

Synergies in Child Nutrition

Interactions of Food Security, Health and Environment,
and Child Care

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Abstract

This paper examines the extent to which the three key underlying determinants of nutrition—food security; adequate caregiving resources at the maternal, household, and community levels; and access to health services and a safe and hygienic environment—on their own and interactively are correlated with nutrition outcomes, such as height-for-age z-scores. Based on data from different years in eight countries in four regions where malnutrition is high, an indicator

is constructed for each component of the three underlying drivers of nutrition. In spite of the limitations inherent in the available data, the analysis (i) reveals that progress toward improved access to adequate food security and adequate environment and health has been quite limited; and (ii) provides evidence of significant synergies among adequate food, child care, and environment and health.

This paper is a product of the Poverty and Equity Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The author may be contacted at eskoufias@worldbank.org.

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1. Introduction

The recent assessments of the global progress towards the achievement of the MDGs show that progress in nutrition has been slower than expected (World Bank, 2013). Malnutrition rates have remained surprisingly high in several countries with robust economic and agricultural growth, which suggests that increases in real GDP and income are insufficient for reductions in child malnutrition.

While there is widespread agreement that reducing childhood malnutrition is critically important for development, there is less consensus on how to achieve improvements in nutrition. A large body of research in the field of public health and nutrition has concentrated on evaluating the impacts of specific interventions such as food, mineral, and vitamin supplements or training programs. On the other hand, the Copenhagen Consensus recommendations suggest that interventions outside the nutrition sector could be more cost effective (Deolalikar, 2008; Hoddinott, et al, 2012). However, up to now, there is little empirical evidence on the factors or combination of sector-specific interventions that are associated with measurable impacts in nutrition.

Recently, a number of initiatives have surfaced at the international front aiming to scale up nutrition interventions. One prominent example is the Scaling Up Nutrition (SUN) movement, whose framework is endorsed by 30 developing countries (Horton, et al. 2010). Leaders of these countries are prioritizing nutrition as an investment in their people's growth, and recognizing nutrition as an investment in economic and social development to strengthen their nations. Along parallel lines, initiatives within the World Bank and other development agencies and research institutions, aim to foster knowledge exchange and cross-sectoral collaboration and coordination at the project level for improving nutrition. All these initiatives are based on the premise that the determinants of malnutrition are multi-sectoral and that the solution to malnutrition requires multi-sectoral approaches.

The UNICEF framework, first proposed in 1990 (UNICEF, 1990), was one of the first attempts at emphasizing food security, environment and health, and child care practices as underlying determinants of child malnutrition in developing countries. One of the fundamental ideas underpinning this framework is that there are substantial interactions and synergies among food security, environment, health, and care. This conceptual framework has been guiding operational and applied analytical work for more than 20 years now.¹

The empirical evidence that exists to date provides a very partial picture regarding the direction and magnitude of the interdependence among adequate (or inadequate) access to food security, environment, health, and child care in child nutrition. One fundamental premise of the UNICEF conceptual framework, is that increases in access to adequate services in one or all of the

¹ At the empirical level, the "guidance" provided by the framework has been primarily in terms of minimizing omitted variable bias or, put differently, in terms of suggesting important variables to be used as explanatory variables in reduced form regressions at the individual, household and/ or community level (Alderman, Hoogeveen and Rossi, 2005; Behrman and Deolalikar, 1998, Christiaensen and Alderman, 2004; Haddad, Alderman, Appleton, Song and Yohannes, 2003; Elfindri and Gouranga Lal Dasvarma, 1996; Rajaram, Zottarelli and Sunil, 2007; Sahn and Alderman, 1997; Skoufias, 1999; Strauss and Thomas, 1998).

subcomponents of any one of these clusters, say for example, food security alone, cannot substitute for inadequate levels of access to the other clusters or individual components of these clusters.

For an accelerated progress towards reducing child malnutrition what is required is a more complete and detailed knowledge of the extent to which there are gaps in access to adequate levels in each of the clusters of underlying determinants. In contexts where child malnutrition is prevalent, a detailed profile of communities or districts or even countries in terms of whether there is adequate or inadequate access to each of the subcomponents of food security, environment, health and child care, can provide a solid basis for the identification of potential binding constraints impeding progress towards reducing child malnutrition. This exercise may also facilitate the prioritization among interventions in the event that limited financial resources or capacity on the ground, do not permit simultaneous improvements in all of the critical factors of child malnutrition.

In spite of the fundamental role of interactions among the three pillars of (i) food security, (ii) environment and health, and (iii) child care, there is a paucity of evidence on the extent to which there is adequate or inadequate access to one or more of these three pillars.² To a large extent the lacuna of such evidence, may be attributed to the relative scarcity of nationally representative data sets with all the necessary detailed information (in the same survey) on child nutrition, and all the variables that could capture in a satisfactory manner the different dimensions of food security, environment and health and care practices. Until now, there has been no systematic effort at documenting the gaps in the necessary data. The most commonly used sources of data such as the Demographic and Health Surveys (DHS) or the Multiple Indicator Cluster Survey (MICS), for historic or budgetary reasons collect data for some key variables such as child care and environment and health without much useful information collected on food security. These surveys are characterized by a strong path dependence, in the sense that the original surveys collected information about specific components of one or two of the three pillars mentioned above with the additional questions added over time constrained by the “straight jacket” of maintaining compatibility with the earlier surveys. In contrast, other specialized surveys ended up collecting information on different dimensions of food security but no information at all child nutrition and anthropometric measures, or on child care or health and environment.³

With these considerations in mind, this report contributes to the existing literature in three ways. First, it provides one of the first comprehensive investigations of the data availability and data constraints associated with a more systematic application of the UNICEF conceptual framework emphasizing the interrelationship among access to adequate food security, environment and health, and child care practices in the prevalence of malnutrition rates among children in developing countries. Using detailed demographic and health survey data are used from Bangladesh, Bolivia,

² Notable exceptions are Chong et al. (2003) and Alderman et al (2003).

³ Interestingly the empirical literature on the determinants of child health does not appear to be affected much by the scarcity of relevant data on the determinants of child malnutrition. The practice prevalent in the majority of studies is to focus the analysis on the contribution of a few key variables on child nutritional outcomes. Examples, of such variables include the economic status of the household, measured by income, consumption expenditures, or household assets (Behrman and Deolalikar, 1987), and the level of education of the mother of the child (Barrera, 1990; Behrman and Wolfe, 1984; Skoufias, 1999; Webb and Block, 2004). In many studies village-level (or sometimes household-level) fixed effects are used to control for the potential influence of unobserved or unmeasured factors such as the environmental health and the care practices. Unfortunately, from the perspective of learning about the interactions among these factors this is tantamount to “throwing out the baby with the bathwater” (Bell and Jones, 2012; Beck and Katz, 1995, 2001).

Cambodia, Ethiopia, Indonesia, Nepal and Zimbabwe, a comparison is carried out of the ideal variables summarizing the various dimensions or components of food security, environment and health, and child care against the measures available from current household surveys. These comparisons serve to highlight the limitations of most data sets and the potential gains associated with the collection and availability of additional information.

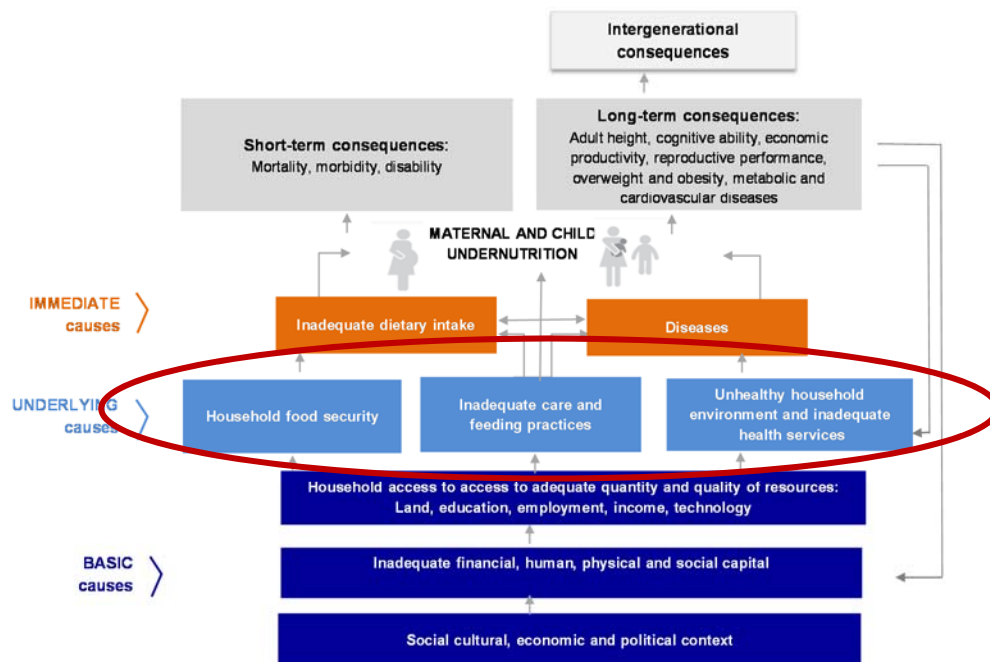
Second, bearing in mind the limitations imposed by the data available, the report also provides a practical diagnostic framework of the main correlates of child malnutrition that could be applied to identify potential “binding constraints” towards the effort to reduce child malnutrition. Specifically, the UNICEF conceptual framework is “operationalized” by serving as a guide for investigating the relationship between the prevalence of malnutrition in the country and inadequate levels and access to the three pillars summarizing the underlying causes of malnutrition. Next, for each indicator available from the survey used in country, a definition of “adequacy” is constructed using thresholds based on accepted international standards. The report aims to provide a “helicopter view” of the extent to which nutritional outcomes, as measured by a child’s height-for-age Z score (HAZ) at any given point in time, as well as over time, are associated with inadequate food security, inadequate environment and health, and inadequate child care practices. In consideration of the complexity of the linkages between the underlying causes of malnutrition and the economic situation of the family, the analysis is also carried out separately for resource-rich (top 60%) and resource-poor (bottom 40%) households based on an asset index constructed for that purpose.

Third, the report provides some of the first empirical evidence on the synergies at work in combating malnutrition in the set of countries used in this study when there is simultaneous access to adequate levels in two or more of the three pillars of the underlying causes of malnutrition. While intuitively appealing, the synergies among the three clusters of malnutrition have received little empirical validation. The recent emphasis on sector-specific nutrition sensitive interventions (World Bank, 2014) rightly emphasizes the synergies that can be exploited *within* specific sectors such as agriculture, water and sanitation, or social protection. The analysis in the report underscores the point that the success of these sector-specific nutrition-sensitive initiatives may be constrained by the slow progress in taking advantage of the synergies among the three broad clusters of the underlying determinants of malnutrition: food security, child care, environment and health. Given that the synergies *among* these three pillars are beyond the scope of any specific sector such as agriculture or social protection, the simultaneous progress towards in all of the three pillars is either taken for granted or underemphasized. As a consequence, nutrition sensitive interventions in specific sectors end up being a sectoral priority in contexts where the chances of success may be limited because of no or very low access to improved infrastructure water and sanitation facilities.

1.1 Methodological Framework

The original UNICEF conceptual framework summarized in Figure 1a views malnutrition as the consequence of a variety of interlinked and interrelated events. The causes of malnutrition are classified into three hierarchical categories: the immediate causes, the underlying causes, and the basic causes of malnutrition. In any given context identification of the immediate causes of malnutrition (disease or inadequate dietary intake) is useful for guiding policy actions especially in situations of crises. However, disease or inadequate dietary intake are typically consequences of a variety of underlying factors that are interrelated. For conceptual simplicity the underlying causes of malnutrition are themselves grouped into the three clusters: inadequate household food security, inadequate care and feeding practices, and unhealthy household environment and inadequate health services. The basic causes of malnutrition summarize the social, cultural, economic and political context and the prevailing inequalities in the distribution of resources in the society. In combination these contextual or structural factors play a fundamental role in the extent to which there are inequalities among households and their members in having adequate food security, care and feeding practices, healthy environment and adequate health services (i.e., the underlying causes of malnutrition).

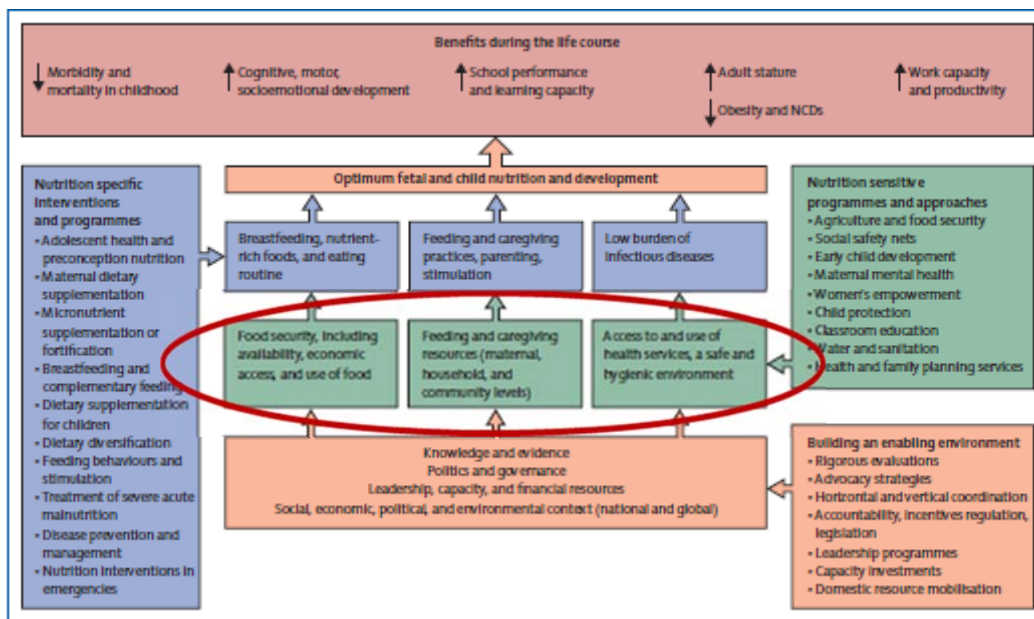
Figure 1a: Determinants of Child Nutrition



Source: An adaptation of the UNICEF (1990) "Strategy for Improved Nutrition of Children and Women in Developing Countries"

Since its conception this conceptual framework has been revised and extended in various dimensions. Various international organizations have adopted as well as adapted this framework. For example, FAO (2011) discusses adaptation of this framework for FAO’s nutrition analysis. USAID - FANTA (Food and Nutrition Technical Assistance) also adapted this framework (Riely et al., 1999). World Food Program (WFP) refers to it as the Food and Nutrition Security Conceptual Framework in its Emergency Food Security Assessment Handbook (WFP, 2009, pg. 25). However, whatever the adaptations and the extensions to the original framework, the fundamental ideas regarding the critical interactions, interrelations and synergies among food security, environment and health, and care have remained at the core. This is also very transparent in the framework for actions to achieve optimum fetal and child nutrition and development extracted from the 2013 Lancet Maternal and Child Nutrition Series (see Figure 1b below).

Figure 1b: Framework for Actions to Achieve Optimum Fetal and Child Nutrition and Development



Source: the Executive Summary of “The Lancet Maternal and Child Nutrition Series 2013.”

The analysis in this report focuses on the underlying causes of malnutrition. This is because actions aimed at affecting the underlying causes of malnutrition are likely to be more feasible in the medium term and thus more likely to have a long term effect on malnutrition.⁴ Food security

⁴ One should not underestimate the potential of reductions in inequalities in the distribution of resources in the society, or changes in the social, cultural, economic and political context in having large and lasting positive effect on child nutrition. However, changes in the basic causes of malnutrition are likely to be inhibited by many more constraints including vested interests and political economy considerations.

summarizes the availability, access, and utilization (consumption) of food.⁵ Environment and health summarizes the variety of contextual factors that can impact on children's susceptibility to diseases such as lack of improved sanitation and water facilities, difficulty of access to health facilities, or low quality of health care. Finally, maternal and child care summarizes the quality of care provided by the caregiver, such as feeding and hygiene practices adopted and by the availability of the caregiver. Furthermore it measures how well the caregiver is supported in her childrearing endeavors.

Although the framework is a holistic way of conceptualizing nutrition it is also important to acknowledge the limitations of the classification scheme. Prices, knowledge, education, and household income all influence components of the three clusters of the framework, resulting in some overlap in the measures. The methodology is informative in finding the overall relationships, from which more focused and detailed analyses can be carried out to determine more concretely the underlying causes. So for example, more detailed information would be needed to determine whether food inadequacies were due to the cost of food relative to income, to lack of information on the importance of diversified diet, or due to some other factor. The models estimated in this report are not reduced form models (taking into account budget constraints etc.) as done in Barrera (1990), but rather correlations between nutritional outcomes such as height for age z-scores and having adequate levels of access to each of the variables grouped into the three clusters.

⁵ It is important to bear in mind that our use of the term "utilization" represents an adaptation to FAO's use of the same term in their definition of food security. For FAO, utilization is the following: "Utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met." This brings out the importance of non-food inputs in food security. <http://www.fao.org/forestry/13128-0e6f36f27e0091055bec28ebe830f46b3.pdf>

2 Data and Measures

Measurement is very important for a proper diagnosis of the longer run constraints to reducing chronic malnutrition in any given context. Each of the three clusters of underlying causes of malnutrition is inherently multidimensional making measurement difficult and costly. As a consequence the main concepts underpinning the original UNICEF framework regarding the interrelationship between and synergies among food security, environment and health, and child care are usually taken for granted or mistakenly assumed to have been investigated by other earlier studies.

Table 1 lists the countries and sources of data used in this study. Two countries were purposefully chosen from each of the four regions where malnutrition is a problem, (i.e. South Asia (SAR), Latin America and the Caribbean (LAC), East Asia Pacific (EAP), and Sub-Saharan Africa (SSA). Additional criteria applied included: (i) the survey contained reliable information of children's height (and weight) which are the widely accepted measures of chronic and short-term malnutrition. This criterion limited the analysis to the Demographic and Health Surveys (DHS) as these are the only surveys in most countries with child height (and weight) measures. (ii) Data were available for at least two years in the last decade; (iii) malnutrition rates were stable or slowly declining over time; (iv) there was parallel analytic work in the Bank on different dimensions of poverty and nutrition taking place in some of these countries (e.g. Ethiopia); and (v) there were more than one survey available in the same country (e.g., Bangladesh). The samples in most countries are mainly rural except for Bolivia, Peru, Indonesia, and the Helen Keller survey in Bangladesh where urban households make up between one-third and one-half of the samples. The IFPRI survey for Bangladesh includes only rural households.

Table 1: Countries and Data Sources

Region	Country - data source
SAR	Bangladesh (Helen Keller 2010, 2011 and IFPRI 2011)
	Nepal (DHS 2001 and 2011)
LAC	Bolivia (DHS 2003 and 2008)
	Peru (DHS 2005 and 2012)
EAP	Cambodia (DHS 2005 and 2010)
	Indonesia (Riskesdas 2010)
SSA	Ethiopia (DHS 2000 and 2011)
	Zimbabwe (DHS 2005 and 2010)

Given these criteria the sample of children used is between 0 and 24 months in Bangladesh (Helen Keller data), Cambodia, and Zimbabwe, between 0 and 25 months in Bangladesh (IFPRI data) and Indonesia, and between 0 and 36 months in Bolivia, Ethiopia, Nepal, and Peru.⁶

⁶ In spite of recent findings that catch-up growth occurs without interventions (Prentice, et al., 2013), or as a result of interventions, much of stunting occurs before the age of 24 months (Victora, et al., 2010). In addition recent research has found that catch up growth in school aged children is not associated with improvements in cognitive ability (Sokolovic, Selvam, Srinivasan, Thankachan, Kurpad and

The set of countries used in the analysis is discussed and the nutrition literature is surveyed for the purpose of identifying as completely as possible the set of factors identified in the nutrition literature as the ideal variables or measures of underlying causes of malnutrition.

2.1 Measures of Food Security

This section serves to highlight the fact that the necessary data for measuring the different dimensions of the concept of food security either at the household or at the individual level are the data missing most frequently from the standard surveys used to assess the levels and determinants of malnutrition. In contrast, more data seem to be available for the measurement of some of the components of child care and environment and health with the latter being measured almost as best as one could hope for. This is probably a reflection of the tradeoffs associated with measurement and cost. Given the limited survey budgets allocated to collecting information on the different dimensions of nutrition, greater emphasis may be placed on collecting information on environment and health and child care as these are collected at lower cost and perhaps even more reliably compared to the cost of a detailed survey collecting information on food availability, access and utilization at the household or individual level.

