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The Global Landscape of Poverty, Food Insecurity, and Malnutrition and Implications for Agricultural Development Strategies

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ABSTRACT

For many years poverty reduction was the overarching welfare objective of a wide range of development institutions and programs, particularly in the context of agricultural development. Yet in recent years the development community has increasingly set for itself more specific welfare objectives by distinguishing between monetary poverty, food security, nutrition and, most recently, resilience. This paper first outlines a basic framework for thinking about the relationships between these different concepts, and then explores the empirical relationships among different indicators of these concepts, and some of their potential determinants. The empirical analysis highlights several important stylized facts. First, key indicators of these three dimensions of welfare suggest strong correlations among the subset of chronic welfare indicators but much weaker relationships between chronic and acute measures of welfare. Put another way, many countries are chronically poor, food insecure or malnourished, but a much smaller set of countries suffer from acute ill-being. For example, countries in the Sahel, the Horn of Africa and South Asia suffer disproportionately from high rates of child and maternal wasting, and a relatively small subset of developing countries are highly prone to natural disasters. Conceivably these acutely vulnerable countries require quite different development strategies. Second, gross domestic product per capita, agricultural productivity, literacy rates, fertility rates, and health burdens all share fairly robust relationships with poverty, food insecurity, and malnutrition indicators, as expected. But somewhat novel is a strong relationship between a simple indicator of dietary diversity and a wide range of both chronic and acute welfare indicators. This perhaps suggests that dietary diversity is a relevant intermediate welfare indicator of particular relevance for agricultural development initiatives.

Keywords: poverty, food security, nutrition, agricultural development strategies

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1. INTRODUCTION

By any reckoning, poverty, food insecurity, and malnutrition remain some of the most serious global challenges of the 21st century. The basic magnitude of these problems is well known and broadly agreed upon; however, often less widely appreciated is that poverty, malnutrition, and food insecurity share complex relationships with one another. In addition to conceptual differences, indicators of these concepts also suggest that food security, nutrition, and material well-being do not always coincide (South Asia, for example, has long been known to have severe problems of malnutrition relative to its poverty levels). Within each of these concepts is a need to distinguish between chronic manifestations (for example, poverty, stunting, and low agricultural productivity) and acute manifestations (for example, vulnerability to income shocks, wasting, and exposure to seasonal shortfalls). Strategies that equate these multiple manifestations of underdevelopment are likely to fail.

In light of these complexities, the overarching objective of this paper is to explore the conceptual and empirical relationships between these different dimensions of human well-being (or "ill-being"). This objective is quite modest, such that many of our empirical findings may not be surprising to experts in the relevant fields. However, one potential source of value added in this paper is that we bring together concepts and indicators from traditionally quite disparate research areas, including economics, agriculture, nutrition, and health, so some aspects of the paper may help to facilitate interdisciplinary learning and research.

The remainder of this paper is structured as follows: In Section 2 we outline a conceptual framework for thinking about food, nutrition and health security, and the broader processes of economic development and poverty reduction that influence these outcomes. The discussion highlights the pertinent differences between these different dimensions of food security, nutrition security, health security, and poverty and puts forth some hypotheses about relationships between these different dimensions. Section 3 discusses the key variables that need to be considered in this framework and addresses measurement issues more broadly. Section 4 provides some basic tests of the relationships of these different indicators with one another, in order to provide some broad validation of the framework. Section 5 maps out levels of these indicators across different regions, including subregions. Section 6 summarizes and concludes.

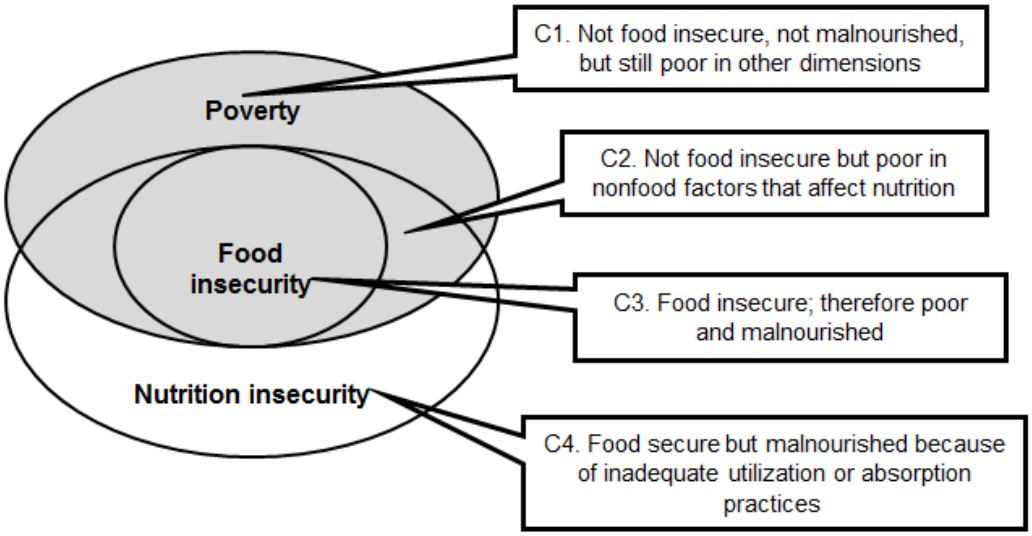
2. POVERTY, FOOD INSECURITY, AND MALNUTRITION: A CONCEPTUAL FRAMEWORK

How is *food security*, *nutrition security*, and *poverty* defined? While these three terms are often used somewhat interchangeably, each of these three dimensions is conceptually distinct from the others. In the context of developing countries, poverty is usually defined in absolute terms, and empirically it has traditionally been measured in monetary terms by measuring income and expenditure relative to a minimum expenditure required to satisfy basic needs. Quite often, term *basic needs* in the context of poverty, is defined as the affordability of calories combined with some adjustments for additional nonfood requirements. More recently, some researchers have advocated multidimensional poverty indicators (Alkire and Santos 2010) to capture expenditure needs not typically well accounted for by conventional monetary poverty indicators, such as adequate access to health, education, clean water, sanitation—and (perhaps more contentiously) adequate physical security, political voice, and sufficient capacity and opportunity to better one's life.

