Wasting	Mortality
HDI	.64***	.32	.70***	.10	.73***	.30	-.11
Life Expectancy Index	.52**	.18	.65***	.12	.66***	.28	-.19
Education Index	.61***	.37*	.63***	.06	.70***	.35*	.06
Literacy	.58***	.35*	.57***	-.01	.69***	.41*	.03
Schooling	.61***	.38*	.70***	.22	.66***	.17	.12
GDP Index	.63***	.29	.67***	.09	.68***	.22	-.19
GRS ^a	.35	.12	.50**	.34	.36	-.10	.23
GII ^a	-.13	-.12	.14	-.00	-.19	-.68***	-.05

Note. $N = 32$ –34 countries for the HDI and indicators. The HDI and GDP Index were not available for Iraq or Somalia, and the Education Index and its components were not available for Somalia. $N = 29$ –30 for GRS and $N = 23$ –26 for GII.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

^aControlling for HDI.