A systematic effort is made to identify the extent to which any or some of these ideal variables/measures identified in the literature as an important underlying cause of malnutrition can be approximated by any proxy measure that is collected in the existing surveys used to analyze or monitor child malnutrition at the national or even at the regional level within any given country.

2.1.1 “Ideal” Indicators of Food Security

The Food and Agricultural Organization (FAO) defines food security as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.” This definition is a significant departure from previous conceptualizations of food security which focused inordinately on the availability of food at the national or local level. But, in being broad and all encompassing, this definition is also a difficult one to operationalize, as it emphasizes the importance of access and utilization of food just as much as availability (Barrett, 2009).

What constitutes availability, access and utilization – the three dimensions of the current thinking on food security? Availability is associated with the supply side of food, measured most often by the extent of agricultural production and food trade balance relative to the size of consumption for any given country. Access, on the other hand, brings in the demand element to the equation: conditional on what is available in the local market and the price at which it is available, what is the range of food choices that are open to households given their incomes? Conceptually, it is this dimension of food security that has the strongest resonance with poverty and vulnerability not only because of

Thomas, 2013) although catch-up growth in earlier childhood was associated with cognitive abilities similar to those who had never been stunted (Crookston, Penny, Alder, Dickerson, Merrill, Stanford, Porucznik and Dearden, 2010).

its direct relationship with income, but also because of its links to broader issues of social and political enfranchisement. Food security of individual household members, for example hinges on their social standing within the household almost as much as it does on the household's overall ability to procure enough food (vulnerable groups within the household may include children, daughters, daughters-in-law, or the elderly). Finally, the utilization dimension brings to bear the quality dimension of the accessed food. Do household's make good use of the food they are able to access? Are diets diverse enough to provide all the micro and macronutrients necessary for healthy physiological and cognitive growth? Are cooking methods sanitary and healthy enough to preserve the nutritional attributes of the eaten food?

Following the FAO's accepted and applied definition of food security an effort is made to map the most commonly used measures into at least one of the three dimensions of food security. Specifically, the measures considered are: per capita expenditure; share of food in total expenditure; per capita caloric availability; food consumption score (FCS); household dietary diversity score (HDDS); child dietary diversity score (CDDS); mother's dietary diversity score (MDDS); household food insecurity access scale (HFIAS); starchy staple ratio (SSR); and share of food expenditure on starchy staples (SSEXR).

Per capita expenditure is a widely used measure of a household's wealth status and overall well-being. It is indicative of resources that are available to a household that the household can tap into to satisfy their food requirements. It is thus used as one of the measures of access component of food security. Food share of total expenditure is an indicator of the household's economic vulnerability and can be a proxy measure of household's ability to access food. Households that spend a larger proportion of their total expenditure on food do not have sufficient safety net of non-food expenditure to rely on and thus are more susceptible to food deprivation. In an event of a negative income shock or increase in food prices, households with a higher share of food expenditure will have to adjust by either reducing food quantity or by lowering the quality of food they eat. Per capita caloric availability is an indicator of diet quantity and relates to the access component of food security. It is one of the most widely used quantitative indicators of food security. It measures whether a household has acquired sufficient calories to meet the daily energy requirements of its members. If a household's estimated per capita daily energy availability is lower than the per capita daily requirement, then the household is considered energy deficient and can be classified as food insecure.

Another measure of food security used is the share of calories derived from starchy staples – or starchy staples ratio (SSR). It is measured as the percentage of calories derived from starchy staples. Starchy staples are energy-dense but are low in protein and micronutrients which means that households with higher value of SSR will have a lower quality diet and will be more vulnerable to protein and micronutrient deficiencies. Moreover, starchy staples are not only cheaper sources of energy but also figure prominently as a part of household's staple diet. Jensen and Miller (2010) suggest this measure to be a potentially promising way to capture food security within the household. It relies on consumption behavior, to reveal the household food security situation, as

opposed to caloric norms.⁷ Finally, there is also the expenditure analog of the starchy staples ratio which is the share of food expenditures that is devoted to the purchase of starchy staples. We call this the starchy staples expenditure ratio (SSEXR).

Dietary diversity is a measure of diet quality and reflects the variation in food typically consumed by households. In general, it is defined as a sum of the number of food items or food groups consumed over a given reference period. Although there is no a general consensus in constructing a measure of dietary diversity, studies have shown that various measures of dietary diversity are positively correlated with others measures of household food security such as per capita consumption, calorie availability, calorie intake, and intake of essential nutrients.⁸

Two of the most commonly used indicators of dietary diversity are household dietary diversity score (HDDS) and individual dietary diversity score (IDDS), developed by USAID Food and Nutritional Technical Assistance (FANTA). HDDS is defined as the number of different food groups consumed at the household level by an average member over a 24-hour recall period. Whereas, IDDS is defined as the number of different food groups consumed by an individual over a 24-hour recall period. FANTA/FAO uses twelve, eight and nine food group classification to construct the HDDS, CDDS and MDDS, respectively. The value of HDDS ranges from 0 to 12 and the values of CDDS and MDDS range from 0 to 8 and 0 to 9, respectively.

Food consumption score (FCS) is a measure of access component of food security developed by the WFP. WFP uses FCS as one of the core measures of food consumption and food security to monitor, assess, and track changes in food security situation and needs of countries and regions that it has programs in. It is a composite score that incorporates dietary diversity, food frequency, and relative nutritional importance of different food groups consumed by a household. For the calculation of the FCS, data is collected on the 7-day recall of frequency of consumption of different food items and food items are grouped into 8 specific food groups with each group given a weight representing the nutrient density of that food group. The value of FCS ranges from 0 to 112 with a higher FCS representing a higher dietary diversity and/or frequency of consumption and higher nutritional value of a household's diet and vice versa.

Household food insecurity access scale (HFIAS) is a measure developed by FANTA to assess food access problems faced by household during a recall period of 30 days. It aims to capture the changes in food consumption patterns and reflect the severity of food insecurity faced by households due to lack of or limited resources to access food. It is composed of nine questions and these questions relate to three different domains of access component food insecurity: anxiety and uncertainty about household food access, insufficient quality, and insufficient food intake (Swindale et al. 2006). Each question has four response options: never, rarely, sometimes, and often, which

⁷ It is based on the idea that at levels below subsistence, individuals have high marginal utilities for calories and are likely to choose cheap sources of calories such as rice, wheat, cassava etc. As they pass subsistence, their marginal utility of calories begins to decline and they begin to value other non-nutritional attributes of food such as taste and start diversifying their diet. While the actual subsistence threshold is unobserved, their "dietary transition" is and this can be used to identify whether or not they have crossed the food security threshold. By relying directly on consumption behavior to elicit information on hunger and food security, this method obviates the need to impose caloric norms and thresholds.

⁸ Ruel (2002), Weismann et al(2009) and Hoddinott and Yohannes (2002).

are coded 0, 1, 2 and 3 in order of increasing frequency. Responses to these nine questions are summed to construct a food insecurity score, with a maximum score of 27 indicating most food insecure households.

Table 2 below presents a summary description of all these “ideal” indicators of the different dimensions of food security.

Table 2: Ideal Food Security Measures

Dimensions of Food Security	Food Security Indicator	Description
Availability	Per capita daily calorie availability	Indicates whether enough food is available to meet the daily energy requirements of a national or local population. Most commonly used measure of food security.
	Per capita household expenditures	Captures the amount of food purchased or acquired during a survey period. Associated with general measures of poverty.
	Share of food in total household expenditures	Indicator of the household’s economic vulnerability. Associated with general measures of poverty.
Access & Utilization	Food Consumption Score (FCS)	Composite score that incorporates dietary diversity, food frequency, and relative nutritional importance of different food groups.
	Starchy staples ratio (SSR)	Percentage of calories that a household derives from starchy staples. Also associated with general measures of poverty.
	Starchy staples expenditure ratio (SSEXR)	Share of food expenditures devoted to the purchase of starchy staples. Also associated with general measures of poverty.
	Dietary Diversity Score (HDDS)	Reflects the variety of foods that a household typically consumes. Captures information about dietary quality. DDS denotes the number of a total of seven food groups consumed during the past 24 hours. The seven food groups considered are (1) grains, roots and tubers; (2) legumes and nuts; (3) dairy products; (4) flesh foods including organ meats; (5) eggs; (6) vitamin A rich fruits and vegetables including orange and yellow vegetables; (7) and other fruits. Ideally, this score should be determined separately for the child and mother. In our study it was only available for the child and in the case of Indonesia only available as an average dietary diversity score for the household.
	Minimum Acceptable Diet –	For children under the age of 6 months, the only acceptable diet considered is breastfeeding. For children 6-36 months the minimum acceptable diet consists of a DDS of 4 or greater, currently breastfed or receiving milk feedings (including cow and other milks in addition to formula feeds) and age appropriate minimum meal frequency. For breastfed children 6-8 months of age, the child needs to have been fed at least twice in the past 24 hours, for children 9 to 36 months at least three times. For non-breastfed children from 6 to 23 months of age, the child needs to have been fed four times in the past 24 hours

Dimensions of Food Security	Food Security Indicator	Description
	Household Food Insecurity Access Scale (HFIAS)	Subjective indicator based on perceptions and experience. The measure is based on statements such as: (1) You were worried you would run out of food because of lack of money or other resources; (2) You were unable to eat healthy and nutritious food because of lack of money or other resources; (3) You ate only a few kinds of food because of lack of money or other resources; (4) You had to skip a meal because there was not enough money or other resources to get food; (5) You ate less than you thought you should because of lack of money or other resources; (6) Your household ran out of food because of lack of money or other resources; (7) You were hungry but did not eat because of lack of money or other resources; (8) You went without eating for a whole day because of lack of money or other resources. Later modified into the Household Hunger Scale (HHS)
	Child Dietary Diversity Score (CDDS)	Reflects the variety of food consumed by the mother and child and is based on individual level intake information
	Mother's Dietary Diversity Score (MDDS)	

2.1.2 Available Indicators for Food

Table 3 lists the various indicators of food security each capturing different dimensions of the ideal food security measure and the indicators that can be constructed from the surveys (mainly DHS) in the countries studied.

Ideal Indicators	AVAILABLE
Children's Dietary Diversity Score (CDDS)	Yes
Mom's Dietary Diversity Score (MDDS)	No
Minimum Acceptable Diet (for children 6-24 months)	Yes
Food Insecurity Access Scale (HFIAS)	No (Only in Helen Keller)
Food Consumption Score (FCS)	No
Relative prices of different food groups	No
PROXIES IF IDEAL INDICATORS ARE NOT AVAILABLE	
Household Dietary Diversity Score (for child/mom)	Helen Keller
Starchy Staple Ratio or the Fraction of household Calories Derived from Starchy Staples	No (since surveys in this study do not contain detailed household consumption module)

Most of the data sets used in this study contain information to construct a diversity score for the child and the minimum acceptable diet measure, but lack information relevant for the other dimensions of food security. The diversity scores measures the consumption from different food groups. In general there are seven groups (grains, roots and tubers; legumes and nuts; dairy products; flesh foods including organ meats; eggs; vitamin A rich fruits and vegetables including orange and yellow vegetables; and other fruits) of which an individual needs daily consume four.⁹ The minimum acceptable diet combines dietary diversity, breastfeeding and meal frequencies.¹⁰ The dietary diversity score depends on the age of the child. For example, those under six months of age should be exclusively breastfed whereas older infants should receive complementary feedings as well as milk.¹¹ For the Helen Keller data from Bangladesh, we are able to construct a household level food insecurity measure, but not a measure of minimum acceptable diet. A child has to meet both the dietary diversity and the minimum acceptable diet (or food security) definitions be considered adequate in food.

2.2 Measurement of Child Care

2.2.1 Ideal Indicators for Child Care

Adequate care measures the capacity of the child's caregiver to provide a healthy environment for the child to grow up in. Ideally, the measure is based on information on (1) the caregiver's education, knowledge, and beliefs; (2) the health and nutritional status of the caregiver; (3) the mental health, lack of stress, and self-confidence of the caregiver; (4) the caregiver's autonomy and control of resources; (5) the workload and time constraints of the caregiver; and (6) the social support received by the caregiver from family members and the community. Below we expand on the specific components of an ideal adequate care measure.

- ***Caring Behavior: Breast-feeding and Complementary Feeding, Health Seeking, Hygiene-Related***
 - Caregiver feeding behavior (observation of one or more eating episodes)
 - Caregiver responsiveness during feeding episodes
 - Frequency of behavior such as feeding, number of spoonfuls, number of touches
 - Breastfeeding practices (e.g., exclusive breastfeeding up to 6 months, early initiation of breastfeeding, breastfeeding at 2 years)
 - Introduction of solid/semi-solid/soft foods 6-8 months
 - Child feeding index (constructed from DHS data using the following yes/no questions: current breastfeeding; use of bottles; dietary diversity; feeding/meal frequency)
 - Taking a child to a health clinic for treatment of illness
 - Maternal hand-washing with soap
- ***Maternal Education, knowledge and beliefs***

⁹ For Indonesia the dietary diversity measures is only available for the household, not specific to each child.

¹⁰ Meal frequency information is not available in the Helen Keller Bangladesh survey or in the Indonesia RKD survey.

¹¹ For milk intake we include breast milk, formula, and cow's milk.

- Years of Schooling
- Literate/illiterate (Self report, simple test or existing data)
- Beliefs and knowledge about initiation of breastfeeding
- Beliefs about complementary feeding – timing, types, control of intake
- **Workload and Time Availability of Caregiver**
 - Observed time in child care (observed in sample of time or continuously)
 - Recalled time in child care (24 hour recall)
 - Quality of care during work time (characteristics of alternate caregivers (e.g. age, gender))
- **Social Support for Caregiver**
 - Availability of alternate caregivers
 - Community support (assessment of community institutions for child care-feeding programs, child care programs)
- **Psychosocial Care**
 - Caregiver/child interactions – naturalistic observation of caregiver and child for a short period (code variables such as delay to respond, type of response, level of vocalization by caregiver and child)
 - Child appearance (rating of appearance either in a public place or over a period of visits)
 - Caregiver’s understanding of motor milestones

2.2.2 Available Indicators for child care

Of the ideal components we have information only on a few of the caring behaviors, namely, some information on breast-feeding and complementary feeding. Table 4 lists the ideal and the available measures. In our measure of adequate care, initial breastfeeding for immediate skin-to-skin contact has to have occurred within the first hour after birth.¹² For children under the age of 6 months, adequate care consists of exclusive breastfeeding. For children 6 to 8 months of age we require complementary feedings. All children under 24 months are required to be breast-fed. Although the surveys have information on the educational level of the mother, the presumed caregiver, there is no consensus on how to translate that information to a measure of the mother’s care giving abilities and thus we do not include it in our measure.

Table 4: Components of Care	
IDEAL	AVAILABLE
Workload and time availability of caregiver	No
Social support for caregiver	No
Psychosocial care	No
Caring Behaviors: Breast-feeding	Yes

¹² For Bolivia and Peru initial breastfeeding can only be identified in the first 100 minutes (instead of 60 minutes) and the measure is not available in the IFPRI Bangladesh data.

Caring Behaviors: Health seeking	No
Caring Behaviors: Complementary feeding	Yes
Caring Behaviors: Hygiene	No
Caring Behaviors: Child feeding index	No
Notes: Another important indicator of care is maternal education though there is no consensus on the threshold (or level of education) for adequate nutrition care behaviors	

2.3 Measurement of Environment and Health

2.3.1 Ideal Indicators for environment and health

The ideal indicator for adequate environment and health captures access to environmental infrastructure and health service utilization. The construction of the ideal measure of adequate environment and health is based on the definitions adopted by WHO and UNICEF. Namely,

- **Access to safe water** – According to WHO and UNICEF (2006), the water source is considered improved if the drinking water is piped into the dwelling/yard/plot, comes from a public tap/standpipe, comes from a tubewell or a borewell, comes from a protected well or spring or rainwater is used. Furthermore, the drinking water is considered improved if it comes from an unimproved source (such as surface water, unprotected well or spring) but it is disinfected by either boiling, adding bleach/chlorine or by solar disinfection. Unprotected springs or dug wells, cart with small tank/drum, tanker-trucks, surface water or bottled water are all considered unimproved.
- **Access to adequate sanitation** – Following WHO and UNICEF (2006) households are defined as having access to improved sanitation if the household uses a flush or pour flush latrine with a latrine pit, septic tank or piped sewer system, a ventilated improved pit latrine, a pit latrine with slab or a composing toilet. Unimproved sanitation facilities include flush/pour flush to unknown or non-closed system, pit latrine without slab, bucket, hanging toilet or latrine or no facilities. The sanitation is considered improved only if it is not shared. Due to lack of information on shared facilities, the condition is dropped in all other countries, but Cambodia.
- **Community level sanitation** – Measures the percentage of households in the child’s locality (i.e. village) with access to adequate sanitation. A threshold of 75% is used, except for Peru where sanitation information was not collected.
- **Use of prenatal services** – Number of prenatal visits by mother while pregnant. The WHO (2007) recommends at least 4 prenatal visits and the adequacy measure uses 4 visits as the threshold.
- **Immunization status** – Based on national or WHO (2013) recommended immunization schedules. Depending on the age of the child, the required vaccines differ. In general, for example, the first DTP3 (diphtheria-tetanus-pertussis) is recommended at 6 weeks of age. Giving a leeway of three months, a child who is 4 months old is in compliance only if they have received the first DTP3 vaccine.

- **Vitamin A Supplementation status** – Based on the WHO guidelines that recommendation children 6 through 59 months should receive a vitamin A supplement in areas where vitamin A deficiency is a known public health problem.
- **Presence of unpenned animals** – Measures the likelihood that a child maybe in contact with non-human sourced fecal matter.
- **ORS use for treatment of diarrhea** – Measure of use of oral rehydration solutions in treating diarrhea in young children.
- **Antibiotic treatment for pneumonia** – A national measure capturing the percentage of children aged 0–59 months with suspected pneumonia receiving antibiotics.

The surveys typically contain more information to construct a comprehensive measure of environment and health than comprehensive measures of food or care. In our measure, we consider access to safe water, improved sanitation, and require that more than 75% of child’s community have access to improved sanitation. In terms of prenatal health services, a mother must have had at least four prenatal visits. For post-natal health services we require the child to have their immunizations up to date and that the child has received a vitamin A supplementation (as drops or tablets) since birth. Although some of the surveys collected information on ORS use or antibiotics, the information was only available for those children who had recently experienced diarrhea or a bacterial infection and not for all children. Table 5 lists the ideal and the available components to be considered for adequate environment and health.

Table 5: Components of Environment and Health	
IDEAL	AVAILABLE
Access to safe water	Yes
Access to improved sanitation	Yes (except Bolivia)
Community level sanitation	Yes (except Bolivia, Ethiopia, Indonesia, and HK)*
Use of prenatal services	Yes (except Indonesia)
Age appropriate immunization status	Yes (except HK)
Vitamin A supplementation status (typically for children 6 months and older)	Yes (except Indonesia, Bolivia)
ORS use for treatment of diarrhea	No
* Community level sanitation was not included for Bolivia as no sanitation information was collected. Community level sanitation was not included in the adequacy measures for Indonesia as we did not have access to the village identifiers. Community sanitation was dropped from the analyses in Ethiopia and Bangladesh HK as the resulting number of children with access to adequate environment become negligible.	

2.4 Other data issues and related considerations

Since each survey is designed slightly differently, care must be taken when comparing across different countries. Table 6 summarizes the comparability of the different indicators across the countries and the survey year for each country. In most cases, the two survey years have comparable data and it is possible to compare the evolution of the indicators within a country. The notable exception is Bolivia where slightly different data were collected in the two survey years and the comparison of adequate food or adequate care measures through time is not possible. Comparisons across countries are more difficult. There are two sets of countries which have similar information. The first is comprised of Cambodia and Zimbabwe and the second of Ethiopia and Nepal. If the fact that the first set collects information for under 24-month olds and the second for under 36-month olds is not a concern, then all the four countries can be compared.

Currently many household level surveys have information on aspects of environment and health but the information regarding food and care aspects of nutrition is less robust. Understanding the synergies from the adequacies and nutrition would benefit from more detailed data collection especially of food and care components. Information on food security is crucial in complementing food diversity and minimum acceptable diet components to construct a holistic adequate food measure. Information on the knowledge of the caregiver regarding best child care practices is missing in all the surveys that we reviewed.

Another important consideration is that currently most studies are cross-sectional and with few questions regarding the timing of various actions or information on past conditions. The implication is that we can only assess the child's current situation and not the child's cumulative experience. The fact that a child meets the recommendations for his or her age at the time of the survey, does not imply that he or she has always met the age appropriate adequacy definitions. So for example in the majority of our studies, for a child that is a year old, it is not possible to know whether the child was exclusively breastfed until 6 months and received at least one complementary food at 6 to 8 months. Similarly it is not usually possible to know if vaccinations or vitamin A supplements were received at the recommended ages, since many families only report whether the child has received the vaccination or supplement but not the actual date. Some components, such as access to improved sanitation, most likely have not changed for the majority of children since their birth, but other behaviors, such as hand washing may be components that may have changed. The lack of past information potentially leads to inflated numbers of children identified as adequate in a particular component when in fact they have been inadequate for some span of time since birth.