Food security is clearly related to poverty and could even be thought of as a subset of poverty. In 1996 the Food and Agriculture Organization of the United Nations (FAO 1996, 5) stated, "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Barrett (2010, 24) provides a similar definition but adds a psychological dimension in terms of the absence of feelings of deprivation, restricted choice, or anxiety related to the quantity or quality of available food. A striking feature of these definitions then is that food security is largely rationalized in terms of its contribution to improved nutrition, with an oft-ignored psychological dimension being the only major distinction. Nutrition security, however, is defined not only in terms of physical and economic access but also in terms of adequate utilization and absorption of nutrients. Nutrition security therefore depends not only on adequate food security but also on adequate care practices (food storage and preparation, appropriate feeding practices, including breastfeeding) and adequate health (including hygiene and sanitation).

Conceptually, then, food insecurity is essentially a subset of overall poverty and of nutrition insecurity, but both poverty and malnutrition can have nonfood determinants or manifestations. These complex relationships are displayed in Figure 2.1, in which we make note of four possible cases of independence and overlap. In category 1 (C1), one's own food needs and nonfood requirements for nutrition are satisfied, but the individual is still poor (perhaps lacking access to education, for example). In C2, one's own food needs are satisfied but the individual is still poor and malnourished (perhaps lacking access to health services that are important for nutrition). In C3, an individual is food insecure and therefore both poor and nutrition insecure. And in C4 an individual is neither food insecure nor poor but malnourished. For example, a child may be subjected to inappropriate feeding practices, or an individual may be obese.

Figure 2.1 Conceptual relationships between food security, nutrition security, and poverty, with different categories (C1–C4) of independence and overlap



Source: Authors' construction.

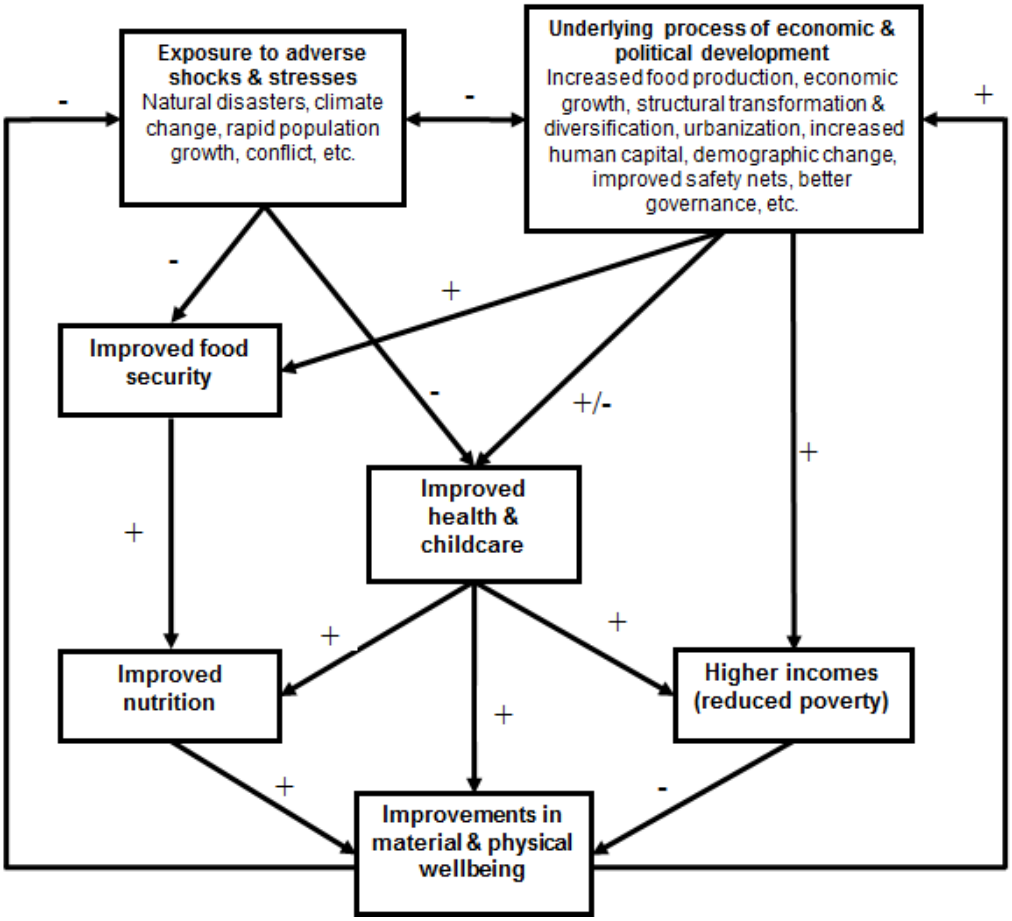
Figure 2.1 is in many respects a simplification designed to illustrate that these three measures of ill-being are indeed conceptually distinct. In fact, these definitional matters are even more complex. First, temporal dimensions are also factors in these issues. For any of these indicators an individual may have adequate income, food availability, and nutrition at a given point of time but be highly vulnerable to idiosyncratic or covariate shocks. Thus, there is a distinction between chronic and acute forms of ill-being, or between current states and vulnerability to more adverse states. The poverty literature, for example, has had some focus on income dynamics, seasonality, and vulnerability in general (for example, Dercon and Krishnan 2000). In nutrition, there are also long-standing distinctions between chronic indicators (such as height for age) and acute indicators (such as weight for height).

Second, while poverty, food security, and nutrition could in principle be measured at common levels of aggregation, nutrition is usually measured at the individual level, and poverty and food security are usually measured at the household level. Levels of aggregation have strategic as well as empirical importance. Nutrition research has shown that lifelong physical, cognitive, and economic outcomes are largely determined in the first 1,000 days of life (Victora et al. 2009). This implies that the bulk of nutritional investments should be targeted toward women and very young children.

Figure 2.1 and the discussion above point to complex relationships and important implications of mainstreaming nutrition security into development objectives; however, we have only touched upon causal relationships. In Figure 2.2 we outline a basic causal model that hypothesizes relationships between economic development, food security, poverty reduction, health and care practices, and nutrition security. At the first level we start with the underlying process of economic and political development. This is a long-term process that involves economic growth, increased food production, structural transformation, economic diversification, urbanization, investments in human and physical capital, demographic shifts in fertility rates and age dependency ratios, and for the most part, improved governance. Obviously such a process is nonlinear and context specific, but over the long run these different economic and political transformations generally go hand in hand. In addition to these generic development processes, we also make note of some determinants of acute poverty, food insecurity, and malnutrition in the form of exposure to adverse shocks and stresses. Although this includes natural events (such as floods, droughts, earthquakes), in reality an economy's vulnerability to natural events depends on man-made factors, including the overall level of economic and political development. At a second level,

the generally positive process of economic and political development involves income growth (poverty reduction), reduced food insecurity, and improved health and childcare practices.[1] Finally, there is a feedback loop from improved nutrition, health, and monetary outcomes into economic development. For example, nutrition and health increase labor productivity via their effect on cognitive ability and physical activity. But higher incomes can also lead to economic diversification, greater investments in education, reduced fertility rates, and even stronger demands for better governance.