Many of the underlying measures are dichotomous leading to binary adequacy measures. The challenge and limitation with binary measures is the underlying assumptions that need to be made regarding cut-off values or conditions. Continuous adequacy measures would allow to measure the correlations between changes in the adequacy levels and nutritional outcomes and thus providing more detailed information on the relationships and synergies. However, it is not easy to envision the construction of meaningful continuous adequacy measures.

Table 6: Comparability of indicators across years and countries

Country and data year	Maximum age (months)	Food					Environment & Health							Care				
		Dietary diversity	Food security	Meal frequency	Acceptable diet	Second round comparable to first round	Improved sanitation	Community sanitation	Access to safe water	Vaccinations	Prenatal checkups	Vitamin A supplementation	Second round comparable to first round	Exclusive breastfeeding	Immediate skin-to-skin contact	Complementary feeding (6-8 months)	Breastfeeding for 24 months	Second round comparable to first round
Cambodia (2005)	24	Y	N	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	
Cambodia (2010)	24	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ethiopia (2000)	36	Y	N	Y	Y		Y	Y ²	Y	Y	Y	Y		Y	Y	Y	Y	
Ethiopia (2011)	36	Y	N	Y	Y	Y	Y	Y ²	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nepal (2000)	36	Y	N	Y	Y		Y	Y ²	Y	Y	Y	Y		Y	Y	Y	Y	
Nepal (2012)	36	Y	N	Y	Y	Y	Y	Y ²	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bolivia (2003)	36	Y	N	N	N		N	N	Y	Y	Y	N		Y	Y ⁴	Y	Y	
Bolivia (2008)	36	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	N	Y	Y ⁴	Y	Y	Y
Peru (2005)	36	Y	N	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y ⁴	Y	Y	
Peru (2012)	36	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y ⁴	Y	Y	Y
Zimbabwe (2005)	24	Y	N	Y	Y		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	
Zimbabwe (2010)	24	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bangladesh (HK, 2010)	24	Y	Y	N	N		Y	Y ²	Y	Y	Y	Y ³		Y	Y	Y	Y	
Bangladesh (HK, 2011)	24	Y	Y	N	N	Y	Y	Y ²	Y	N	Y	Y ³	N	Y	Y	Y	Y	Y
Bangladesh (IFPRI, 2011)	24	Y	N	Y	Y	n/a	Y	Y	Y	Y	Y	Y	n/a	Y	N	Y	Y	n/a
Indonesia (RKD, 2010)	24	Y ¹	N	N	N	n/a	Y	N	Y	Y	N	N	n/a	Y	Y	Y	Y	n/a

NOTES: Y = yes, N = no; ¹At the household level instead of child-specific; ²Community sanitation not included in the environment adequacy measure used in the regressions (only in summary statistics). ³Vitamin A supplementation information asked for only 6 to 24 month olds. ⁴Within first 100 minutes (not 60 minutes) as is used in the other countries.

3 Prevalence of stunting and access to adequate food security, child care, and health and environment

In line with the common practice in the literature, the report adopts height-for-age as the measure of chronic malnutrition. Given that stunting, height-for-age more than two standard deviations below the median height-for-age for the particular age and gender, captures chronic malnutrition, it is chosen over wasting, weight-for-height more than two standard deviations below median weight-for-height, since the latter most frequently indicates a recent episode of severe weight loss associated with starvation and/or severe disease resulting in acute malnutrition.

3.1 Prevalence of stunting

Although stunting remains high in most of the study countries, it has decreased significantly over time for both under two-year olds as well as for under five-year olds. Figure 2 depicts stunting in the under two-year group in the eight countries and Figure 3 depicts stunting in the under five-year group. It is important to bear in mind that for Bolivia, Cambodia, Ethiopia, Nepal, Peru, and Zimbabwe the stunting rates are based on stunting rates reported by the StatCompiler of DHS for the indicated years using all the children with height information. For Bangladesh the information is derived from the HK and IFPRI data sets and for Indonesia from the RKD data set. In both age groups the seven countries for which there are multiple years of data show no increases in stunting. In Ethiopia and Nepal the reductions have been the greatest. From 2001 to 2011, Nepal experienced a 17 percentage point reduction in the prevalence of stunting in Nepal in the under 5-year cohort and 15 point reduction in the under 2-year cohort. In Ethiopia from 2000 to 2011, stunting reduced by 13 percentage points in both age cohorts. Ethiopia and Nepal were also the two countries with the highest baseline stunting rates. In addition, Peru achieved large reductions in stunting, by nearly halving the stunting prevalence in the under 5-year old cohort so that in 2012 the prevalence of stunting was 18%. In the other countries the reductions have been in the right direction but modest reductions of five percentage points or less.

Figure 2: Stunting under 2-year olds

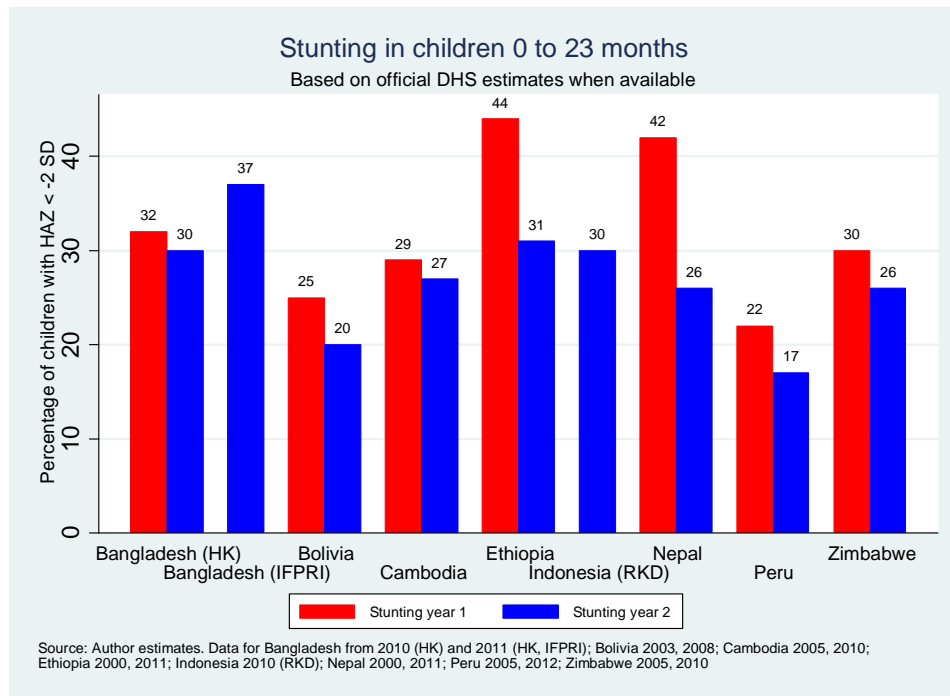
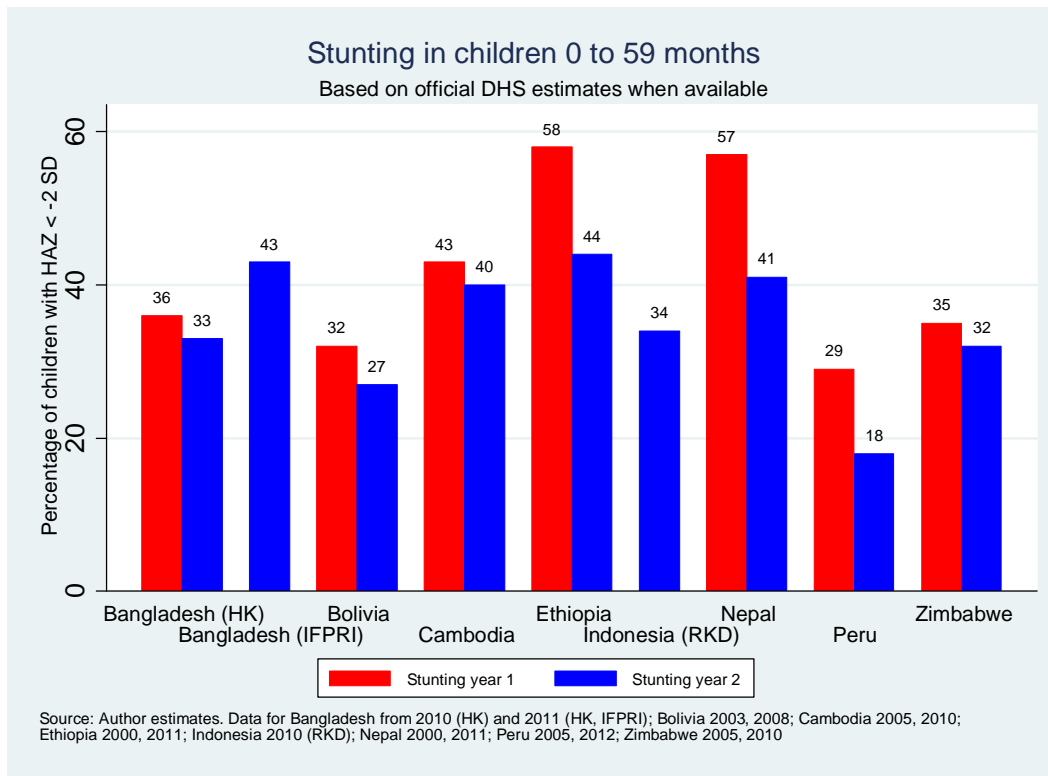
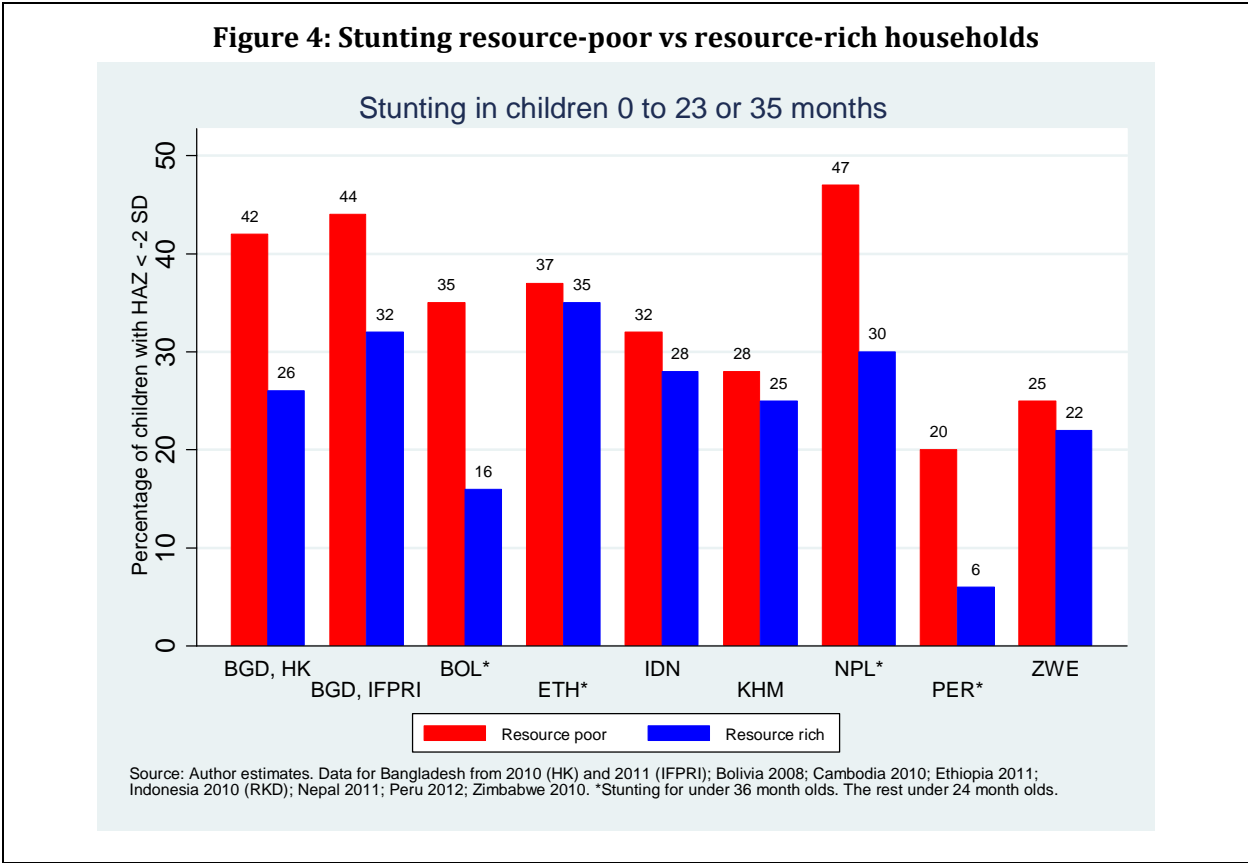


Figure 3: Stunting under 5-year olds



In all eight countries, children living in resource-poor households are more likely to be stunted than children living in resource-rich households. A household is classified as resource rich if it is in the top 60% of an asset index and as resource poor the bottom 40% of the index value. Annex 1 describes the construction of the asset index. The difference in stunting rates by access to resources is especially marked in Peru where only 6% of the children in resource-rich households are stunted, but 20% of children in resource-poor households are stunted—a quadrupling of the prevalence (Figure 4). Similarly, the other LAC country of the study—Bolivia—showed large differences in stunting rates by wealth. Children in resource-poor Bolivian households were more than twice as likely to be stunted as children in resource-rich households. The other countries with a large prevalence gap by resource access were Bangladesh based on the Helen Keller data and Nepal. In Cambodia, Ethiopia, Indonesia, and Zimbabwe, the stunting rates for resource-poor and resource-rich children were within 4 percentage points.



3.2 Adequacies in Food Security, Environment, Health, and Care Practices

Given the indicators available in the surveys, the determination of whether children have access to an adequate or inadequate level of each specific underlying determinant of nutrition is carried out using accepted international standards regarding infant and child feeding practices, food security, improved water and sanitation, and pre- as well as post-natal care practices. Specifically, the WHO (2008) standards are used for assessing infant and young child feeding practices, the USAID (2012)

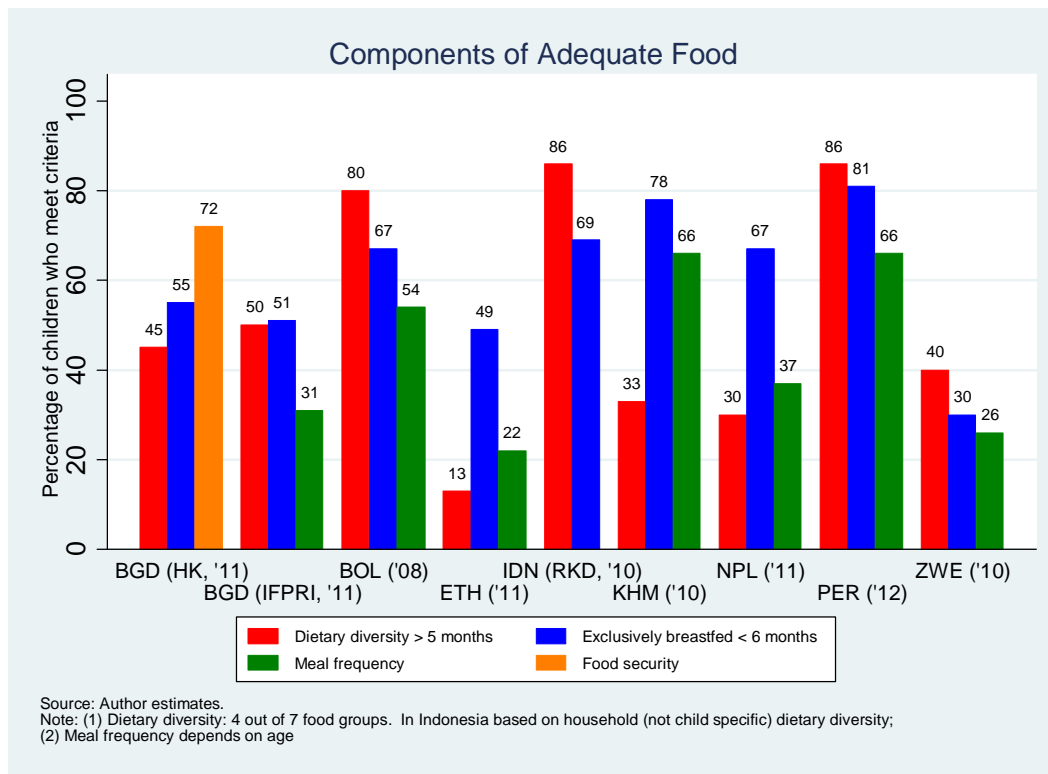
standards on maternal dietary diversity, the WHO (2013) recommendations on child immunizations schedules, the WHO and UNICEF (2006) guidelines on drinking water and sanitation, as well as the 1990 UNICEF strategy on improved nutrition of children and women. In Bolivia and Peru country specific immunization practices are used. These immunization schedules follow closely the WHO guidelines.

The prevalence of adequacies varies across countries and resource access, but in most contexts children were most likely to be adequate in care and least likely to be adequate in environment and health. Adequate care was the facet which was most likely to be met in all countries with the exception of Indonesia, where the prevalence of adequate food was greater than the prevalence of adequate care (Figure 5a, 6a and 7a). In all countries it is adequate environment and health that is most lacking. With the exception of Bolivia, in the most recent survey for each country only 10 % or less of the children lived in a household where the housing infrastructure and health opportunities were adequate (Figure 7a). However, for Bolivia no information on sanitation was collected and thus the measure is not comparable to the other countries where sanitation measures were included.

3.2.1 Adequate food security

In most countries either adequate dietary diversity or adequate meal frequency is the component of food security which is least prevalent among children. In four of the seven data set with comparable information we find meal frequency to be the least prevalent component and in three it is dietary diversity (Figure 5a). The two South American countries have above 80% of the children consuming foods from at least four of the seven groups. Indonesia also has more than 80% of children with diverse diets, however, the measure is not comparable to the others since it is based on household food consumption and not child-specific food consumption. Except for Ethiopia and Zimbabwe, more than half of the children under 6 months are exclusively breastfed. The highest prevalence of exclusively breastfed children are in Cambodia (78%) and Peru (81%).

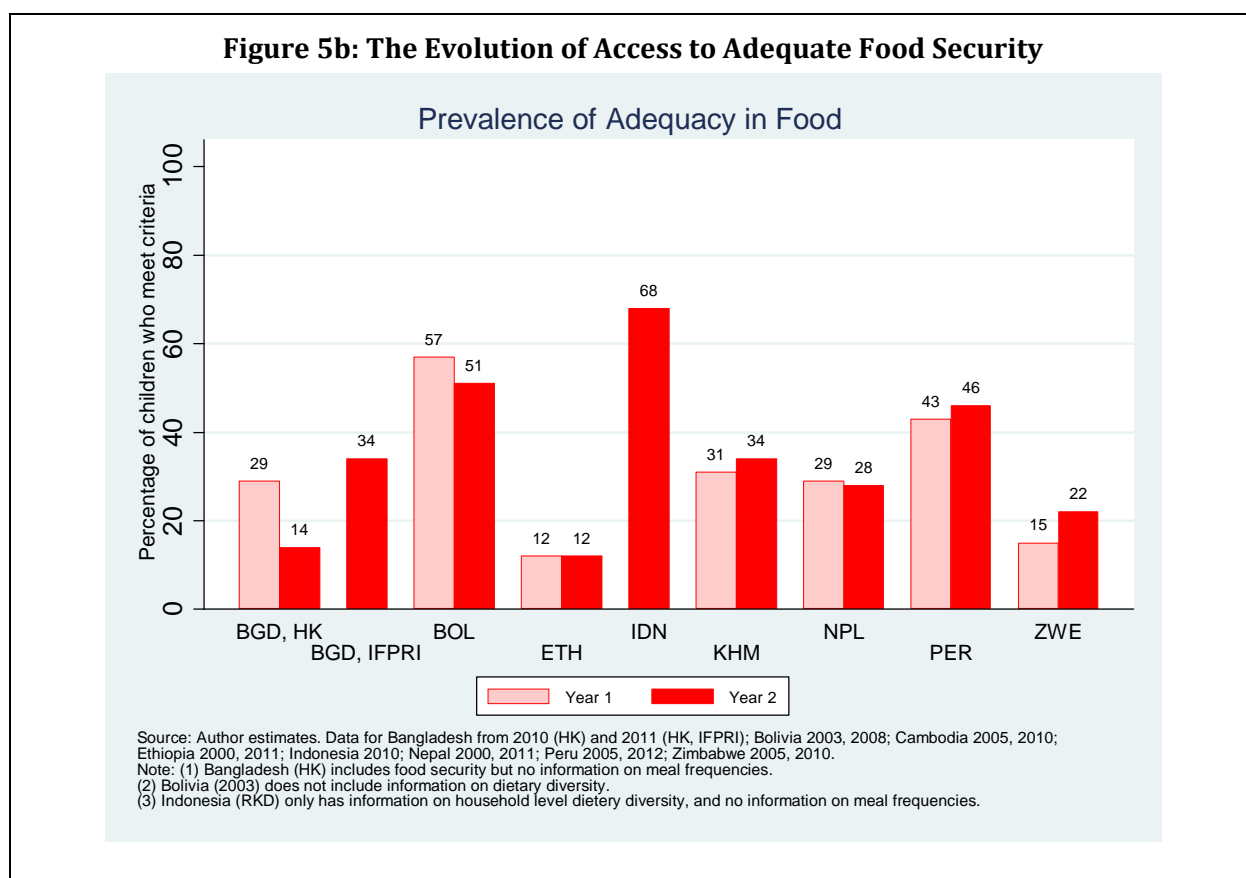
Figure 5a: Components of Adequate Food Security



Applying stricter standards by requiring simultaneous access to adequate levels of each component of food security, less than one-half of the young children in the study countries appear to have access to adequate food security. In fact in six out of the 9 surveys less than one-third of the children had access to adequate food (Figure 5b). In Ethiopia, with the lowest access to adequate food security, only 12 percent of the children met the criteria for adequate food security. As figure 5a above clearly indicates, this is primarily due to the very low prevalence of adequate dietary diversity (13 percent). Bolivia and Indonesia were the only countries where more than half of the children had access to adequate food security, at 51 and 68 percent, respectively. However, in Indonesia the dietary diversity was not measured for each child, and the measure is based exclusively on the dietary diversity at the household level so it is not comparable with the other studies. Depending on how different the child’s diet is from the general diet of the family, the true prevalence of adequate food security may be much smaller.

In most countries, the improvements in access to adequate food security (as defined above) have been modest (Cambodia, Peru and Zimbabwe) to none (Ethiopia, Nepal) in the 5 to 10 years between surveys. The decrease in Bolivia in access to adequate food security is due to the change in the definition. In 2003 no information was collected on meal frequencies and thus the minimum acceptable diet variable could not be constructed. In 2008 the information was available and it was included as part of the food adequacy measure, thus making the 2008 definition a more comprehensive one than the 2003 measure. Furthermore, based on the Helen Keller data, in Bangladesh the access to adequate food halved between 2010 and 2011. Comparing the second

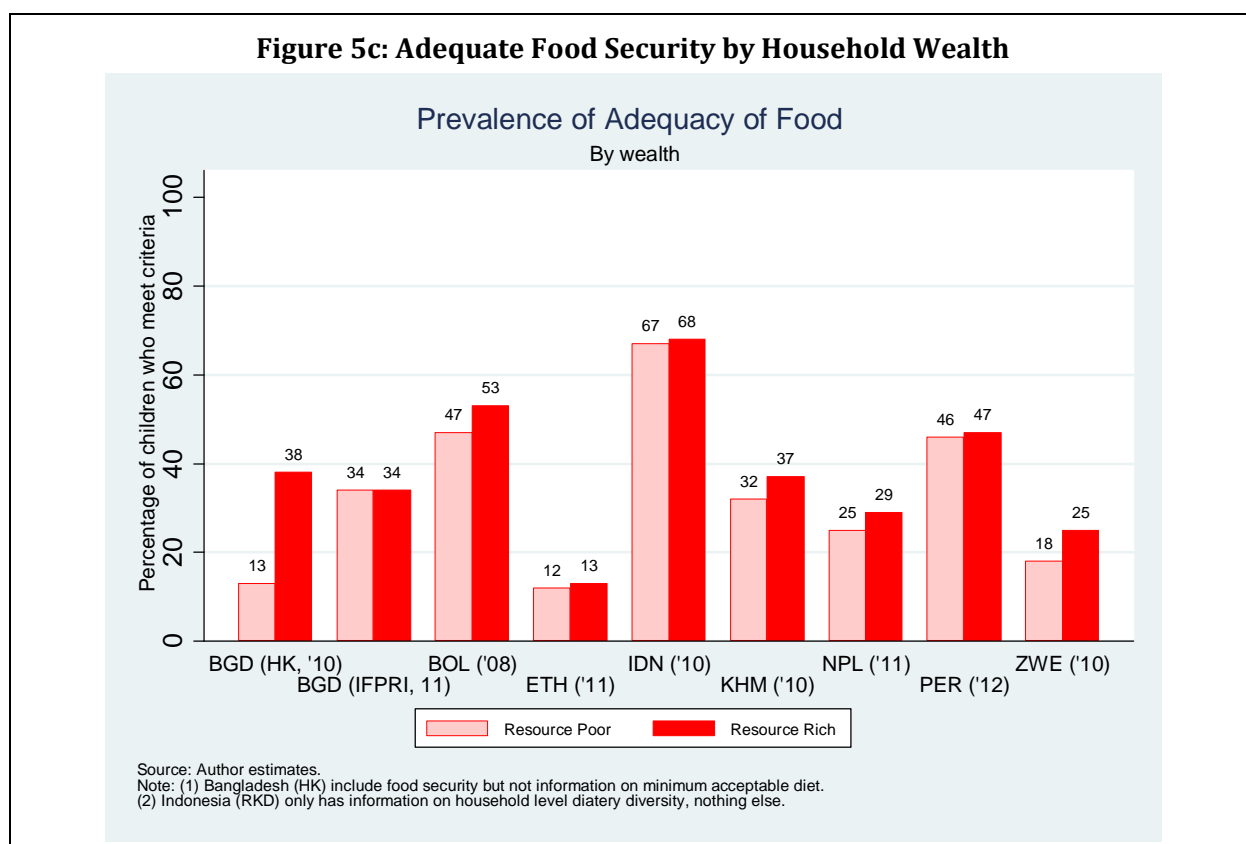
year of the Helen Keller survey and the IFPRI survey which were both collected in 2011, we observe large differences in the number of children classified as adequate in food. Based on the IFPRI survey 33% of the rural children in Bangladesh had access to adequate food but only 14% of both rural and urban children were found to be adequate in food in the Helen Keller survey. Besides sampling a different population, the two surveys lend themselves to different definitions of adequate food. In Helen Keller it is not possible to determine whether a child has met the minimum acceptable diet based on the composition and frequency of meals, but it possible to determine whether the household has experienced food insecurity. In the IFPRI sample it is possible to determine the minimum acceptable diet, but not whether the household experienced food insecurity.



Children in resource-poor households are less likely to have access to adequate food security than children in resource-rich households, but in general the differences are small. Although in all the countries analyzed children in resource-poor households were less likely to have access to adequate food, there were differences in the degree of disparity (Figure 5c).¹³ The largest disparity

¹³ We use the most recent year of data for the comparisons between resource-poor and resource-rich households. The only exception is the Helen Keller data for Bangladesh where we use 2010 and not 2011, the reason being that no vaccination information was available for 2011.

was observed in Bangladesh for the Helen Keller sample, which include both urban and rural children, where the disparity was 25 percentage points. In the IFPRI sample which only includes rural children, there was no difference between the two groups. In Bolivia, Cambodia, Nepal and Zimbabwe, the difference between the two groups was between seven and four percentage points. These findings are consistent with the fundamental role of nutrition-related behaviors and caring practices and the critical need for nutrition knowledge across all income groups. In Ethiopia, Indonesia and Peru both resource-rich and resource-poor children had similar access to adequate food as the differences were only one percentage point.

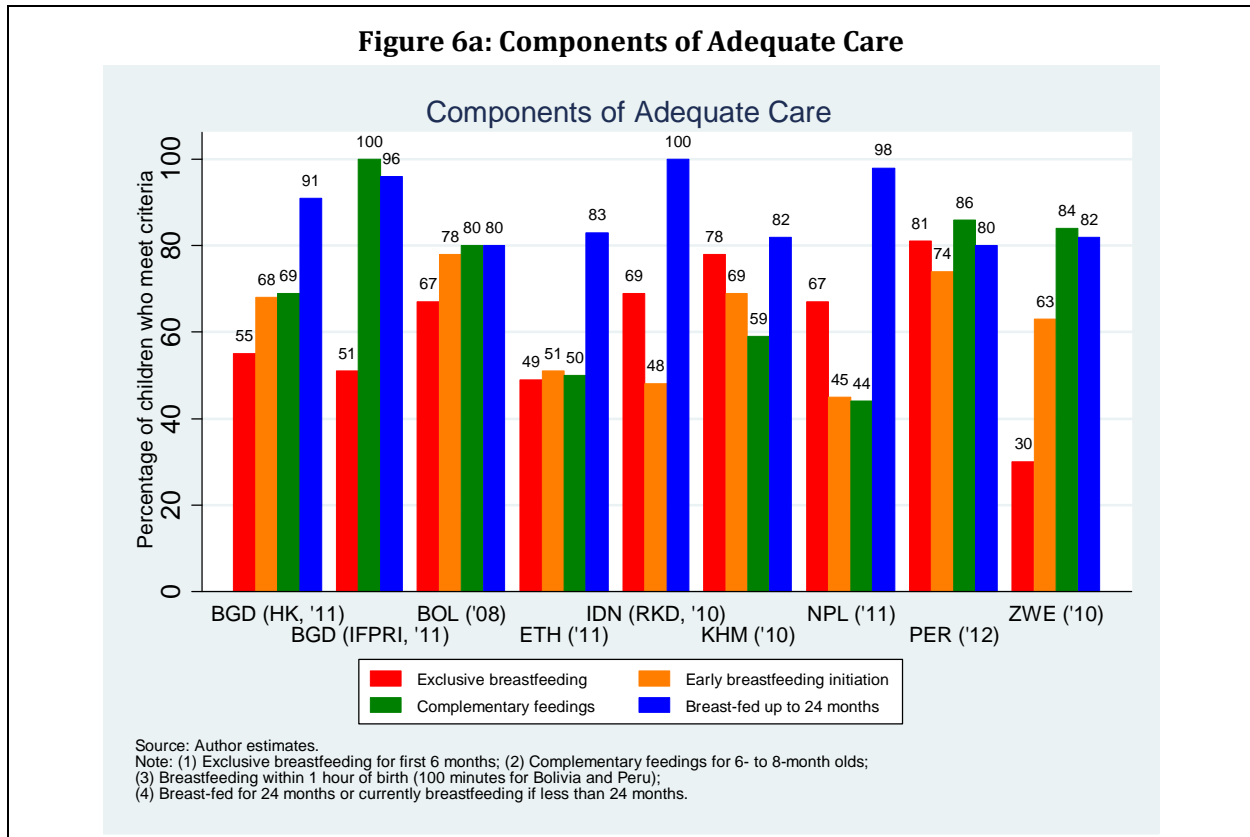


3.2.2 Adequate Care Practices

More than 80% of the children under age of 24 months were breastfed in the countries studied, but access to the other three components of adequate care was mixed.¹⁴ In Zimbabwe only 30% of the children under the age of six months were exclusively breast-fed and only in Cambodia and Peru were more than three-fourths of the children under six months exclusively breast-fed (Figure 6a). Early initiation of breastfeeding ranged from 45% of children in Nepal to 78% of children in Bolivia.

¹⁴ Since we used children under 24 or 36 months of age, this does not imply that more than four-fifths of the children received milk until they were 24 months old.

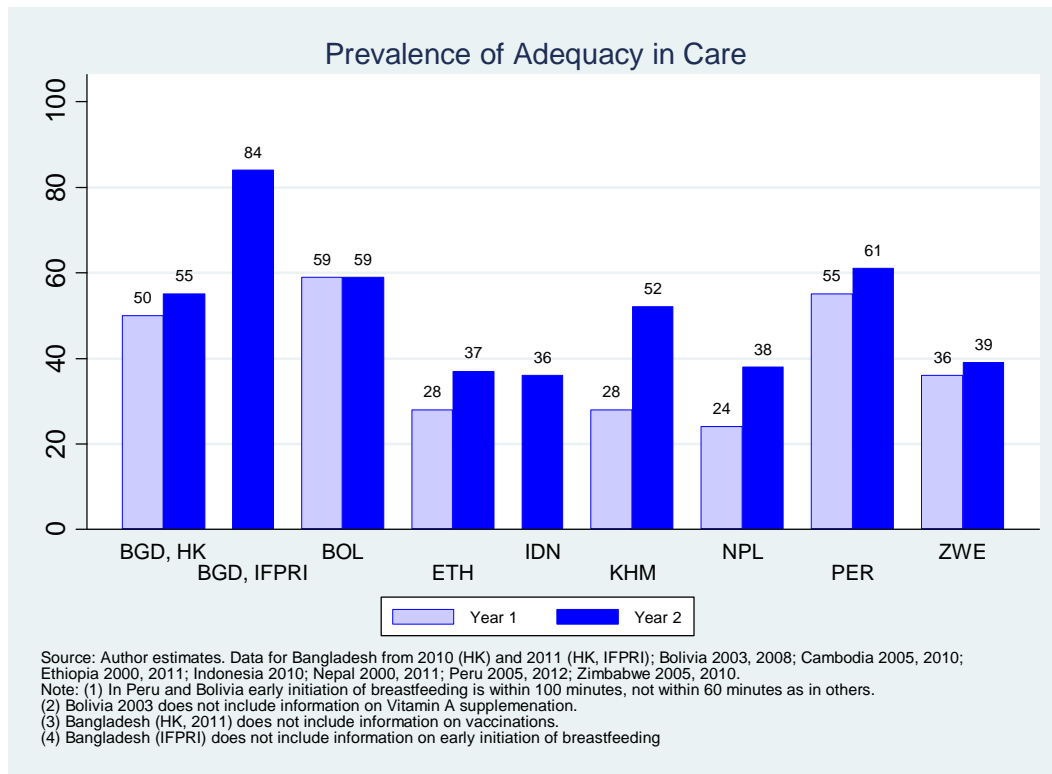
Complementary feedings for six- to eight-month olds was high in Bangladesh (in the IFPRI sample), Nepal, Zimbabwe and Bolivia, where more than 80% of the children of the age range received complementary foods. In Nepal, only 44% of the six- to eight-month olds received complementary feedings from one of the dietary diversity food groups.



Applying stricter standards by requiring simultaneous access to adequate levels of each component of child care, access to adequate care has increased significantly over time in most countries. Adequate care increased by 24 percentage points in Cambodia, 14 percentage points in Nepal, 9 percentage points in Ethiopia, 6 percentage points in Peru, 5 percentage points in Bangladesh, and 3 percentage points in Zimbabwe (Figure 6b).¹⁵ For the most recent year of data, most countries had about one-third to two-thirds of the children living in situations with adequate care. However, adequate care was also the measure for which many of the ideal components were missing. Nonetheless, the results suggest an increased awareness of the importance of early initiation of breastfeeding and continued breastfeeding until two years of age, as well as following the recommendations on age-appropriate complementary feedings.

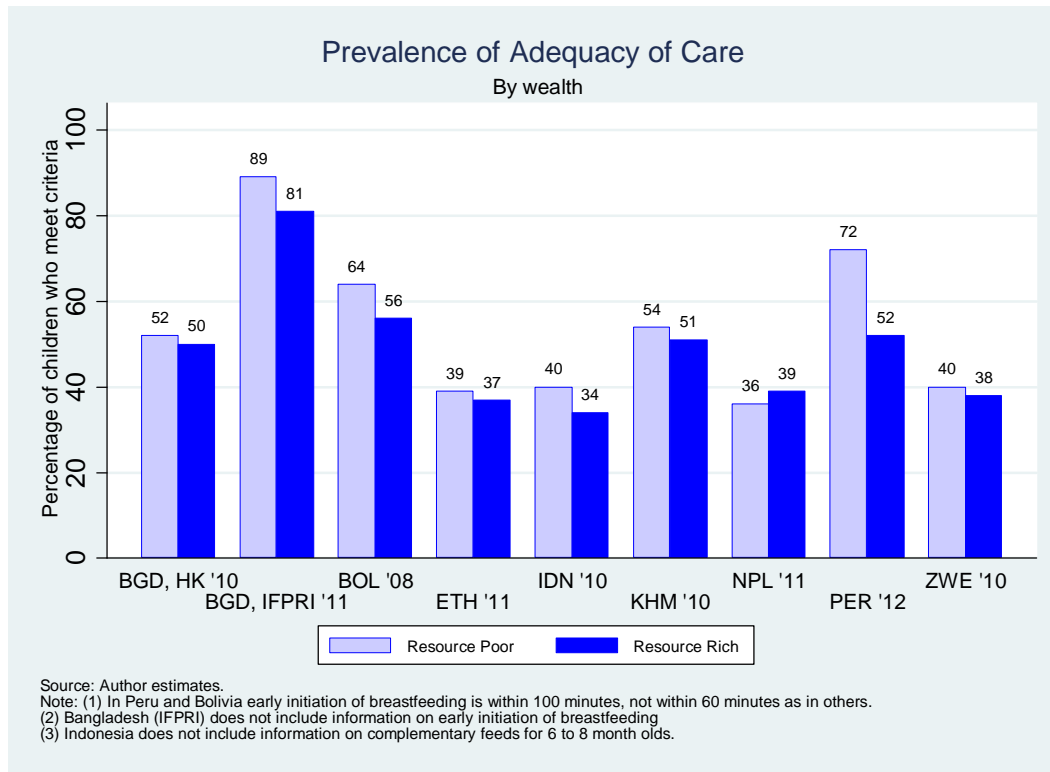
¹⁵ In Bolivia the prevalence of adequate care was the same for the two surveys. However, the 2003 definition does not include vitamin A supplementation (as the information was not collected) and the 2008 definition does.

Figure 6b: The Evolution of Access to Adequate Care



Children in resource-poor households are more likely to have access to adequate care than children in resource-rich households. Possibly contrary to expectation, in all countries except for Nepal, children in resource-poor households were more likely to have access to adequate care than children in resource-rich households (Figure 6c). That is, children from resource-poor households did not have worse access to the components of adequate care that were measured. Although the differences in most cases were modest, in Peru 72% of the children in resource-poor households were adequate in care whereas only 52% of children in resource-rich households were adequate, a difference of twenty percentage points. In Bangladesh (IFPRI) and Bolivia the difference in adequate care was eight percentage points and for the rest the differences were six percentage points or less. Across the eight countries, children in resource poor households tended to be breastfed longer, but were less likely to receive complementary feeds during the ages of six to eight months (Annex 2). Overall, these findings further underscore the important role of nutrition knowledge regardless of socioeconomic status.