Figure 2.2 A basic causal model of interactions between different dimensions of well-being



Source: Author's construction.

Figure 2.2 is still a relatively basic model, but it does capture a series of important relationships and processes that are the subject of substantial interest among policymakers and researchers. The framework also provides a list of the kinds of indicators required to capture these factors and some basic hypotheses about the relationships between these indicators.

[1] Economic development need not always improve healthcare. One exception that comes to mind is increased prevalence of obesity (Webb and Block 2010).

3. INDICATORS OF POVERTY, FOOD INSECURITY, AND MALNUTRITION

In this section we outline a set of indicators designed to measure some of the important factors in Figure 2.2, though we restrict our analysis to indicators at the country level. Table 3.1 outlines these different dimensions of underlying processes and welfare outcomes by chronic and acute dimensions, while Table 3.2 gives more precise definitions of the actual indicators used and the sources from which they were collated. Note that while we had the choice of selecting an even greater number of indicators, obviously the analysis and the discussion must be kept as parsimonious as possible.

Table 3.1 Dimensions of food and nutrition insecurity and the indicators used

	Temporal dimensions	
Indicator	**Chronic factors**	**Acute factors**
Underlying structural factors	Gross domestic product per capita; agricultural productivity; governance quality; literacy; fertility rates	Exposure to natural disasters; vulnerability to food price hikes
	<<Water resources; soil constraints>>	
Health security (nutrition relevant)	<<DALYs lost to diarrhea, malaria and maternal/perinatal conditions>>	
	<< DALYs lost to childhood cluster diseases>>	
Food insecurity	Macro- and micronutrient availability; poverty	Self-reported hunger; food aid requirements
Nutrition security	Stunting prevalence	Wasting prevalence
	<<Prevalence of underweight mothers>>	

Source: Author.

Notes: << >> indicates factors that have both chronic and acute dimensions. See Table 3.2 for more precise definitions and sources. DALYs = disability-adjusted life years.

Table 3.2 Definitions of the indicators used to measure food and nutrition insecurity

	Short name	Definition	Comments	Source
Underlying factors	Nonfarm population	Population not dependent on agriculture	Estimates based on agricultural employment data	FAO
	GDP per capita	GDP per capita measured in constant purchasing power parity	Purchasing power parity units ensure comparability	WB
	Agric. Productivity	Agricultural output per agricultural worker	Measures agricultural contribution to food security	WB
	Governance	Kaufman–Kraay governance index	We use the aggregate index covering six dimensions	WB
	Food imports	Food imports (% of exports + net remittances)	Measures capacity to pay for food imports	WB
	Disasters	Number of people affected by natural disasters	Measured over last 20 years	EM-DAT
	Water resources	Freshwater resources per capita (cubic meters)	Captures agricultural potential, sustainability, drought exposure	WB
	Soil constraints	Soil-constrained agricultural land (%)	Captures poor soil quality and land degradation	IIASA
Health	DALYs: diarrhea, malaria and maternal	Disability-adjusted life years (DALYs) lost to infectious diseases	Arguably the health outcomes most directly relevant to malnutrition	WHO
	DALYs: childhood cluster diseases (1,000s)	DALYs lost to maternal and perinatal conditions	Major determinants of poor nutrition outcomes	WHO

Table 3.2 Continued

	Short name	Definition	Comments	Source
Poverty and food security	Calories	Mean calorie availability	Does not factor in inequality between individuals	FAO
	Dietary diversity	Share of daily energy supply (DES) from micronutrient-rich foods	Includes animal products, fruits, vegetables, pulses	FAO
	Hunger	Self-assessed hunger	Asks question on hunger experiences in last 12 months	Gallup
	Poverty	% population living below US$1.25 per day	A broader indicator of food accessibility	WB
Malnutrition	Stunting, under age 5	% with height-for-age less than 2 standard deviations below international norms	Chronic malnutrition; wasting reflects macro and micronutrient deficiencies and disease burdens	WHO and DHS
	Wasting, under age 5	% with weight-for-height less than 2 standard deviations below international norms	Captures acute malnutrition; wasting reflects macro and micronutrient deficiencies and disease burdens	WHO and DHS
	DALYs: malnutrition	DALYs lost to malnutrition	Covers both macro and micronutrient deficiencies	WHO
	Low adult body mass	Percentage of adults with body mass index (BMI) less than 18.5	Captures elements of both chronic and acute malnutrition; probably reflects macronutrient deficiencies more than micronutrient	WHO and DHS
	High adult body mass	Percentage of adults with BMI greater than 25	Although BMI > 30 is the definition of obesity, including preobesity levels (25 < BMI < 29) may be indicative of future obesity problems in less-developed countries.	WHO and DHS

Sources: World Development Indicators (2012); Gallup (2011), WHO (2008, 2010); FAO (2012); Demographic Health Surveys (2012); EM-DAT (2009); FAO and IIASA (2009).

Notes: WB = World Bank; WHO = World Health Organization; FAO = Food and Agriculture Organization of the United Nations; DHS = Demographic Health Survey; EM-DAT = IIASA = International Institute for Applied Systems Analysis

Underlying Structural Factors

Underlying structural factors refer to both slower-moving economic, political, and social processes of development and the incidence of short-run shocks. Starting with underlying indicators of economic and political development, we chose gross domestic product (GDP) per capita (in constant purchasing power parity units) as an indicator of economic development and transformation,[2] productivity of food production (food production per agricultural worker in US dollars) as an indicator of agricultural development, the Kaufman and Kraay (2003) overall governance indicator, fertility rates as an indicator of demographic changes, and adult literacy as an important human capital indicator (nutrition and health outcomes are measured elsewhere, of course). We also use freshwater resource per capita as a measure of agricultural potential and environmental sustainability. This variable also seems to capture exposure to drought.

[2] We also considered using urbanization levels, but these correlated so closely to levels of GDP per capita that they added little value to the discussion. The inaccuracy of measurements of urbanization across countries is also a major concern (Uchida and Nelson 2008). Similar comments apply to indicators of structural transformation, because agriculture as a share of GDP is highly correlated with GDP per capita.