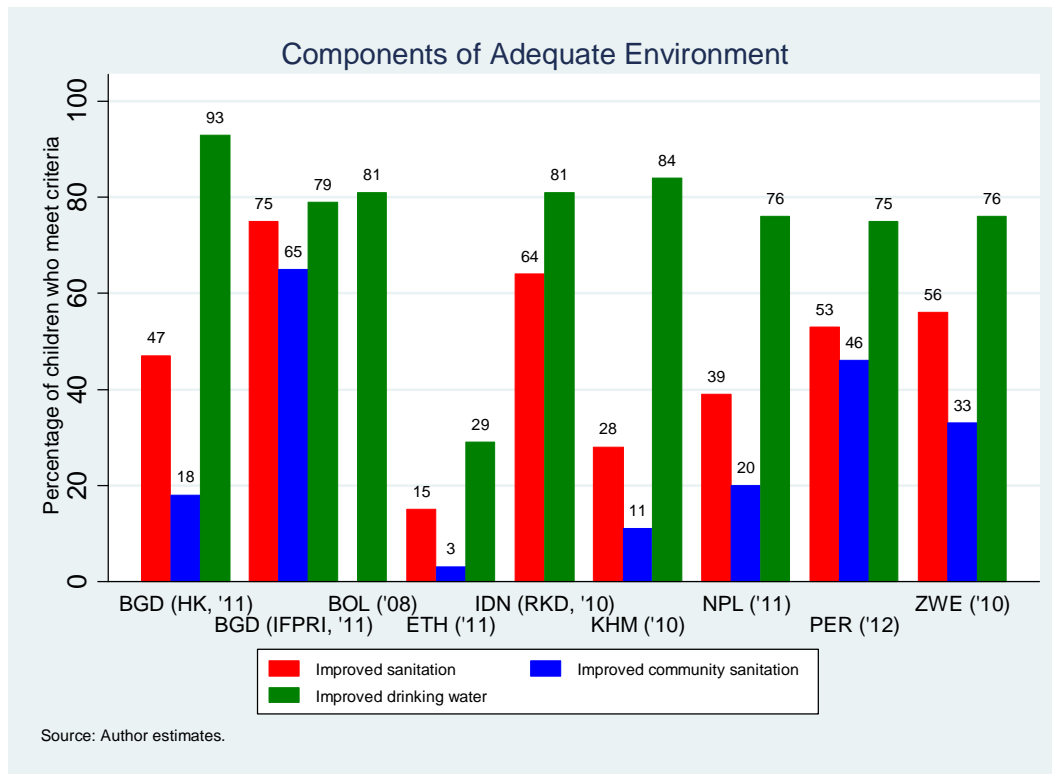
Figure 6c: Access to Adequate Care by Household Wealth



3.2.3 Adequate Environment and Health

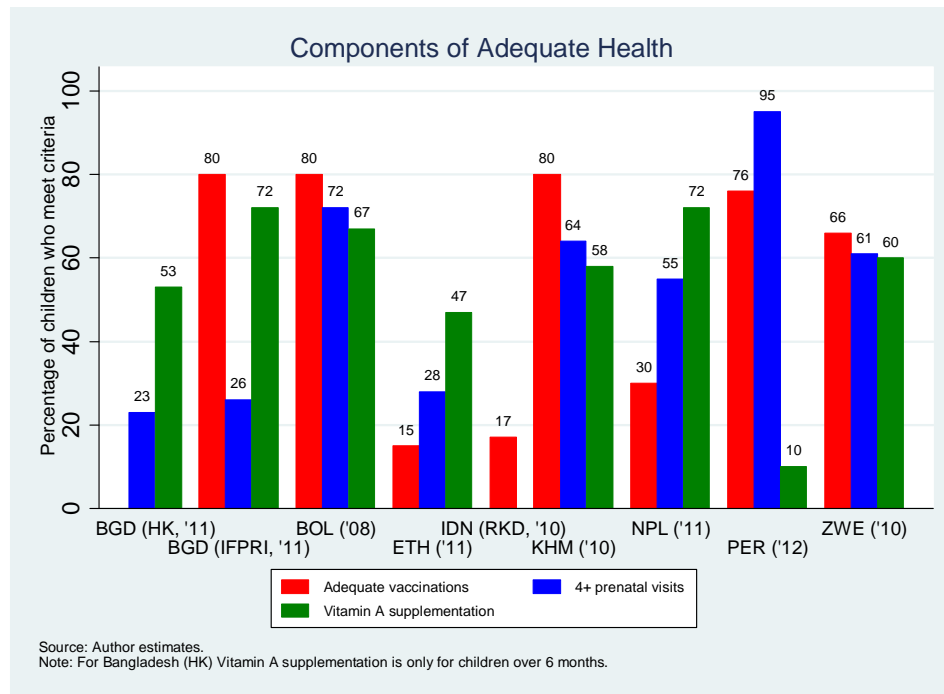
In general children lack access to improved water and sanitation infrastructure. Figure 7a highlights the lack of access to improved sanitation at the household and community level. Even if a child has access to improved sanitation in their home, the great majority of the children live in communities where less than 75% of the households of the community have access to improved sanitation (Figure 7a). Only in the IFPRI sample of Bangladeshi children do more than 50% of the children live communities where 75% of the households have access to improved sanitation. In Ethiopia only 3% of the children live in such communities and in Cambodia only 11%. However, except for Ethiopia, more than three-fourths of children in the surveys have access to improved drinking water. That is, the majority of the children drink water that has been treated to reduce disease-producing contaminants.

Figure 7a: Components of Adequate Environment



In contrast to the case of basic infrastructure, children appear to do better in having access to adequate preventive health services and facilities. In terms of vaccinations, there are two groups of countries. The first group consisting of Bangladesh, Bolivia, Cambodia, Peru and Zimbabwe, where more than two-thirds of children have had received age appropriate vaccinations. The second group consisting of Ethiopia (15%), Indonesia (17%) and Nepal (30%) where less than one-third have received them (Table 7b). More than half of the children in Bolivia, Cambodia, Nepal and Zimbabwe have had four or more prenatal visits, and less than a third did so in Bangladesh and Ethiopia. More than 50% of the children in the studies have received vitamin A supplementation, except for in Ethiopia (47%) and Peru (10%). In Ethiopia none of the components reach 50% prevalence.

Figure 7b: Components of Adequate Health Services



Applying stricter standards by requiring simultaneous access to adequate levels of each component of environment/infrastructure and health services, access to adequate infrastructure appears to have increased over time in most countries. For example, access to adequate infrastructure has increased in Bolivia, Nepal, Cambodia, and Peru (Figure 7c). Ethiopia shows very little progress primarily because of the low prevalence of improved sanitation at the community level (see also Figure 7a). Along similar lines, access to adequate health services have increased in Bolivia, Cambodia, and Zimbabwe, with little or very minor progress in Ethiopia (Figure 7d).¹⁶

¹⁶ In Peru the decline was caused by the decline in vitamin A supplemental dose coverage which fell from 22% to 10%. All the other components of the measure improved over time.

Figure 7c: The Evolution of Access to Adequate Environment

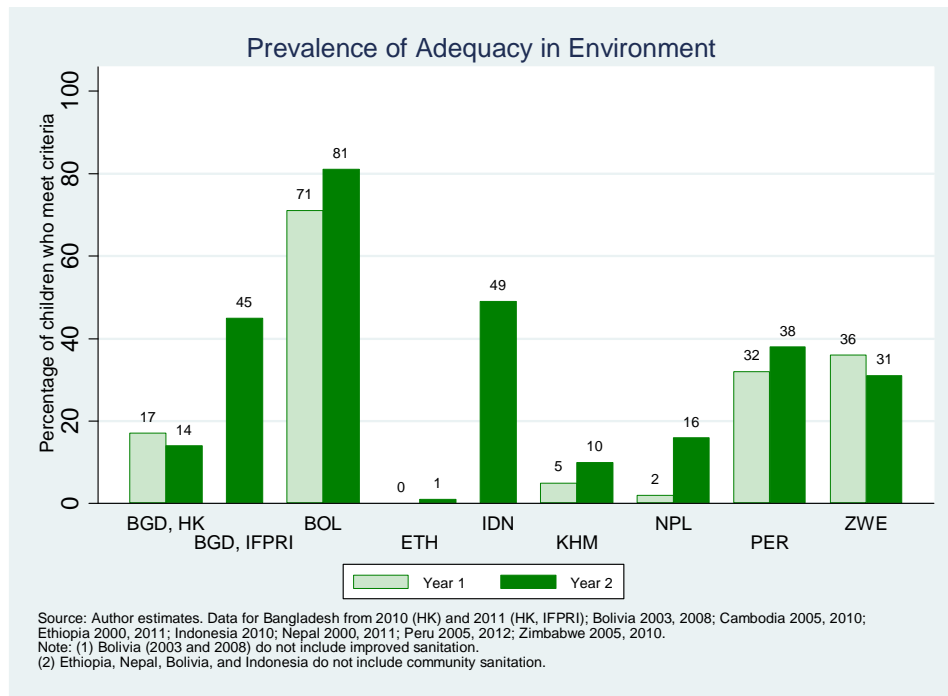
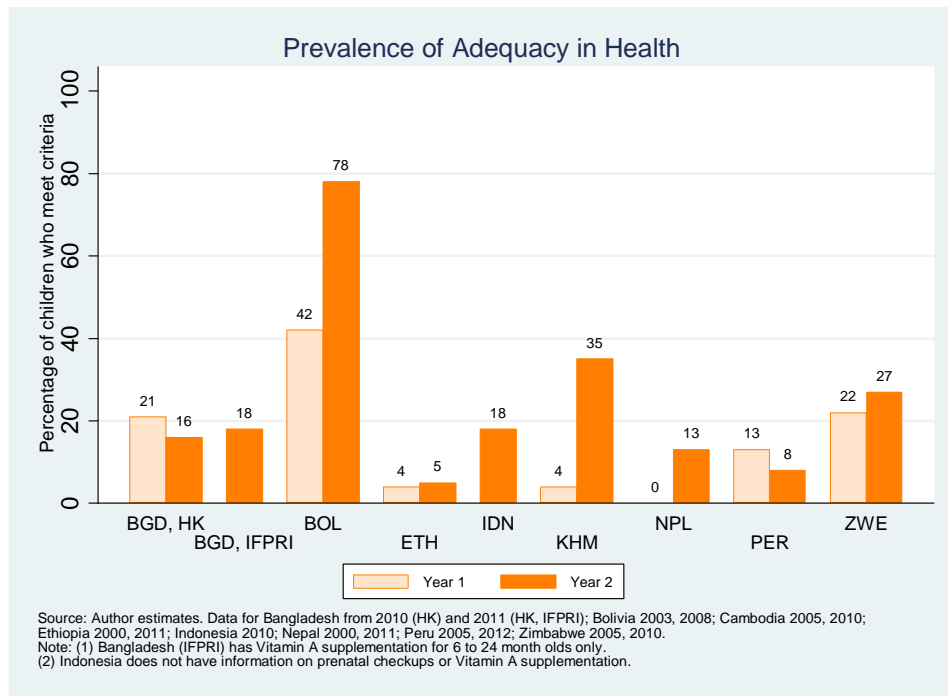


Figure 7d: The Evolution of Access to Adequate Health Services



Children in resource-poor households are less likely to have access to adequate environment and health services than children in resource-rich households. Thus, in contrast to the situation with

child care where the resource poor households appeared to have higher access to adequate care than children in resource rich households (see figure 6c), children in resource-poor households have lower access to adequate infrastructure and adequate health services (Figures 7e and 7f).). These differences are substantial. Except for Ethiopia, the differences in access to adequate environmental infrastructure are more than ten percentage points in the countries studied and more than 25 percentage points in Bolivia, Peru, and Zimbabwe. Excluding Peru, the differences in access to adequate health services ranges from 4 percentage points to 12 percentage points in our set of countries, favoring children in resource-rich households. In Peru children in resource poor households are more likely to have access to adequate health services. The result is driven by the higher likelihood of a child from a resource-poor household in having had a vitamin A supplement.

Figure 7e: Access to Adequate Environment by Household Wealth

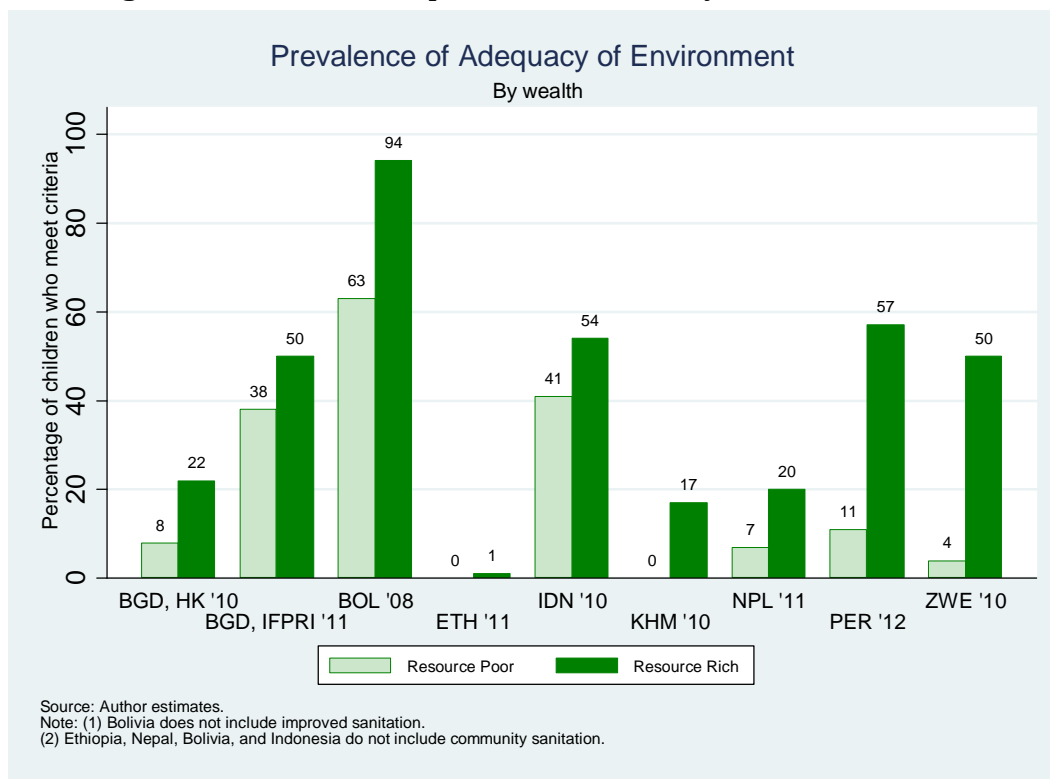
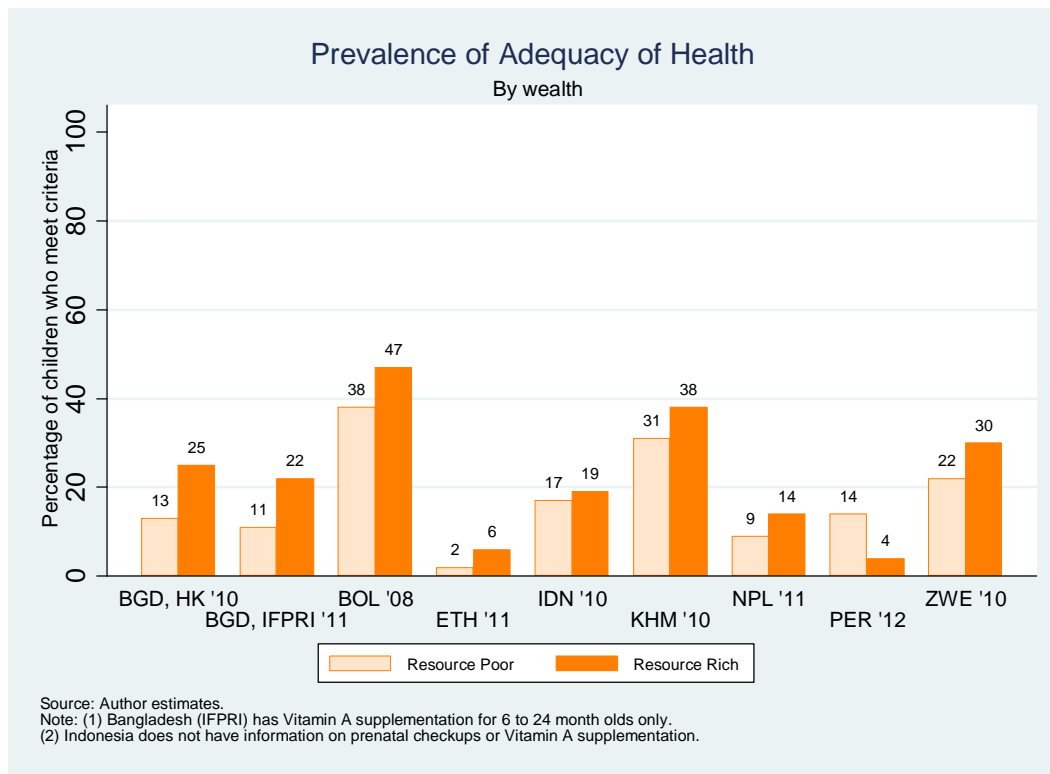


Figure 7f: Access to Adequate Health Services by Household Wealth



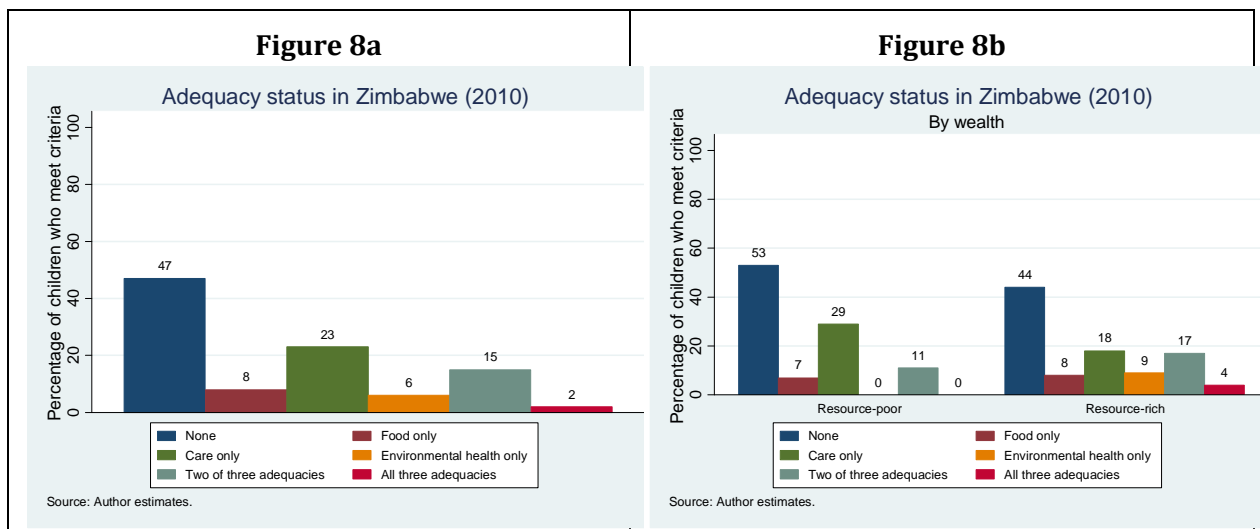
3.3 Additional Considerations: Weak Links in a Chain

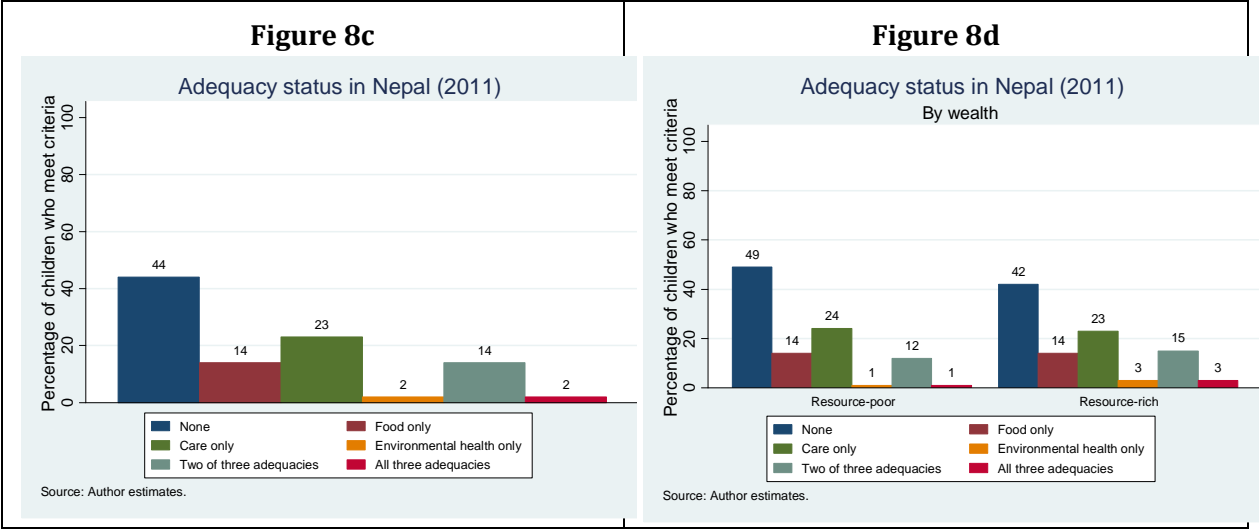
The preceding discussion suggests a correlation between the observed reductions in stunting and the increases in access to adequate food security, adequate care and adequate environment and health services over the same period in the countries studied. For the countries with two years of similar survey data, the prevalence of stunting fell (Figures 2 and 3). In the same time span there were marked improvements in the adequacy of care (Figure 6b), some improvement in adequate environment and health (Figures 7c and 7d) and a mixed story in adequate food with some countries experiencing a decrease in the access to adequate food (Figure 5b). Whether there is indeed a “causal” relationship as opposed to a simple correlation between improved access to adequate food, care and environment and health and the observed reduced stunting and increased average height-for-age of children, is a question that needs to be addressed with more complex models using detailed panel data on children through time.