In terms of exposure to shocks, we focus on a measure of the number of people affected by natural disasters during 1981–2001 (affected population per 1,000 people). This is not necessarily an ideal indicator, but alternative indicators also have their flaws.[3] We also use dependence on food aid as an additional indicator of acute food insecurity, although this indicator could obviously be biased by political economy factors. In addition to these two indicators of acute food insecurity, we sought to measure exposure to international food price inflation given the recent food crisis. We use an indicator of food imports relative to foreign exchange earnings. This indicator could be thought of as a macroeconomic food security indicator.

Finally, we also considered measures of exposure to conflict; however, because conflict-affected countries tended to score poorly on the governance indicator (one of the six dimensions deals with violence and insecurity), we concluded that conflict was already captured by the governance indicator. Moreover, the literature suggests that poor governance is a good predictor of vulnerability to future conflict, especially in multiethnic societies (Stewart 2009).

Health Security

For health, we try to focus on the most nutrition-relevant indicators. While mortality rates for infants and children under age five are common indicators of health with some relevance to nutrition (given that poor nutrition indirectly accounts for a substantial share of total infant deaths), these indicators do not directly capture nutrition-related morbidity. For this reason we chose indicators that are relevant to different types of poor nutrition outcomes and reflect both morbidity and mortality. Hence we use disability-adjusted life years (DALYs) lost to different diseases and conditions. DALYs for a disease or health condition are calculated as the sum of the years of life lost due to premature mortality in the population and the years lost due to disability for incident cases of the health condition. A nice advantage of such a measure is that one can focus on diseases and conditions that are most relevant to nutrition. In this regard, we use two indicators: DALYs lost to very nutrition-relevant diseases such as diarrheal diseases, malaria, maternal and perinatal conditions (prematurity and low birth weight, birth asphyxia and birth trauma, neonatal infections, and other conditions), and DALYs lost to childhood cluster diseases.[4] We could arguably have chosen other indicators (like DALYs lost to HIV/AIDS), but more broadly defined disease burdens did not perform any better in our correlation or regression analyses, though they remain quite highly correlated with the indicators that were chosen.[5]

Poverty

For poverty we use the standard US$1.25/day head-count measure of poverty produced by the World Bank. Though poverty could itself be considered a food security indicator, the advantage of a monetary poverty indicator is that it factors in the need for nonfood expenditures. We also note that although we considered multidimensional poverty indexes, these indexes include nutrition, health, and education variables that really ought to be distinct indicators in our analysis.

[3] Some flaws include that *affected* could cover various ranges of impact; exposure to disasters in the past might not be a good indicator of exposure in the future, given climate change (on the other hand, climate change models and predictions are not regarded as very accurate); and exposure to shocks is in some sense endogenous, depending upon existing levels of development, including food and nutrition security.

[4] Childhood cluster disease includes pertussis, poliomyelitis, diphtheria, and measles. These account for much fewer DALYs lost than other diseases such as diarrhea and malaria, but are still relevant. We note that both of these indicators should be thought of both as comorbidities of malnutrition in that directions of causality run from health to nutrition and from nutrition to health.

[5] See Mathers et al. (2006) for a discussion of measurement issues with respect to DALYs.

Food Security

In terms of food security, we use two diet-related indicators and a subjective indicator. The diet-related indicators are mean calorie availability (macronutrients) and a dietary diversity indicator. Calorie availability is a standard indicator, but the dietary diversity indicator is relatively new, motivated by recent work by Jensen and Miller (2010), who provide a theoretical foundation for the share of calories from nonstaple foods as an indicator of general welfare. Moreover, previous research has shown that individual-level dietary diversity is a strong predictor of childhood nutrition outcomes (Arimond and Ruel 2006). Our indicator is measured using national-level food balance sheets. It is the share of mean calorie availability obtained from nutrient-rich foods (meats, vegetables, fruits, pulses, nuts, and oils and fats). This is quite a simple indicator, but as we will see below, it actually correlates quite strongly with many other welfare outcomes.

Finally, we use the Gallup World Poll indicator of self-reported hunger—largely as an indicator of acute food insecurity. Subjective indicators have their weaknesses (Headey 2011), and so too do objective indicators of hunger. Moreover, it could be argued that subjective information has value in its own right, given that anxiety over food availability is regarded as one dimension of food security (Barrett 2010). It also appears that this hunger indicator potentially adds value to other welfare indicators. For example, while the poverty measure suggests that poverty in India and China is above 20 percent, self-assessed hunger in both of these countries is very low.

Nutrition Security

Finally, in terms of malnutrition, we take child stunting prevalence as an indicator of chronic undernutrition, or the cumulative effects of macro- and micronutrient intake, and health shocks. Wasting among children is a standard indicator of acute malnutrition and nutritional vulnerability, while low adult body mass seems to capture both chronic and acute malnutrition to some degree. Again, both of these indicators seem to capture both macro- and micronutrient deficiencies.[6]

As for the country coverage, we collect these data for low- and middle-income countries only, and we exclude a number of smaller countries that tend to suffer from missing data. This leaves us with 97 low- and middle-income countries covering every region of the developing world, and roughly 4.3 billion people. For many of the variables, fewer than 97 countries are covered. For our descriptive statistics, we therefore impute values for missing observations using regression-based predictions. The specific countries and their regional groupings are listed in Table A.1 in the Appendix.

[6] We also considered other indicators of malnutrition, such as DALYs lost to macro- and micronutrient deficiencies, and anemia and vitamin A deficiencies. For the DALYs indicators, one concern was that it was not obvious how these indicators were estimated. In particular, it seems that the information on nutrition outcomes and diets was used to make the estimates, causing superfluous overlap with indicators. Anemia and vitamin A deficiencies were not chosen because of insufficient country coverage.

4. EXPLORING THE EMPIRICAL RELATIONSHIPS BETWEEN POVERTY, FOOD INSECURITY, AND MALNUTRITION

In this section we aim to explore the relationships between food security, nutrition security, and the various underlying factors discussed in the previous section. Our approach is relatively simple, with a focus on establishing some important correlates with the different food and nutrition security measures. For this we use both simple correlations and least squares regression analysis.[7]

Table 4.1 shows a correlation matrix between the different food and nutrition security indicators. We use this table to draw several important points. First, it is interesting to observe quite a low correlation between mean calorie intake and the dietary diversity indicator (0.26). However, the dietary diversity indicator is strongly correlated with the World Health Organization estimate of DALYs lost to macronutrients (–0.46) and micronutrients (–0.50). This very simple dietary diversity indicator also possesses a stronger correlation with stunting than with calories (–0.63 versus –0.53), a much stronger correlation with wasting (–0.58 versus –0.07 for calories), and a much stronger correlation with low maternal body mass index ([BMI]; –0.47 and –0.21). On the other hand, mean calorie intake is indeed more strongly correlated with self-assessed hunger than the dietary diversity indicator is (–0.46 versus –0.30), and calories are slightly more strongly associated with monetary poverty than with dietary diversity (–0.63 versus –0.55). But for the nutrition outcomes of young children and mothers, it appears that dietary diversity is a more relevant intermediate goal than increasing sheer food availability (though the two are closely linked). Previous research has also found that dietary diversity indicators are strong predictors of childhood stunting (Arimond and Ruel 2006).

Table 4.1 Correlations between different indicators of food and nutrition security

Indicator	Calories	Diet diversity	DALYs: macro	DALYs: micro	Poverty	Hunger	Child Stunting	Child Wasting	Low BMI
Calories	1								
Diet diversity	0.26	1							
DALYs: macro	–0.52**	–0.46**	1						
DALYs: micro	–0.37**	–0.50**	0.66**	1					
Poverty	–0.63**	–0.55**	0.71**	0.69**	1				
Hunger	–0.46**	–0.30*	0.66**	0.62**	0.71**	1			
Stunting	–0.53**	–0.63**	0.73**	0.51**	0.68**	0.51**	1		
Wasting	–0.07	–0.58**	0.29*	0.41**	0.38**	0.28*	0.45**	1	
Low BMI, maternal	–0.21	–0.47**	0.15	0.26	0.31*	0.08	0.47**	0.77**	1

Source: Author's estimates. See Table 3.2 for definitions and sources of variables.

Notes: BMI = body mass index. DALYs = disability-adjusted life years. * Denotes significant at the 10% level, ** denotes significance at the 5% level.

[7] Such an analysis has obvious caveats. Ordinary least squares regressions of cross-sectional data are likely to be somewhat biased by endogeneity problems, and of course the analysis is static. For a more dynamic approach, see papers such as Headey (2011) on anthropometric indicators and Christiaensen et al. (2011) on poverty indicators.

Potentially, this finding has important research and programmatic implications, as it suggests that increasing sheer food availability could be misplaced if the more important nutritional constraint is lack of dietary diversity. On the other hand, it could be argued that diversifying agricultural production first requires the attainment of basic food security (that is, sufficient calories). There may also be additional benefits to promoting the production of micronutrient-rich foods in contexts of small farms, since micronutrient-rich foods are generally high-value foods. It also has implications for safety net programs, which often involve transfers of cereals (or calories) rather than micronutrient-rich foods or cash payments, which could be used to purchase micronutrients.

A second point of note is that some of the correlations between these indicators are quite low. For example, while most indicators of chronic food and nutrition security are strongly correlated (poverty, hunger, and stunting share correlations in the range of 0.60 to 0.70), acute malnutrition and all the indicators of chronic ill-being show low correlations. Child wasting prevalence is strongly correlated with dietary diversity (–0.58), but only moderately strongly correlated with stunting (0.45) and poverty (0.38), rather weakly correlated with self-assessed hunger (0.28), and insignificantly correlated with mean calorie availability. The prevalence of low-BMI mothers shares similar patterns. Particularly striking are the low correlations between low maternal BMI prevalence and monetary poverty (0.31) and hunger (0.26).

One obvious disadvantage of Table 4.1 is that the bivariate correlations could be biased by omitted factors, such as other underlying factors that influence food and nutrition security outcomes. For this reason Tables 4.2 and 4.3 regress the food and nutrition indicators in Table 4.1 against the underlying factors listed in Tables 4.1 and 4.2, as well as a series of regional fixed effects. The latter is designed to capture unobserved regional factors and involve fairly disaggregated regional categories in Africa: coastal West Africa, Sahelian Africa (inland West Africa), Central Africa, Southern Africa, and Eastern Africa (see Table A.1 in the Appendix for country lists by region). However, in all regressions we run general-to-specific models, which successively eliminate insignificant variables. In some cases we found correlations between different underlying factors so strong that multicollinearity was a significant problem. For example, agricultural output per worker (productivity) and GDP per capita are quite highly correlated, as is GDP per capita, adult literacy and fertility rates.

Since such high intercorrelations can affect significance levels and coefficients, we use a residual-generated regressor approach to disentangle some of the different relationships between variables (see Pagan 1984). We specifically focus on GDP per capita and adult literacy as two generic development indicators that influence several other variables in the model. Hence additional variables in the model that are highly correlated with these two generic variables are measured relative to these variables. We regress agricultural productivity against GDP per capita and take the residuals as an indicator of agricultural productivity levels that are high or low relative to GDP per capita. We do the same for fertility rates, which are measured relative to education levels. In both cases we denote these indicators as *relative agricultural productivity* and *relative fertility*. We note that there are some precedents for this approach using similarly structured data (Gomanee, Girma, and Morrisey 2005; Headey 2008).

In addition to multicollinearity concerns we should be concerned about various endogeneity biases. In cross-sectional data at the country level it is extremely hard to control for such biases (Durlauf, Johnson, and Temple 2005), although the use of fixed regional effects and residual-generated regressors may reduce them somewhat. Even so, one can certainly hypothesize reverse or simultaneous causation for many of these relationships, so we urge readers not to attach too much causal inference to these results.

Table 4.2 reports regressions of the food security and poverty indicators against underlying factors and regional effects, while Table 4.3 does the same for nutrition security indicators. The pattern of significance of both underlying factors and fixed effects is quite interesting. From Table 4.2 it is clear that GDP per capita is a highly robust determinant of food security. Unsurprisingly, GDP per capita has a strong impact on mean calorie consumption (as per Engel's law), but surprisingly also on dietary diversity (Bennett's law). Higher mean incomes also reduce poverty and subjective hunger (though the effects on monetary poverty are much larger), and richer countries tend to be less dependent on food imports and less exposed to natural disasters.