As the first step towards exploring potential synergies in relation to child nutrition, the analysis below investigates in more detail the extent to which children have simultaneous access to adequate levels in any one, or two, or all three of the clusters of underlying determinants of nutrition. So far the access to adequate environment was treated separately from the access to adequate health services. In the remainder of this report environment and health are combined into one cluster mainly for the purpose of simplifying the presentation. One should bear in mind, that combining health and environment into one aggregate cluster creates a very strict set of standards

for adequacy in health and environment requiring simultaneous access to improved levels for each component of infrastructure as well as access to adequate level for each component of health services. In this case the “chain is only as strong as its weakest link” in the sense that as long as there is very low access to an adequate level in any one of the components of the cluster (e.g. sanitation at the community level) then overall access to adequate health and environment is forced to be very low, in spite of considerably higher access to adequate levels in the other components of health and environment. The preceding argument is also valid for the determination of whether a child has access to adequate care or adequate food security. As long as each one of the clusters consists of numerous indicators measuring the different dimensions of child care or food security, adequate care or adequate food security overall will be determined by the level of adequacy in one of the sub-components or the “weakest link.” In other words, the analysis following takes it as a given that the three clusters—food, care, environment and health—and the various sub-components of each of these clusters work in tandem to produce nutritional outcomes.

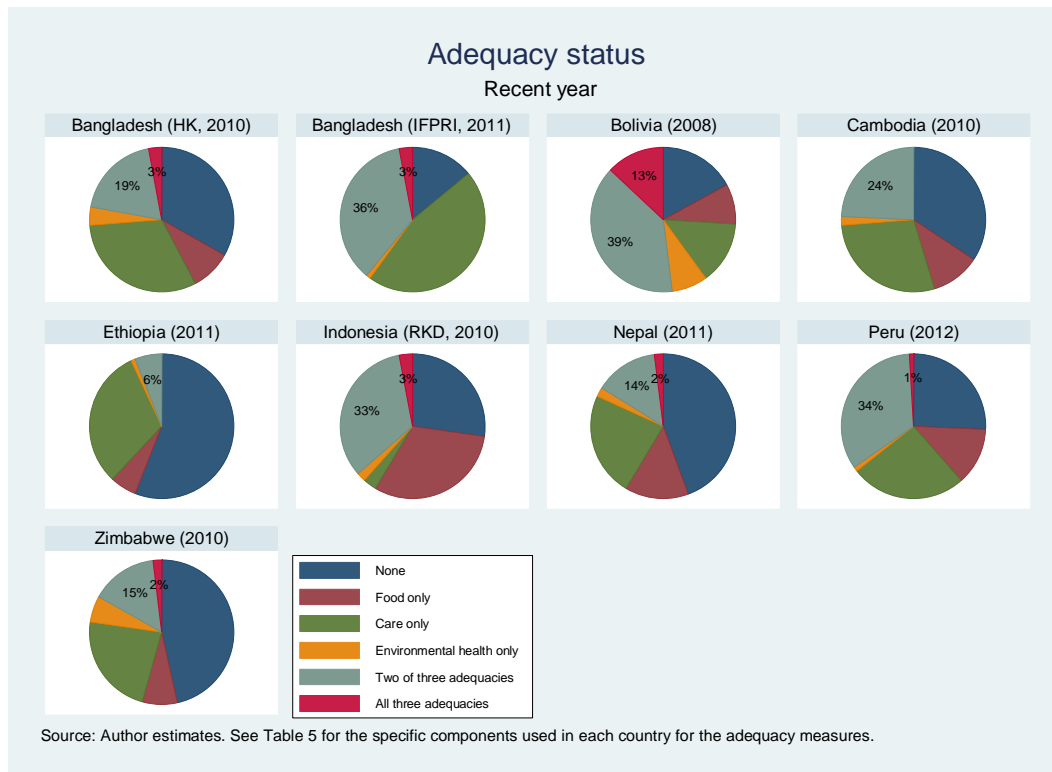
Using Zimbabwe as an example, although there are 22% of children adequate in food, 39% adequate in care, and 10% adequate in environment and health combined (Figures 5a, 6a and 7a), many children (47%) are not adequate in any component and only a few (17%) are adequate in more than one component (Figure 8a). As expected, from the earlier analysis, children in resource-rich households are more likely to be adequate in two of the three facets (17% vis-à-vis 11%) and in all three components (4% vis-à-vis 0%) than children in resource-poor households (Figure 8b). The same general patterns appear to hold for Nepal (see Figures 8c and 8d).





Overall, this descriptive analysis reveals that (i) there are only a few children adequate in all three clusters and (ii) many children are adequate in none or in only one of the underlying clusters. With the exception of Bolivia and Bangladesh (IFPRI), more than one quarter of the children do not have adequate access to any of the three pillars (Figure 9). Bolivia, with the caveat that the adequate environment does not measure sanitation, has the highest percentage (13 percent) of young children with access to adequate levels in all three clusters. The other countries included in the study have less than five percent of the children meeting the three adequacies with Cambodia and Ethiopia having the fewest, with less than half a percent of young children having access to all three adequacies. Between 6% (Ethiopia) and 39% (Bolivia) of children are adequate in two of the three adequacies. When only one adequacy is met, in most of our study countries it is care. The only exception is Indonesia where a child who only meets one of the adequacy categories is more likely to be adequate in food than in care or in environment and health. However, in Indonesia the food adequacy measure is based on household level information on food consumption and not child specific information on what kinds of foods the child consumed.

Figure 9: Prevalence of Adequacies, recent year



Although children in resource-rich households are in general more likely to have met all three adequacies, in some countries they are as likely as children from resource-poor households to meet none of the adequacies. Between 6% (Ethiopia) and 48% (Bolivia) of the children from the poorest 40% of households are adequate in at least two of the three measures (Figure 10a). However, children from the wealthiest 60% of the households, do not fare much better, since only between 7% (Ethiopia) and 55% (Bolivia) of the children are adequate in at least two of the three measures (Figure 10b).¹⁷ That is, in the study countries, children in the wealthiest households are still more likely to be without access to adequate levels in any of the three clusters than to have access to two or more adequacies.

¹⁷ The prevalence of adequacies in Bolivia, Ethiopia, Nepal and Indonesia are inflated in comparison to the others as there is no community sanitation information.

Figure 10a: Prevalence of Adequacies, Resource-poor households

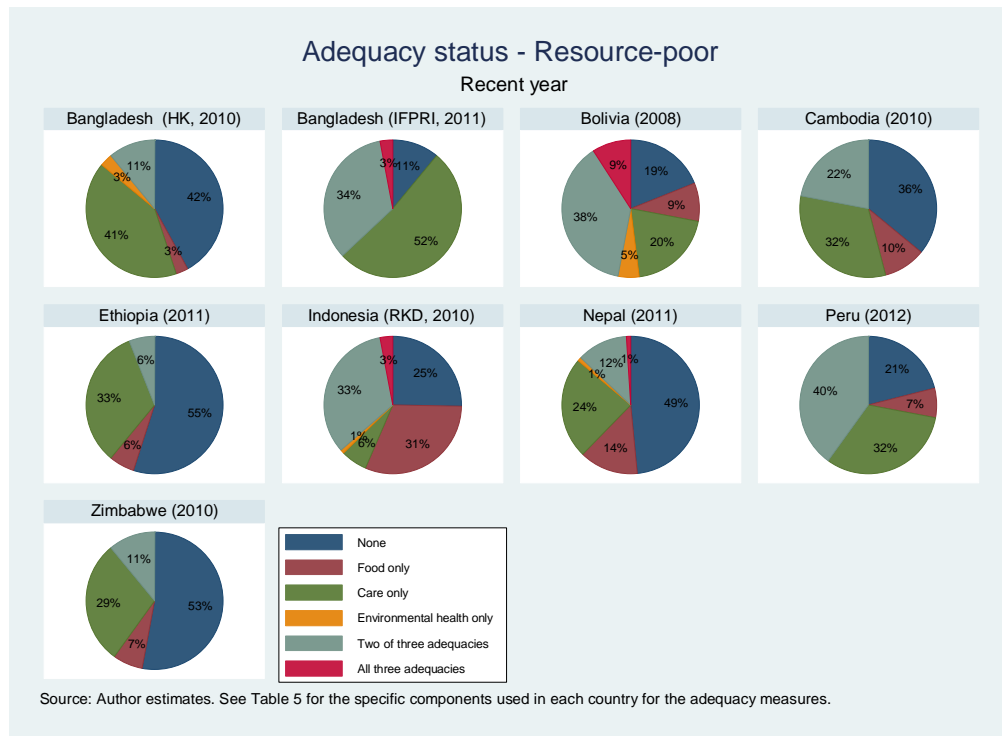
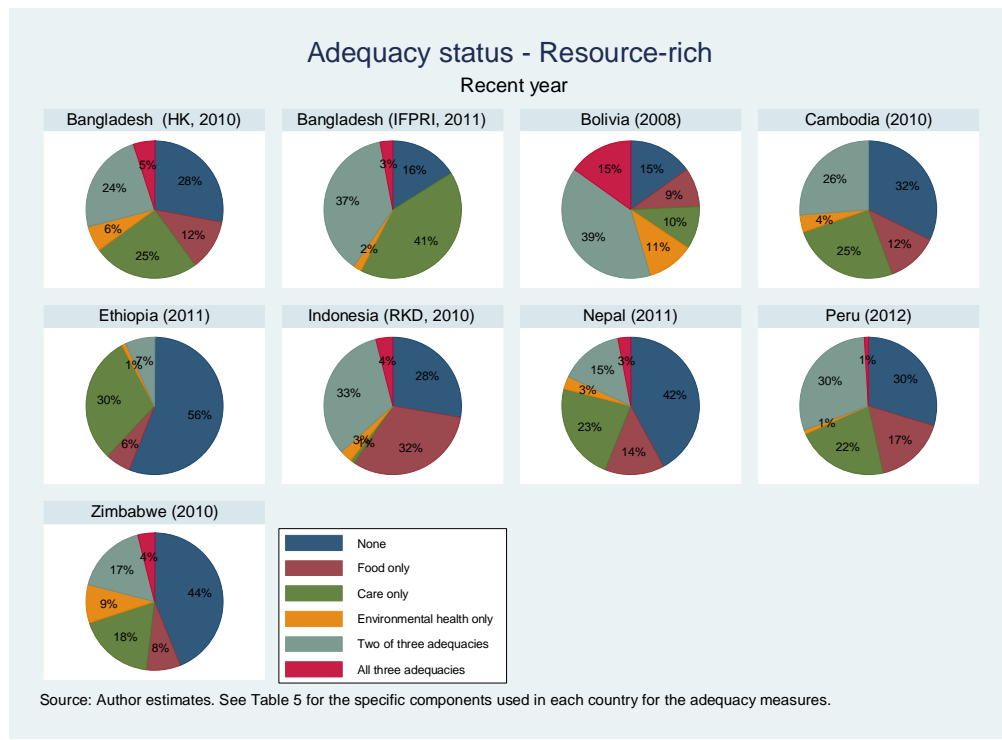


Figure 10b: Prevalence of Adequacies, Resource-rich households



4 Synergies

In this section, an effort is made to derive some quantitative estimates of the role of synergies associated with having simultaneous access to adequate levels in one or more of the clusters of food security, child care, and health and environment, on child nutrition. The analysis is purely descriptive, in that it is aimed at quantifying the correlation between improved or higher height for age Z-scores and simultaneous access to adequate levels in more than one of the clusters. To explore the potential synergies among the three clusters of underlying determinants and nutritional outcomes, a simple regression model is used to summarize in a parsimonious way the differences in the mean height-for-age among children with access to only or more of the three of the three clusters of the underlying determinants of nutrition. Purposefully, no additional controls are used in these regressions since including such controls is likely to create the impression that an effort is made to minimize the influence of confounding factors in the relationship between the dependent and independent variables in the regression, a practice common to all studies aimed at estimating causal regressions within an econometric framework

4.1 Model

The following econometric specification is estimated

$$\begin{aligned} HAZ_i = & \alpha + \beta_1 A_1 + \beta_2 A_2 + \beta_3 A_3 + \\ & \gamma_{12}(A_1 * A_2) + \gamma_{13}(A_1 * A_3) + \gamma_{23}(A_2 * A_3) + \\ & \gamma_{123}(A_1 * A_2 * A_3) + \varepsilon_i \end{aligned} \tag{A1}$$

where HAZ_i is the Height-for-Age Z-scores for the child i , and A_i denotes access to the three adequacies, for each child i . Namely, A_1 is 1 when the household is adequate in food (F) and is 0 otherwise; A_2 is 1 when the household is adequate in environment and health (H) and is 0 otherwise; and, A_3 is 1 when the household is adequate in care (C) and is 0 otherwise. These binary variables are constructed without any consideration of whether the child has access to adequate levels in the other two clusters. It is also important to keep in mind that there are no additional control variables used in the regression because the objective here is simply to compare mean values in HAZ among children in these different sub-groups of children defined by the extent to which they have access to one or more of the pillars.

In this specification the constant term α provides an estimate of the mean value of HAZ scores for children without access to adequate food security ($A_1 = 0$), adequate environment and health ($A_2 = 0$), and adequate care ($A_3 = 0$). That is, with $E(HAZ|A = 1 \text{ or } 0)$ denoting the expected (or mean) value of height-for-age (outcome), conditional on having adequate access ($A=1$) or inadequate access ($A=0$) to cluster A, the expected height-for-age for when the child does not have adequate access to any of the three clusters is:¹⁸

¹⁸ It is also assumed that $E(\varepsilon_i | A_1, A_2, A_3) = 0$.

$$E(HAZ_i | A_1 = 0, A_2 = 0, A_3 = 0) = \alpha$$

The coefficients β_i yield estimates of the increase in the mean HAZ score of children when a child has access to adequate levels in one of the clusters only (and not the others). That is:

$$E(HAZ_i | A_1 = 1, A_2 = 0, A_3 = 0) = \alpha + \beta_1$$

$$E(HAZ_i | A_1 = 0, A_2 = 1, A_3 = 0) = \alpha + \beta_2$$

$$E(HAZ_i | A_1 = 0, A_2 = 0, A_3 = 1) = \alpha + \beta_3, \text{ respectively.}$$

Specifically, the coefficient β_1 yields an estimate of the increase in the mean HAZ score of children (compared to the mean HAZ score of reference group summarized by the constant term, α) that have access to adequate food security only ($A_1= 1$) but do not have access to adequate environment and health ($A_2= 0$), and no access to adequate care ($A_3= 0$). The coefficients β_2 and β_3 have an analogous interpretations for environment and health and care, respectively.

Moreover, the coefficients γ_{ij} yield estimates of the synergies or complementarities associated with having access to adequate levels in more than one of the cluster of underlying determinants of nutrition. Specifically, the mean HAZ score of children having access to adequate food security ($A_1= 1$) and adequate environment and health ($A_2= 1$) is summarized by the expression

$$E(HAZ_i | A_1 = 1, A_2 = 1, A_3 = 0) = \alpha + \beta_1 + \beta_2 + \gamma_{12}.$$

The expression for the mean value of HAZ scores of children in households with access to adequate food security and adequate environment and health can be considered as consisting of the sum of three components: the first component is the increase in HAZ scores associated with children in households with adequate food security only (i.e., β_1); the second component (i.e., β_2) is the increase in HAZ scores associated with children in households with adequate environment and health only, and the third component (i.e., γ_{12}) is the increase in HAZ scores associated with children in households that have access to both adequate food security and adequate environment and health. Thus the coefficient γ_{12} yields information on whether there are additional (extra) gains (or losses) in HAZ scores derived from access to adequate food only or access to adequate environment and health only. A significant and positive value of the coefficient γ_{12} implies synergies from the simultaneous access to adequate food security and adequate environment and health in the production of child nutrition.

Along similar lines, the mean HAZ of children from having access to adequate food security ($A_1= 1$) and adequate care ($A_2= 1$) or adequate environment and health ($A_2= 1$) and care ($A_3= 1$) are summarized by the expressions

$$E(HAZ_i | A_1 = 1, A_2 = 0, A_3 = 1) = \alpha + \beta_1 + \beta_3 + \gamma_{13}.$$

$$E(HAZ_i | A_1 = 0, A_2 = 1, A_3 = 1) = \alpha + \beta_2 + \beta_3 + \gamma_{23}$$

with the coefficient γ_{13} summarizing potential synergies from simultaneous access to adequate food security and adequate care and the coefficient γ_{23} summarizing potential synergies from simultaneous access to adequate environment and health and adequate care.

The mean HAZ of children from having access to all three components (i.e. adequate food security ($A_{i1} = 1$) and adequate environment and health ($A_{i2} = 1$) and adequate care ($A_{i3} = 1$)) is given by the expression

$$(HAZ_i | A_1 = 1, A_2 = 1, A_3 = 1) = \alpha + \beta_1 + \beta_2 + \beta_3 + \gamma_{12} + \gamma_{13} + \gamma_{23} + \gamma_{123}$$

with the coefficient γ_{123} summarizing the potential synergies from simultaneous access to all three components.

The model employed above does not allow for causal inferences on the effects of having access to adequate levels in the various clusters adequacy components on nutrition nor provide a formal test of the UNICEF framework. A more rigorous causal analysis would require the use of methods aimed at addressing the endogeneity bias associated with the fact that many of the clusters themselves are to a large extent choice variables (e.g. such as child care variables, vaccinations, and visits for prenatal care) as well as the inclusion of additional control variables aimed at reducing or eliminating the impact of other contextual variable omitted from the regression (omitted variable bias).

Nevertheless, the estimates from such a model serve as a useful benchmark for policy in terms of highlighting the potential gains that could be accomplished with having simultaneous access to adequate levels of the other clusters. This specification allows for the exploration of the patterns of correlation between the various adequacy measures and nutritional outcomes as measured by height-for-age. That is, the model estimates the correlation between adequacies and height-for-age for each child based on information in one time period.

An important caveat to the model is that in many of the countries analyzed only a small fraction of children are adequate in environment and health. In most cases, the sample sizes are too small to yield reliable estimates of the synergies with environment and health. In fact, in Ethiopia and Nepal the community level sanitation condition was dropped given the restriction it placed on the number of children adequate in environment and health.

4.2 Results

There are significant and sizable synergies associated with simultaneous access to adequate levels in 2 or more clusters. Table 7 and Figure 11 present a summary of the results from estimating Equation A1. Most of the synergy coefficients, γ_{12} , γ_{13} , and γ_{23} , associated with simultaneous access to adequate food security and adequate care, or adequate environment and health and adequate care, or adequate foods security and environment and health are positive. Therefore, there are

additional (extra) gains in HAZ scores over and above the gains derived from having access to adequate food only or access to adequate environment and health only or access to adequate care only. Focusing on the five countries for which we have the most complete information—Cambodia, Ethiopia, Nepal, Peru, and Zimbabwe—we find that the synergy coefficients between two clusters are in general positive and that six out of the fifteen coefficients are statistically significantly greater than zero. That is, there are positive synergies from having access to adequate levels in more than one cluster. Given the small number of children who are adequate in more than one component in most of the countries, it may be that with additional observations the currently statistically non-significant coefficient estimates would become statistically significant and suggest positive synergies in additional countries.

Access to adequate care only is in many cases negatively associated with height-for-age. All the coefficient estimates for care are non-positive with six of the eight coefficient estimates being statistically significantly negative (Table 7). This negative association is the likely consequence of targeting healthy childcare campaigns to populations at risk. Even after adopting the promoted behaviors (such as exclusive breastfeeding and breastfeeding until the child's second birthday) the population at risk may still not be able to overcome the other obstacles in providing adequate nutrition to the children. Of the three measures, the components of adequate care are more easily modified by the mother and the family as they are behavioral. Ultimately adequate food depends on the availability of different food types in the household's community and the financial ability of the household to purchase nutritious food. Adequate environment and health partly depends on larger investments in infrastructure that a household may not have the financial ability to do (even if they have the knowledge and willingness).

In general, the synergy coefficient from having access to adequate levels in all three clusters is negative. Having a negative synergy coefficient in all three does not imply that children who are adequate in all three are shorter, but that the synergies from the adequacy pairs overestimate the difference. Table 8 and Figure 12 present the total coefficient estimate for children in each specific adequacy category. Except for Peru and Bangladesh (IFPRI) the children who are adequate in all three are also taller. In four of the seven cases they are statistically significantly taller.¹⁹ Again, given the small number of children who are adequate in all three these coefficient estimates are based on only a few observations.

Synergy coefficients do not appear to be systematically different for children in resource-poor households than for children in resource-rich households. There is some preliminary evidence that in some countries (namely Peru, Bolivia, Nepal, Bangladesh and Zimbabwe) being adequate in more than one of the adequacy measures is associated with larger synergies in resource-poor households vis-à-vis resource-rich households (Annex 3). However, in other cases (Ethiopia, Indonesia, and Cambodia) the synergies are larger in resource-rich households than in resource-poor households.

¹⁹ In Peru, if vitamin A supplements are removed from the adequate environmental health condition then the total coefficient estimate for being adequate in all three becomes 0.270 and it is statistically significant at the 99% level of confidence.

Table 7: Marginal increases (Synergies) in mean HAZ of children under 37 or 24 months

	Coefficient	Cambodia (2010)	Ethiopia (2011)	Nepal (2011)	Bolivia (2008)	Peru (2012)	Zimbabwe (2010)	Bangladesh (HK, 2010)	Bangladesh (IFPRI, 2011)	Indonesia (RKD, 2010)
Adequacy										
Food only	β_1	0.220	1.000***	0.498***	0.140	0.004	-0.031	0.055	-1.094*	-0.187**
Environment and health only	β_2	0.214	0.863***	-0.212	0.059	-0.210	-0.085	0.570***	-0.824*	0.720***
Care only	β_3	0.092	-0.255***	-0.074	-0.570***	-0.133**	-0.158*	-0.121*	-0.602***	-0.219
Environment x Food	γ_{12}	0.208	-0.479	0.671*	0.166	-0.478	-0.028	-0.261	2.107***	-0.563**
Environment x Care	γ_{23}	0.525	0.685*	0.951***	0.329**	0.476*	0.418	-0.371	1.104**	-0.136
Care x Food	γ_{13}	0.172	0.708***	0.331	0.473***	-0.090	0.332*	0.241	1.478**	0.240
Food x Care x Environment	γ_{123}	-0.557	-1.175**	-1.701***	-0.573**	0.012	-0.387	0.415	-2.559***	0.511
Observations		1,354	5,605	1,397	4,311	5,248	2,022	4,994	1,056	6,671

Source: Author calculations.
Notes: *** p<0.01, ** p<0.05, * p<0.1

Table 8: Simultaneous Adequacy in 2 or more clusters and the total effect on mean HAZ of children under 37 or 24 months

Adequacy	Coefficient	Cambodia (2010)	Ethiopia (2011)	Nepal (2011)	Bolivia (2008)	Peru (2012)	Zimbabwe (2010)	Bangladesh (HK, 2010)	Bangladesh (IFPRI, 2011)	Indonesia (RKD, 2010)
E x F	$\beta_1 + \beta_2 + \gamma_{12}$	0.643	1.384***	0.957***	0.365**	-0.684**	-0.144	0.364*	0.188	-0.030
E x C	$\beta_2 + \beta_3 + \gamma_{23}$	0.832	1.293***	0.665**	-0.183*	0.133	0.175	0.078	-0.323	0.365
C x F	$\beta_1 + \beta_3 + \gamma_{13}$	0.484***	1.453***	0.756***	0.043	-0.219***	0.143	0.175*	-0.218	-0.166**
F x C x E	$\beta_1 + \beta_2 + \beta_3 + \gamma_{12} + \gamma_{23} + \gamma_{13} + \gamma_{123}$	0.875***	1.346***	0.465	0.023	-0.419***	0.062	0.528***	-0.391	0.365**

Source: Author calculations.
Note: *** p<0.01, ** p<0.05, * p<0.1

Figure 11: Synergy effects

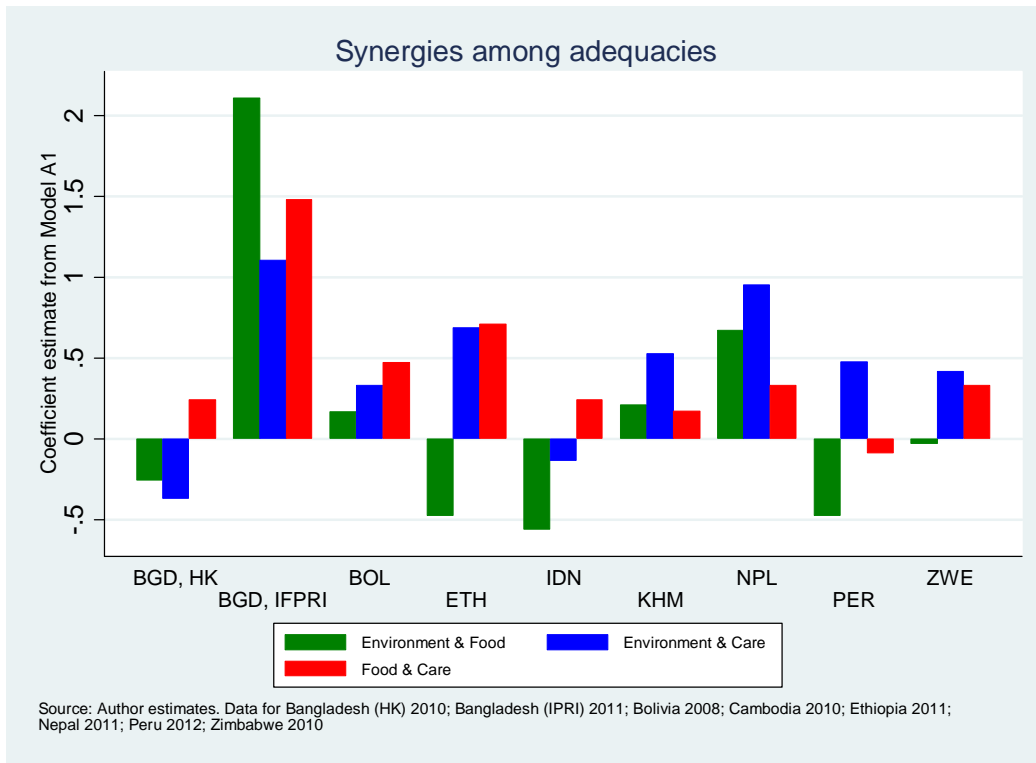
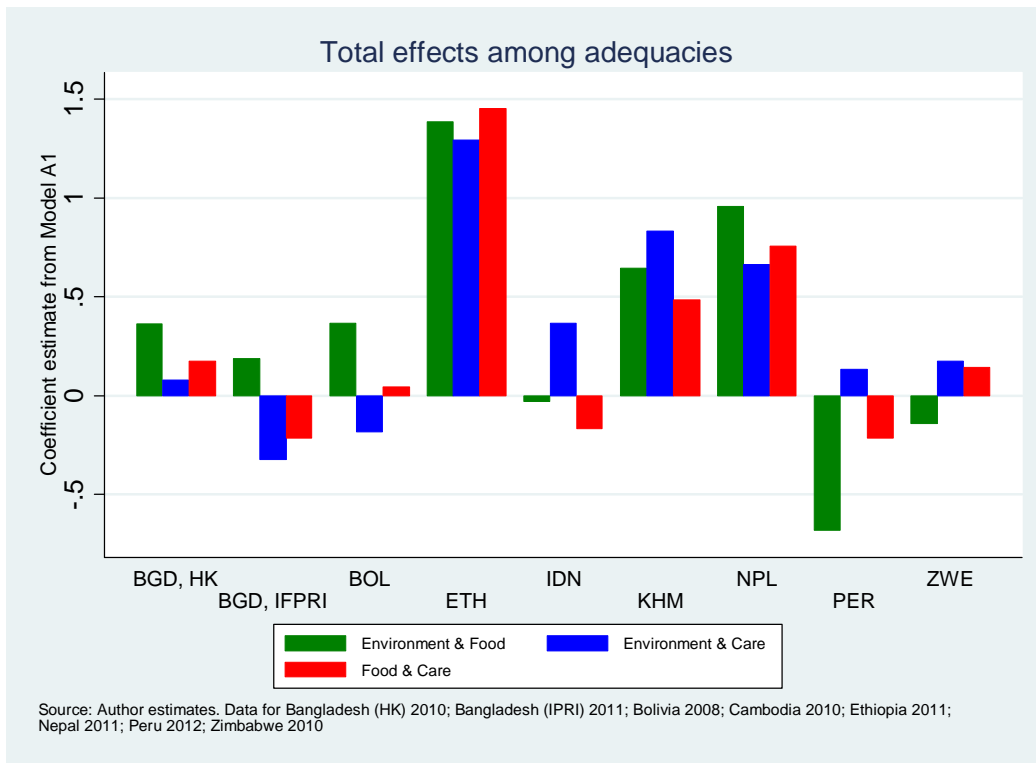


Figure 12: Total effects



5 Concluding Remarks and Policy Considerations

This study provided one of the first comprehensive investigations of the data availability and data constraints associated with a more systematic application of the UNICEF conceptual framework emphasizing the interrelationship among access to adequate food security, environment and health, and child care practices in the prevalence of malnutrition rates among children in developing countries. Using detailed demographic and health survey data from Bangladesh, Bolivia, Cambodia, Ethiopia, Indonesia, Nepal and Zimbabwe, a comparison is carried out of the ideal variables summarizing the various dimensions or components of food security, environment and health, and child care against the measures available from current household surveys. These comparisons serve to highlight the limitations of most data sets and the potential gains associated with the collection and availability of additional information.

Bearing in mind the limitations imposed by the data available, the report also provided a practical diagnostic framework of the main correlates of child malnutrition that could be applied to identify potential “binding constraints” towards the effort to reduce child malnutrition. Specifically, the UNICEF conceptual framework is “operationalized” by serving as a guide for investigating the relationship between the prevalence of malnutrition in the country and inadequate levels and access to the three pillars summarizing the underlying causes of malnutrition. Next, for each indicator available from the survey used in country, a definition of “adequacy” is constructed using thresholds based on accepted international standards. The report aims to provide a “helicopter view” of the extent to which nutritional outcomes, as measured by a child’s height-for-age Z score (HAZ) at any given point in time, as well as over time, are associated with inadequate food security, inadequate environment and health, and inadequate child care practices. In consideration of the complexity of the linkages between the underlying causes of malnutrition and the economic situation of the family, the analysis is also carried out separately for resource-rich (top 60%) and resource-poor (bottom 40%) households based on an asset index constructed for that purpose.

The report also provided some of the first empirical evidence on the synergies at work in combating malnutrition in the set of countries used in this study when there is simultaneous access to adequate levels in two or more of the three pillars of the underlying causes of malnutrition. While intuitively appealing, the synergies among the three clusters of malnutrition have received little empirical validation. The recent emphasis on sector-specific nutrition sensitive interventions (World Bank, 2013) rightly emphasizes the synergies that can be exploited *within* specific sectors such agriculture, water and sanitation, or social protection. The analysis in the report underscores the point that the success of these sector-specific nutrition-sensitive initiatives may be constrained by the slow progress in taking advantage of the synergies among the three broad clusters of the underlying determinants of malnutrition: food security, child care, environment and health. Given that the synergies *among* these three pillars are beyond the scope of any specific sector such as agriculture or social protection, the simultaneous progress towards in all of the three pillars is either taken for granted or underemphasized. As a consequence, nutrition sensitive interventions in specific sectors run the risk of being a sectoral priority in contexts where the chances of significant success may be limited because of no or very low access to improved infrastructure water and sanitation facilities.

Overall, the analysis highlighted the critical need for additional information on national health surveys. A systematic review of the data available in the current national health surveys in relation to the specific components of the three clusters of underlying causes of malnutrition considered as important by the nutritional scientific community reveals that these surveys contain information on only a small fraction of the ideal measures of food security, child care and environment and health. The collection of information on these additional variables currently missing from these surveys will enable a more robust understanding of the extent to which children have access to adequate care or adequate food security or environment and health. Panel data of young children between the ages of 6 and 18 months would also further our understanding of the relative contribution of the various components of the three pillars, and how access to different components of the three pillars at different ages of a child affects nutritional outcomes. In the sample of countries covered in this report it is found that the most complete information is collected on the components of environment and health, while there is much less robust information collected on the components of child care and food security. As pointed out by Barrett (2010) in his article on measuring food security, recognition that **“measurement drives diagnosis and response”** is critical for setting a renewed and higher standard in the effort to reduce child malnutrition worldwide.

Using all the information available, albeit incomplete, the analysis revealed that progress towards improved access to adequate food security and to adequate environment and health has been quite limited. It appears that access to adequate environment and health remains the greatest challenge relative to the other two pillars of food security and care. Access to improved sanitation both in the household and in the community as a whole were the lowest of all the other components of environment and health. In the countries covered in this report access to adequate environment and health in general is not surpassing 10% of the population of children. Access to adequate care has improved in some countries by more than 10 percentage points suggesting the success of campaigns on the importance of breastfeeding and complementary feeding which comprise the measure. However, this has to be viewed in perspective as this improvement is based only on the one or two child care variables that may be found in the surveys collected.

In spite of the limitations inherent in the available data, the report presented evidence of important synergies among adequate food, child care and environment and health. The econometric analysis carried out is aimed at summarizing simple correlations rather than causal relations, nor does it provide a formal test of the validity of the UNICEF conceptual framework. However, it does serve as useful evidence that access to adequate level of service in more than one pillar at the same time is associated with better nutritional outcomes compared to the “sum of its parts”. In other words, in the aggregate, the reductions in child malnutrition that can be accomplished are greater when some children are provided simultaneously with access to adequate food security, care, and environment and health compared to the reduction in malnutrition that can be accomplished by providing some of the children with adequate health environment and another group of children with adequate food security and another group of children with adequate care. The degree and the importance of the synergies varies from country to country but in general simultaneous access to the three clusters is associated with higher HAZ scores.

The report also highlighted the need for increased awareness at the operational and project level of the limits of exclusively focusing on tackling one particular dimension of inadequacy without considering the greater context. For example, the best designed program for improved access to nutritious food, may yield minimal returns if the program beneficiaries do not have access to sanitation or clean water. Similarly, health campaigns to encourage breastfeeding or vaccinations may change these behaviors to be in line with best practices, but without addressing the needs for access to adequate food security or adequate environment and health, may result in very limited reductions in malnutrition. Moreover, such coordination across sectors may be necessary not only at the broad level but also within sector-specific projects. For example, emphasis on improved nutrition-sensitive agricultural interventions, such as home grown vegetable gardens may be moot if most dwellings are surrounded by unpenned animals roaming freely and increasing the potential exposure of a child to animal fecal matter.

References

- Alderman, H., Hentschel, J., and Sabates, R. (2003): "With the Help of One's Neighbors: Externalities in the Production of Nutrition in Peru" *Social Science & Medicine* 56 (2003) 2019–2031
- Alderman, H., Hoogeveen, H., & Rossi, M. (2005): "Reducing child malnutrition in Tanzania – combined effects of income growth and program interventions," World Bank Policy Research Working Paper 3567. The World Bank, Washington, DC.
- Alderman, H., Hoddinott, J., and B. Kinsey (2006): "Long term Consequences of Early Childhood Malnutrition", *Oxford Economic Papers*, 58(3): 450-474.
- Alderman, H., M.Garcia (1994): "Food Security and Health Security: Explaining the Levels of Nutritional Status in Pakistan," *Economic Development and Cultural Change*, 42(3): 485-507.
- Arimond, M., MT. Ruel (2004): "Dietary Diversity is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys," *Journal of Nutrition*, 34(10):2579-85.
- Barrera, A. (1990): "The Role of Maternal Schooling and Its Interaction with Public Health Programs in Child Health Production," *Journal of Development Economics* 32: 69–91.
- Barrett, C. B. (2009): "Measuring Food Insecurity", *Science*, 327, 825(2010)
- Beck, N., and J.N. Katz. (1995): "What to do (and not to do) with time-series cross-section data." *American Political Science Review*, 89 (3): 634-47.
- _____ (2001). "Throwing out the baby with the bath water: A comment on Green, Kim, and Yoon." *International Organization*, 55 (2): 487-95.
- Behrman, J.R. and Wolfe B. L. (1987): "How Does Mother's Schooling Affect Family Health, Nutrition, Medical care usage, and Household Sanitation?" *Journal of Econometrics*, 36: 185-204.
- Behrman, J. R., and Wolfe, B. L. (1984): "More evidence on nutrition demand: Income seems overrated and women's schooling underemphasized." *Journal of Development Economics*, 14(1), 105–128.
- Behrman, J., Deolalikar, A., (1987): "Will developing country nutrition improve with income? A case study for rural south India," *Journal of Political Economy*, 95, 492–507.
- Behrman, J. and Deolalikar, A., (1988): "Health and Nutrition", in Hollis Chenery and T.N. Srinivasan (eds), *Handbook of Development Economics*, North Holland, Amsterdam.
- Bell A., and Jones, K., (2012) "Explaining Fixed Effects: Random Effects modelling of Time-Series Cross-Sectional and Panel Data" Unpublished manuscript
- Borooh, V. K. (2005) "The Height-for-Age of Indian Children," *Economics and Human Biology*, 3(1), 45–65.
- Chong, A., Hentschel, J., and Saavedra, J. (2003) "Bundling of Services and Household Welfare in Developing Countries: The Case of Perú" World Bank Policy Research Working Paper 3310. The World Bank, Washington, DC.
- Christiaensen, L., and Alderman, H. (2004). Child malnutrition in Ethiopia: Can maternal knowledge augment the role of income? *Economic Development and Cultural Change*, 52(2), 287–312.
- Coates, J., A. Swindale, and P. Bilinsky (2007), "Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v.3)." Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

- Crookston BT, Penny ME, Alder SC, Dickerson TT, Merrill RM, Stanford JB, Porucznik CA, Dearden KA (2010): Children who recover from early stunting and children who are not stunted demonstrate similar levels of cognition. *The Journal of Nutrition*, 140 (1): 1996–2001.
- Deolalikar, A. (2008): Malnutrition and hunger. Copenhagen consensus 2008 perspective paper. Copenhagen: Copenhagen Consensus Centre.
- Elfindri and Gouranga Lal Dasvarma (1996): 'Child Malnutrition in Indonesia', *Bulletin of Indonesian Economic Studies* 31 (1): 97–111.
- FAO, (2011): Developing A Response Analysis Framework For Food Security Emergencies, Discussion Paper FAO. http://www.fao.org/fileadmin/templates/tc/tce/pdf/Response_Analysis_Framework_Discussion_Papers.pdf, accessed on June 6, 2013.
- Haddad, L., Alderman, H., Appleton, S., Song, L., & Yohannes, Y. (2003): "Reducing Child Malnutrition: How Far Does Income Growth Take Us?" *World Bank Economic Review*, 17(1), 107–131.
- Hoddinott, J., Rosegrant, M., & Torero, M. (2012): "Investments to reduce hunger and undernutrition." Copenhagen Consensus Challenge Paper, prepared for 2012 Global Copenhagen Consensus Challenge, Copenhagen Consensus Centre, Copenhagen.
- Hoddinott, J. and Yohannes Y., (2002): "Dietary Diversity as a Household Food Security Indicator," Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington, D.C.
- Horton S., Shekar M., McDonald C., Mahal A.; Krystene B. J. (2010): *Scaling Up Nutrition: What Will it Cost?*. Washington, DC: World Bank. <http://hdl.handle.net/10986/2685> accessed on June 6, 2013.
- Prentice, A. M., Ward, KA, Folgerg, GR, Jarjou, LM, Moore, SE, Fulford, AJ, and Prentice, A (2013): "Critical windows for nutritional interventions against stunting," *The American Journal of Clinical Nutrition*, 97(5), 911-918.
- Rajaram, S., Zottarelli, L. K., & Sunil, T. S. (2007): "Individual, household, programme and community: Effects on childhood malnutrition in rural India." *Maternal and Child Nutrition*, 2007(3), 129–140.
- Riely, F., Mock, N., Cogill, B., Bailey, L. & Kenefick, E. (1999): "Food Security Indicators and Framework for Use in the Monitoring and Evaluation of Food Aid Programs", Food Security and Nutrition Monitoring (IMPACT) Project for the U.S. Agency for International Development, Arlington, VA. <http://www.fantaproject.org/downloads/pdfs/fsindctr.PDF> , accessed on June 6, 2013.
- Ruel, M. (2002): "Is Dietary Diversity an Indicator of Food Security or Diet Quality? A Review of Measurement Issues and Research Needs," FCND Discussion Paper No. 140, IFPRI, Washington, D.C.
- Save the Children (2012): "Nutrition in the First 1,000 Days: State of the World's Mothers 2012" <http://www.savethechildren.org/atf/cf/%7B9def2ebe-10ae-432c-9bd0-df91d2eba74a%7D/STATEOFTHEWORLDSMOTHERSREPORT2012.PDF>
- Sahn, D. and Alderman H. (1997): "On the Determination of Nutrition in Mozambique: The Importance of Age-Specific Effects," *World Development*, 25(4): 577-588.