Table 4.2 Regressions of food security indicators against underlying factors

Regression number	1	2	3	4	5	6
Dependent variable	**Calories per capita (kcal)**	**Dietary diversity (%)**	**$1.25/day poverty (%)**	**Subjective hunger (%)**	**Food import (% of exports + remittances)**	**Incidence of natural disasters per 1,000 people, 1980–2001**
Log of GDP per capita	220.46***	8.44***	–18.06***	–6.24**	–5.07***	–0.77**
Literacy	–0.34		–0.24***	–0.42***	–0.12**	0.01
Relative agricultural productivity	25.27	2.82***	–2.37*	3.93**	2.46**	–0.58**
Relative fertility rate	–101.45**		2.86***	8.96***	1.91*	–0.50*
Governance index	159.84**					0.93**
Food aid					0.27***	
Freshwater per capita			4.10**			
Freshwater per capita, squared			0.30**			
Soil constraints			0.10*			
Regional dummies (East Asia omitted)						
Middle East and North Africa	391.61***					
Eastern Africa		8.17*				
Southern Africa			18.38***	9.98**	–4.4*	
Horn of Africa			–16.22*			1.7#
Central Africa				39.1***		
Sahelian Africa						2.3***
South Asia						
Number of observations	87	86	85	64	89	89
Adjusted R-square	0.56	0.51	0.86	0.73	0.56	0.27

Source: Author's estimates. See Table 3.2 for sources and definitions of variables.

Notes: GDP = gross domestic product. These are ordinary least squares regressions of cross-sectional data. * Denotes significant at the 10% level, ** denotes significance at the 5% level, *** denotes significance at the 1% level. # Indicates marginal insignificance at the 10% level.

Literacy rates are also a strong predictor of poverty and hunger but not of natural disasters or the dietary indicators. Interestingly, relative agricultural productivity (that is, relative to GDP per capita) is a strong predictor of dietary diversity but not a significant predictor of mean calorie supply (though the coefficient bears the expected sign). Higher relative agricultural productivity does not seem to explain poverty levels across countries (though this is perhaps not so surprising in that the importance of agriculture varies across countries) and has a surprising positive correlation with subjective hunger and food import dependence, but a negative relationship with exposure to natural disasters.

Relative fertility rates are the most robust predictor of food security outcomes after GDP per capita. Higher fertility rates are associated with reduced calorie availability, although the correlation with dietary diversity is only significant and negative in a bivariate setting (hence fertility rates are dropped in the relevant regression). Higher fertility rates are also strongly associated with higher poverty and hunger, and more marginally associated with food imports (positively) and exposure to natural disaster (negatively). The strong impact of demographic factors on all of these variables (and on nutrition outcomes) perhaps points to the need to focus more research and policy interventions on family planning interventions as a means of achieving food and nutrition security (Kohler 2012; Headey 2012). Moreover, demography also has some important linkages to agriculture, since fertility rates are pervasively higher in rural areas than in urban areas for various reasons.

Turning to governance, we found only the governance indicator to yield a significant coefficient in the calories and natural disasters regressions. This may be because the governance indicator is a broad one and not specifically linked to food security outcomes, or because the latent concept of good governance is simply very hard to measure. Finally, we found a positive correlation between food import dependence and food aid (causality could run both ways, of course).

In addition to the coefficients on the specific explanatory variables, some of the regional effects are also interesting. The Middle East and North Africa (MENA) have much higher calorie consumption than is predicted by the regression specification (an extra 391 calories per capita), which would seem to at least superficially explain high rates of obesity in these countries. For dietary diversity, we found a marginally insignificant but positive effect of East Africa on dietary diversity. This probably reflects diverse agricultural portfolios in countries like Ethiopia and Uganda, but this could partly be an aggregation bias. In Ethiopia, for example, diets are not diverse at the household level but are more diverse at the national level because of different agroecologies and cultures.

On poverty, we find that the MENA and Horn of Africa (Ethiopia, Djibouti, and Somalia) regions have lower poverty than expected and that Southern Africa has higher poverty and hunger rates than predicted by the regression specification. Subjective hunger is also much higher than predicted in Central Africa. Other regional effects are more marginal, although Sahelian Africa and the Horn of Africa have more natural disasters than predicted by the regression equation, which would almost certainly reflect the role of low and volatile rainfall patterns in that region. In a systematic way, however, water supply per capita explains only poverty and in a nonlinear fashion (too much or too little rainfall increases poverty). It is difficult to interpret these regional effects in any precise way. One possible explanation is that poverty and hunger measures simply contain error and that these significant regional effects are picking up that error.

Table 4.3 shows the results for nutrition security. Here we drop agricultural productivity and GDP per worker, as these variables strongly affect more proximate dietary determinants of malnutrition, as well as fertility rates and other intermediate variables. Regressions 1 to 3 in Table 4.3 focus on chronic malnutrition, or stunting. Focusing first on dietary indicators, both calorie availability and the dietary diversity indicator are strongly and negatively associated with stunting. So too are adult literacy and the relative fertility rate (relative to GDP per capita and literacy levels). In these regressions we also add the two health security indicators, but only the childhood cluster diseases are strongly associated with stunting. However, when we drop literacy and fertility rates—which are quite strongly correlated with DALYs lost to diarrhea, malaria, and maternal conditions—we find a significant correlation with DALYs lost to these conditions. On regional effects on stunting we find that coastal West Africa, Eastern Europe, and Central Asia have lower stunting than expected (the latter seems partly explained by high literacy and low fertility rates).

Table 4.3 Regressions of nutrition security indicators against underlying factors

Regression Number.	1	2	3	4	5	6
Dependent variable	**Stunting (%)**	**Stunting (%)**	**Wasting (%)**	**Wasting (%)**	**Wasting (%)**	**Low body mass index (BMI), mothers (%)**
Log of calories	–30.31***	–24.70***				–9.92*
Dietary diversity (%)	–0.48***	–0.45***	–0.09***	–0.05	–0.15***	–0.21**
Governance index (2.5 to +2.5)						–3.18*
Adult literacy (%)	–0.16**					
Relative fertility rate (children)	2.56*					
Fertility rate (children)						
Soil constraints				–0.01	–0.07***	
Low BMI, mothers (%)			0.23***			
Disability-adjusted life years (DALYs): diarrhea, malaria and maternal	–0.44	0.76**				
DALYs: childhood cluster diseases (1,000s)	4.78**	3.65**	1.27**	0.58	3.18***	
Regional dummies (East Asia omitted)						
South Asia			3.20**	5.79***		18.38***
Coastal West Africa	–7.02**	–6.17**				
Sahelian Africa			5.33***	7.65***		6.20**
Eastern Africa						9.72***
Horn of Africa				7.41***		
East Europe and Central Asia	–6.82***	–12.13***		–1.75		
Central America				–3.18**		
South America				–3.86***		
Constant	298.44***	239.74***	6.52***	7.88***	10.39***	91.41**
Number of observations	84	94	65	93	93	65
Adjusted R-square	0.68	0.67	0.73	0.56	0.35	0.56

Source: Author's estimates. See Table 3.2 for sources and definitions of variables.

Notes: These are ordinary least squares regressions of cross-sectional data. * Denotes significant at the 10% level, ** denotes significance at the 5% level, *** denotes significance at the 1% level. # Indicates marginal insignificance at the 10% level.

In regression 3 we look at acute malnutrition in the form of wasting. Dietary diversity is the only significant indicator when regional effects are included. However, soil constraints and childhood cluster disease DALYs lost share significant relationships when regional dummies are dropped. Somewhat surprisingly, literacy and fertility rates are not significant. However, highly significant and large regional effects are apparent with wasting and low BMI for South Asia (hence the so-called Asian enigma; see Ramalingaswami, Jonson, and Rohde 1997).

Finally, regression 6 focuses on maternal malnutrition in the form of low BMI. Here, calorie supply and dietary diversity are significant (though calories only marginally so). Moreover, governance is marginally significant at the 10 percent level. Regional effects are strong also. As with wasting, the dummy variable for South Asia is extremely large: The prevalence of underweight mothers is an astonishing 18.4 percentage points larger in South Asia than is predicted by the regression.

Overall, the correlation and regression analysis results are consistent with the framework proposed in Figure 2.1, although some nuances are interesting in the cross-country relationships between various indicators. The different dimensions of poverty and food and nutrition security (macro- and micronutrients, chronic and acute, macro- and microeconomic) are not necessarily strongly correlated with one another. And while some common correlates of the different indicators are important, some explanatory factors are clearly more important for some indicators than others.

5. REGIONAL VARIATIONS IN POVERTY, FOOD INSECURITY, AND MALNUTRITION

As we saw in the previous section, empirical relationships in the data are consistent with the theoretical model in Figure 2.1. Underlying processes of development and various economic shocks substantially explain food security and health security outcomes, which in turn account for malnutrition outcomes. However, the addition of regional dummy variables also pointed to significant unexplained regional effects that exist above and beyond the theoretically mandated variables. Hence in this section we explore how these important indicators vary across regions.

To see these different regional patterns, we adopt a relatively informal approach. More formal attempts to develop food security typologies have used cluster analysis (Yu, You, and Fan 2010) to group structurally similar countries together, but cluster analysis becomes complex with large numbers of variables. And since we are trying to go beyond a narrow definition of food security to look at nutrition security, health security, and various underlying developmental processes, it is indeed necessary to look at a broad array of variables.[8] Hence in this section we adopt a fairly simple approach of including a fairly large array of variables but reporting regional averages and defining regions by more disaggregated regional classifications, as in the regressions in the previous section. We also report a number of more populous countries separately (China, India, Brazil, South Africa) and discuss clear outliers within these regional disaggregations (for example, Yemen in the MENA region).

The regional and subregional averages are reported in Tables A.2, A.3, and A.4 in the Appendix, so readers can peruse more detailed statistics in these tables. Tables 5.1, 5.2, and 5.3 summarize the results by regions, and here we focus on only the most salient points.

First, Africa in many ways faces the most severe food and nutrition security problems. It has the lowest agricultural productivity of any region and the lowest GDP per capita. Fertility rates are very high and populations are growing quickly, but literacy and education levels are very low, particularly in East Africa and the Sahel, two regions that are also highly exposed to natural disasters (as are parts of Southern Africa). Although African economies have grown quite quickly in the last decade or so, these economies are not experiencing much diversification. Moreover, African countries are ranked poorly in terms of governance, particularly in Central Africa (the population of which is dominated by the Democratic Republic of Congo).

In terms of food security, Africa has some severe problems. Calorie supply appears to be very low in Eastern Africa and Central Africa. Diets are highly undiversified, and Africa now has the highest rates of chronic monetary poverty. Self-assessed hunger is twice as high in Africa as in the next poorest region, South Asia. Many African countries are also very dependent on food aid and exposed to international price shocks (see also Minot 2011 and Headey and Fan 2010 on price transmission in Africa during the 2008 food crisis).

[8] Another approach might be to condense a larger number of variables in various indexes (for example, using factor analysis), but bundling variables together also obscures their potential differences.

Table 5.1 Summary of the various dimensions of food and nutrition security in African regions

Underlying structural factors	Food security	Health security	Nutrition security
West Africa Low levels of agricultural productivity, gross domestic product (GDP) per capita, literacy and governance. Sahelian countries more underdeveloped than coastal countries and much more prone to natural disasters, particularly drought. Coastal West Africa much more urbanized than the Sahel. Good water supply, but 50% of coastal West Africa has severe soil constraints.	Diets are undiversified in general, and calorie availability is low in the Sahel. Poverty rates are 40% in coastal countries and 46% in Sahel, and self-reported hunger is 50%. The region is highly dependent on food imports, and many countries are dependent on food aid.	Like all African regions, health outcomes are very poor, though HIV prevalence is lower in West Africa than in Eastern and Southern Africa.	Stunting prevalence is high: 35% in coastal countries and 44% in Sahel. Yet acute malnutrition is high only in the Sahel, with child wasting and maternal underweight prevalence both at 15%.
Central Africa Agricultural productivity and GDP per capita are very low, and infrastructure is particularly bad in the Democratic Republic of Congo (DRC). DRC is regarded as having significant agricultural potential, with good water supply and land abundance, but 70% of land has severe soil constraints. Literacy rates are surprisingly high (67%), but governance is the poorest of any region. The region is not very prone to natural disasters.	Mean calorie supply is low and diets are undiversified. The $1.25/day poverty head count is very high (59%) largely because of DRC. Self-assessed hunger is extremely high (79%), but the region is only moderately dependent on food aid and imports.	Health outcomes are very poor, with disability-adjusted life years (DALYs) lost to malnutrition the second highest of any region.	Stunting averages 39%, but acute child malnutrition is relatively low (7%), though maternal malnutrition is substantial (13%).
East Africa Agricultural productivity is the lowest of any region, as is GDP per capita. It is also one of the least urbanized regions in the world, with a very low rate of literacy (59%) and poor governance scores. Water is a significant constraint, and the drier parts of East Africa are very prone to droughts.	Mean calorie supply is very low, though diets in some parts of the region are relatively diversified. Poverty is controversially lower than in other regions (34%), but self-assessed hunger is high (40%). The region is still highly dependent on food aid and food imports.	Health outcomes are very poor, the worst after Southern Africa and Central Africa. AIDS/HIV is still a major problem.	Stunting prevalence is a high 42%, underweight prevalence of mothers is a high 21.4%, and wasting is 12%, but significantly higher in some pastoralist areas.
Southern Africa Agricultural productivity and GDP per capita are very low. Governance is moderately poor and literacy is about 70%. Soil and water constraints are significant problems (including exposure to drought).	Low calorie supply and one of the least-diversified diets. Poverty very high at 60.5%, and self-assessed hunger just under 50%. Food aid and imports are moderately important in the region.	DALYs lost to infectious diseases are the highest of any region because of HIV/AIDS.	Stunting prevalence is very high (46%), but wasting prevalence is low (6%), and maternal underweight prevalence is relatively low (10%).