- Schnepf, R. D. (1992): "Nutritional Status of Households: Survey Evidence on the Role of Household Consumption Behavior," Working Paper no. 23. Cornell Food and Nutrition Policy Program.
- Skoufias, E. (1999): "Parental Education and Child Nutrition in Indonesia." *Bulletin of Indonesian Economic Studies*, Vol.35, No. 1, (April), pp. 99-119.
- Sokolovic, N, Selvam, S, Srinivasan, K, Thankachan, P, Kurpad AV, and Thomas, T (2013): "Catch-up growth does not associate with cognitive development in Indian school-age children," *European Journal of Clinical Nutrition*, 68, 14-18.
- Strauss, John, and Thomas D., (1995): "Empirical Modeling of Household and Family Decisions", in J. Behrman and T.N. Srinivasan (eds), *Handbook of Development Economics*, 3A, North Holland, Amsterdam.
- Strauss, J., and Thomas, D. (1998): "Health, nutrition, and economic development". *Journal of Economic Literature*, 36(2), 766–817.
- Swindindale, A. and Bilinsky P., (2006): "Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (v2)," Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development.
- Tiwari, S., Skoufias E., Sherpa M., (2013): "Shorter, Cheaper, Quicker, Better: Linking Measures of Food Security to Nutritional Outcomes in Bangladesh, Nepal, Pakistan, Uganda, and Tanzania". **Policy Research Working Paper No. 6584**, August 2013, The World Bank, Washington D.C. <http://go.worldbank.org/BWBRP91A50>
- UNICEF (1990): "Strategy for Improved Nutrition of Children and Women in Developing Countries"
- USAID (2012): "Maternal Dietary diversity and the implications for children's diets in the context of food security." USAID's infant and young child nutrition project [link](#) ; www.iycn.org
- Victora, C. G., de Onis, M., Hallal, P. C., Blössner, M., & Shrimpton, R. (2010): "Worldwide timing of growth faltering: revisiting implications for interventions." *Pediatrics*, 125 (3), 473-480.
- Webb, P., and Block, S. A. (2004): Nutrition information and formal schooling as inputs to child nutrition. *Economic Development and Cultural Change*, 52(4), 801–820.
- Weismann, D., Hoddinott, J. Aberman, N., and Ruel, M., (2006): "Review and Validation of Dietary Diversity, Food Frequency, and Other Proxy Indicators of Household Food Insecurity,"
- Wiesmann, D., Bassett, L. Benson, T., and Hoddinott, J., (2009): "Validation of the World Food Programme's Food Consumption Score and Alternative Indicators of household Food Security," IFPRI Discussion Paper 00870
- WHO (2008) "Indicators for assessing infant and young child feeding practices – part I: definition" [link](#)
- WHO (2011). *Guideline: Vitamin A supplementation for infants and children 6-59 months of age*. Geneva, World Health Organization.
- WHO (2013). Table 2 Summary of WHO Position papers- recommended routine immunizations for children [link](#)
- WHO and UNICEF (2006) "Core questions on drinking-water and sanitation for household surveys," [link](#)
- World Bank (2013). "Improving Nutrition Through Multisectoral Approaches." Washington, DC, The World Bank.

World Food Programme, (2009) Emergency Food Security Assessment Handbook WFP, Rome, http://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp203244.pdf, accessed on June 24, 2013.

World Food Programme (WFP). (1996) Rome Declaration on World Food Security

World Food Programme (WFP). (2008). "Food Consumption Analysis: Calculation and Use of the Food Consumption Score in food Security Analysis," Technical Guidance Sheet. Rome.

Annex 1: Asset index

Table A3: Components of asset index used to determine resource-rich and -poor households

Asset	Cambodia	Ethiopia	Nepal	Bolivia	Peru	Zimbabwe*	Bangladesh (HK)**	Bangladesh (IFPRI)***	Indonesia****
Electricity		yes	yes	yes	yes	yes	yes		
Radio	yes	yes	yes			yes	yes ¹	yes	
TV	yes	yes	yes			yes	yes ¹	yes	
Computer				yes	yes				
Refrigerator	yes					yes	yes		
Garbage disposal				yes	yes				
Mobile/telephone		yes	yes	yes	yes	yes	yes	yes	
Telephone		yes	yes			yes		yes	
Floor type	yes	yes	yes			yes		yes	
Cooking fuel type	yes	yes	yes	yes	yes	yes		yes	
Roof type				yes	yes	yes		yes	
Wall type				yes	yes	yes		yes	
Kitchen				yes	yes				
Bicycle	yes	yes	yes			yes	yes	yes	
Motorcycle	yes	yes	yes	yes	yes	yes	yes	yes	
Car/truck	yes	yes	yes	yes	yes	yes	yes		
Boat with motor	yes					yes	yes	yes	
Oxcart/horse	yes					yes	yes	yes	

Notes: ¹ TV and radio are combined

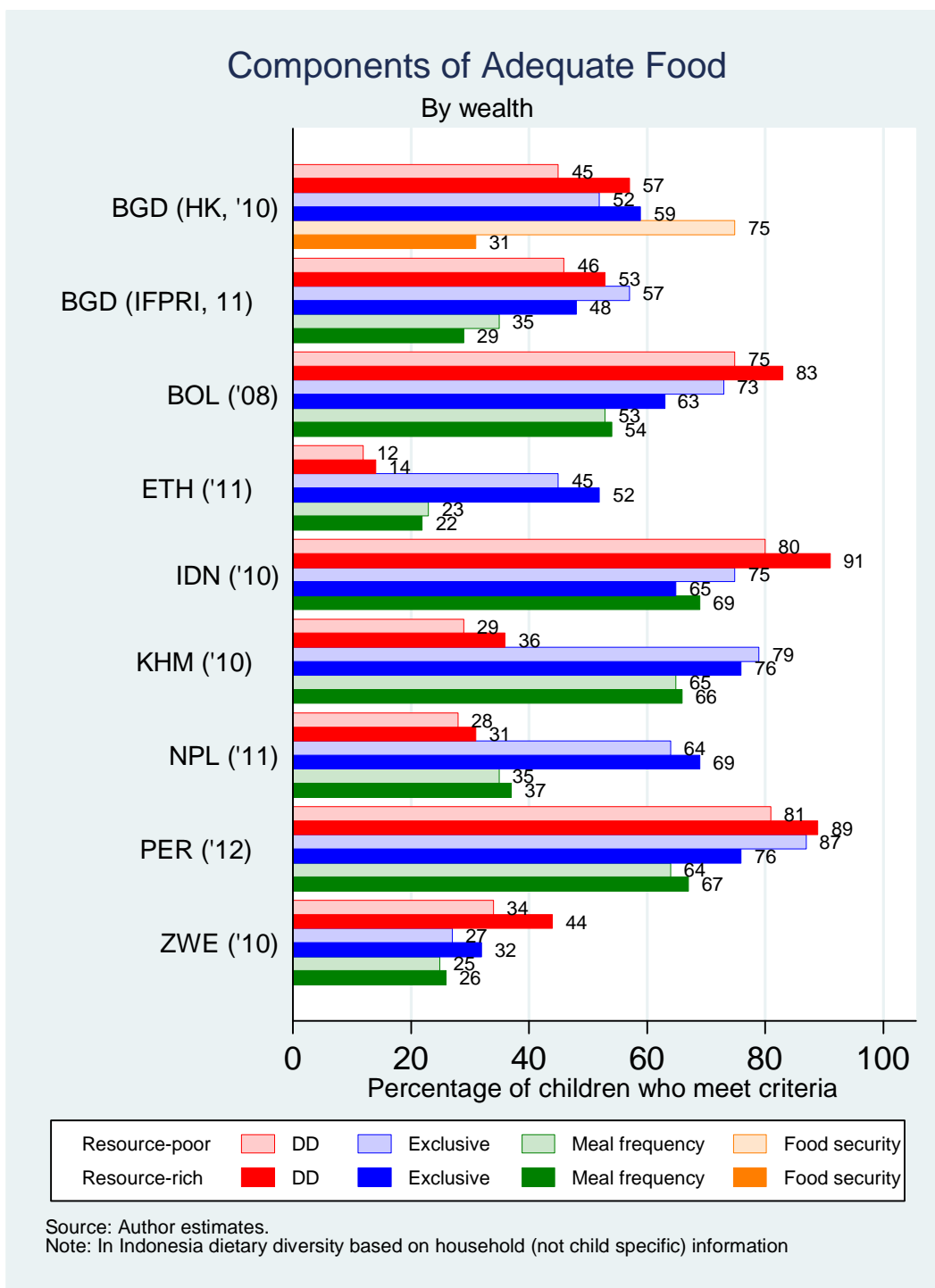
* Also included source of water supply, sanitation facility, ownership of a watch, land, livestock, cattle, goats, sheep, pig, poultry, having a bank account, domestic servant

** Also includes solar panel, khat/chawki, almirah, table/chair, watch/clock, rickshaw/van, power tiller, shallow machine, and fishing net.

*** Also includes ownership of suitcase, buckets, stove, metal cooking pots, bed/khat/chowki, armoire/cabinet/alna, table/chair, hukka, electric fan, electric iron, audio cassette/cd player, wall clock/watch, jewelry, sewing machine, rickshaw, van, boat, dheki, jata, randa, saw, hammer, patkoa, fishing net, spade, axe, shovel, shabol, daa, khacchar, ass, solar energy panel, electricity generator, IPS, other assets, kaste, nirani, ladder, rake, plough, reaper/sickle, manual sprayer, wheelbarrow, bullock cart, push cart, light machinery, tractor, power tiller, trolley, thresher, fodder cutting machine, swing basket, don, hand tube well, treadle pump, rower pump, low lift pump, shallow tube well, deep tubewell, electric motor pump, diesel pump, spraying machines, harvester, other heavy machinery, mason equipment, potters chaka, blacksmith's hapor, charka, a servant in household, more rooms than median; the household has access to health center/hospital, bus stop, main road, railway station, local shop/shops, bazaar, nearest town, college, agricultural extension office, post office, bank, brac, Grameen bank, asa.

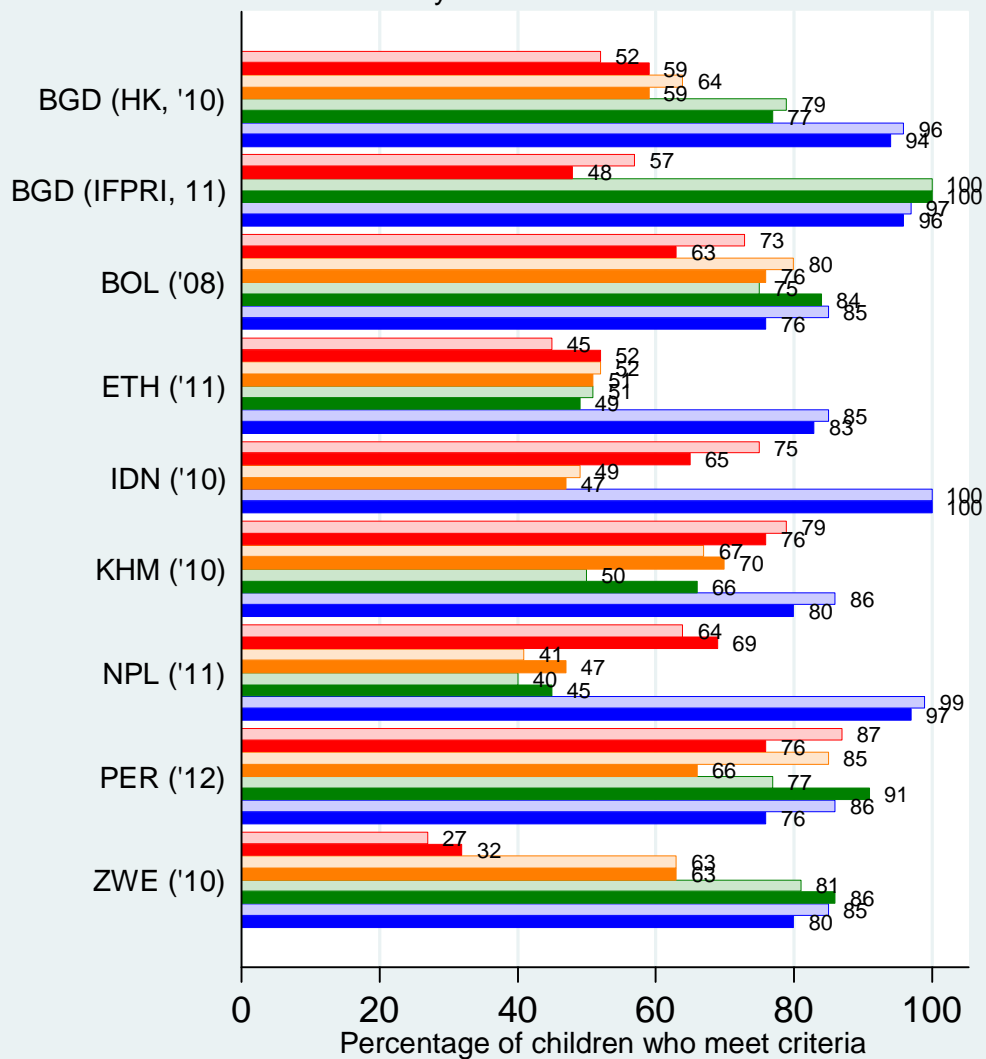
**** Used per capita expenditures to divide the sample to resource rich (top 60%) and resource poor (bottom 40%).

Annex 2: Components of adequacy measures by wealth



Components of Adequate Care

By wealth



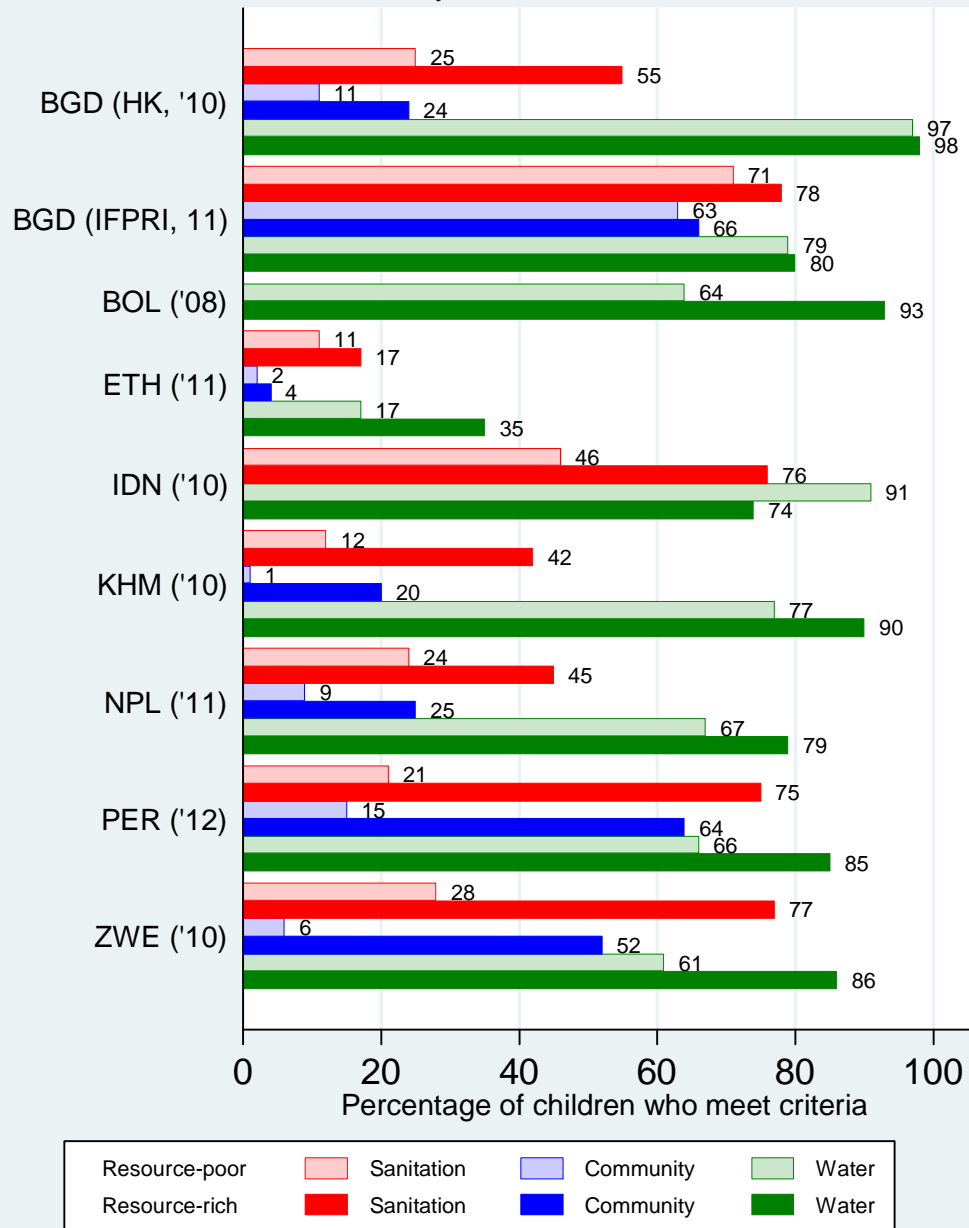
Resource-poor Exclusive Early initiation Complementary Breastfeeding
 Resource-rich Exclusive Early initiation Complementary Breastfeeding

Source: Author estimates.

Note: Exclusive breastfeeding for first 6 months; Complementary feedings from 6 months;
 Early initiation of breastfeeding within 60 mins (100 mins BOL and PER) of birth;
 Continued breastfeeding until 24 months

Components of Adequate Environment

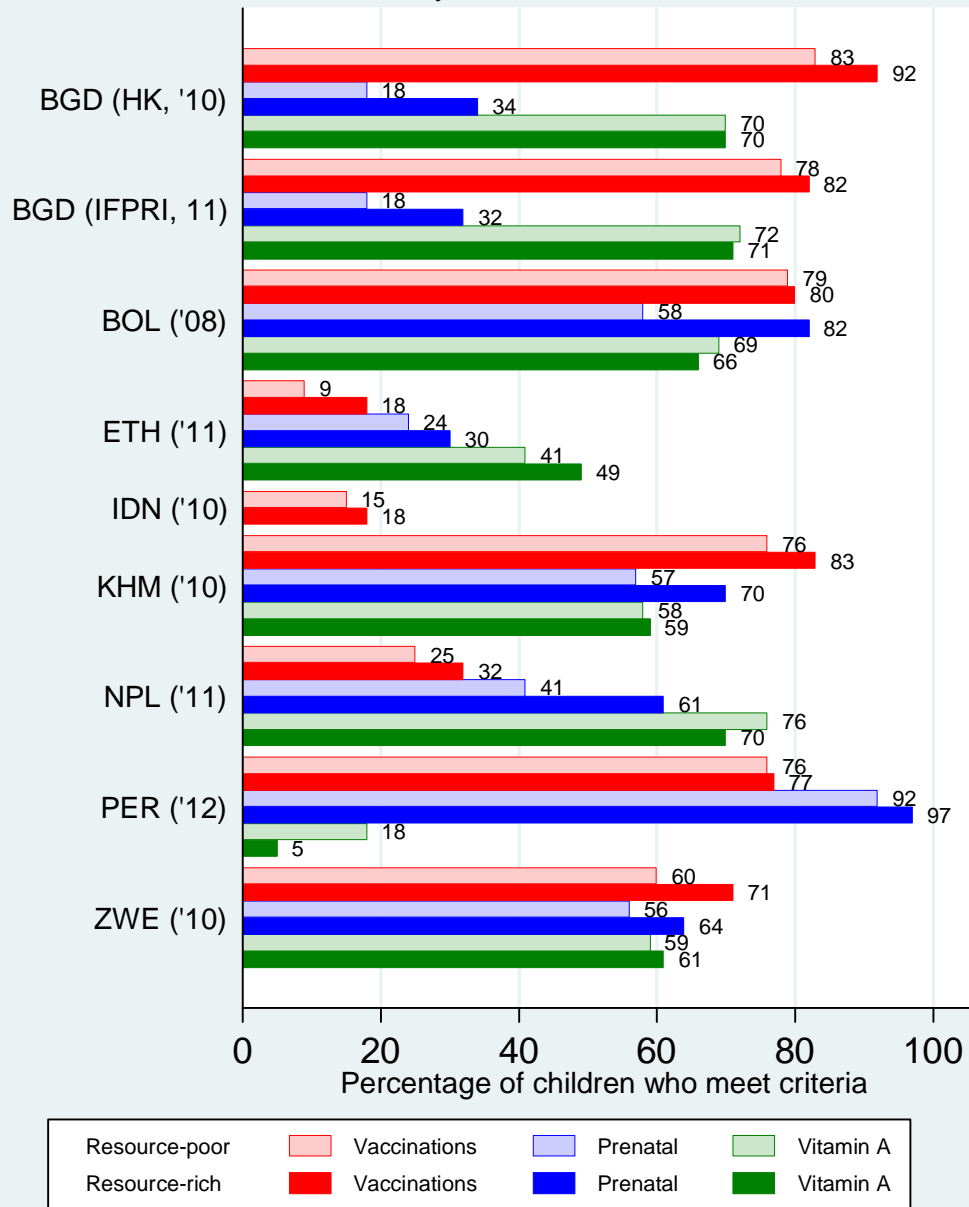
By wealth



Source: Author estimates.

Components of Adequate Health

By wealth



Source: Author estimates.

Note: In Helen Keller (HK) Vitamin A supplementation only for 6 months and older

Annex 3: Synergies by wealth group