Source: Author's estimates.

Table 5.2 Summary of the various dimensions of food and nutrition security in Asian regions

Underlying structural factors	Food security	Health security	Nutrition security
South Asia			
Agricultural output per worker in South Asia remains very low (as low as Africa) because of small farm sizes (despite relatively high yields). Gross domestic product (GDP) per capita is slightly higher than in Africa but also growing quickly. Governance scores are relatively low, but better in India. Literacy is still very low at 60%. The region is significantly exposed to natural disasters. Water resources are substantially constrained in India, and 40–50% of land faces severe soil constraints.	Diets are undiversified in much of the region, and calorie availability is relatively low. Poverty is around 40% but self-assessed hunger is somewhat lower at 25%. India is not dependent on food aid or food imports, but the rest of South Asia has quite high levels of dependence on food imports and moderate dependence on food aid.	Nutrition-relevant health outcomes are the worst outside Africa. Disability-adjusted life years (DALYs) lost to maternal conditions are 10 times higher relative to China.	Acute malnutrition remains very high in South Asia (17% of children in India), but stunting is also very high (38% in India, 46% in the rest), as are anemia and other micronutrient deficiencies. South Asia has largest share of world's malnourished children.
Southeast (SE)Asia and China			
Agricultural output per worker is still relatively low in Asia, especially in China. Most countries are now middle income, but urbanization is still relatively low, though population density is high. Governance is still relatively poor, although literacy rates are relatively high (91% in China and 82% in the rest of SE Asia). There is still significant exposure to natural disasters. China is moderately water and soil constrained, and 60% of SE Asian land is soil constrained.	Calorie supply is relatively high, but diets are still not very diverse in much of SE. Asia. Poverty in China is a relatively low 16.5% but around 25% in SE. Asia. Self-reported hunger is very low in China (4%) but moderately high in SE. Asia (17.5%). Little dependence on food aid and moderate dependence on imports.	Health outcomes in China are relatively good, but DALYs lost to infectious diseases and maternal conditions are some seven times worst in the rest of SE Asia and equivalent to South Asia.	China has low rates of acute malnutrition but reasonably high stunting (22%), but SE Asia still has relatively low body mass for children (11%) and mothers (18%), and stunting remains highly prevalent (35%). Obesity is also an emerging problem in China.
Central Asia			
Agricultural productivity is moderate, but still lower than in Latin America. There is significant land abundance and scope for increased output. The region is middle income and moderately urbanized. Governance scores are much lower than other middle-income regions, yet literacy rates are very high (almost 100%). Exposure to disasters is low. Turkmenistan is substantially less developed than other countries. Water and soil issues are not major constraints.	Calorie consumption is moderately high in Central Asia and diets are moderately diverse. The $1.25/day poverty head count is around 20%, but self-reported hunger is very low, just 6%–8%. The region is moderately dependent on food aid and food imports.	Nutrition-relevant health outcomes are somewhat worse than expected at the observed income and literacy levels. DALYs lost to infectious disease are 33% higher than in South America.	Acute malnutrition is quite low (6%–8%), although almost a quarter of Central Asian children are stunted. Obesity and overweight prevalence are only moderately common. Obesity may be an emerging problem in Central Asia.

Source: Author's estimates.

Note: See Table 3.2 for definitions and sources of variables.

Table 5.3 Summary of the various dimensions of food and nutrition security in the Latin America and Middle East and North Africa regions

Underlying structural factors	Food security	Health security	Nutrition security
Latin America and Caribbean			
Relatively high agricultural productivity, especially in Brazil, but Central America is substantially dependent on food imports. Greater economic transformation and urbanization than in many other regions. Moderate governance scores, but higher in Brazil. Literacy moderately high (85%). Moderate exposure to natural disasters relative to other regions. Water is not a constraint, but soil constraints characterize 60%–70% of agricultural land.	Mean calorie supply is relatively high, and diets are quite diverse. Poverty head count is generally below 20%. Acute food insecurity is generally not high, although some exceptions such as Haiti.	Nutrition-relevant health outcomes are much better than in Asia and Africa but still lag behind comparable regions such as MENA and Eastern Europe.	Acute malnutrition of adults or children is not common in most of Latin America, but around 25% of children are still stunted and substantial micronutrient deficiencies exist. Overweight and obesity prevalence are now quite high: Almost 40%–50% of adult women are obese in many countries.
Middle East and North Africa (MENA)			
Relatively high per capita incomes and agricultural productivity, though Yemen is an outlier. Governance is regarded as fairly poor, although substantial regime in recent years may lead to change. Adult literacy is much lower than other in regions with comparable levels of income. Many countries in the region are highly dependent on cereal imports. Water is, of course, a major constraint throughout the region, though soil constraints are relatively moderate.	Calorie supply is mostly high, and diets are relatively diverse, but largely because of high oil and fat consumption. Obesity is therefore a significant problem in many countries. Self-reported hunger is still relative to other regions with similar income (20%), and significantly higher the poverty (35). Note that Yemen is a major exception, with much higher food insecurity than other MENA countries.	Health outcomes are similar to regions with comparable incomes such as Latin America, Eastern Europe, and Central Asia. Yemen is a major exception with disability-adjusted life years lost to infectious diseases about twice as high as the rest of the region.	With the exception of Yemen, acute malnutrition is fairly low, although stunting prevalence is surprisingly high (20%–25%). Obesity is a major problem, with half of MENA women overweight. Yemen is a major exception: 25% of adult women are underweight, 50% of children are malnourished, and 13% are wasted.

Source: Author's estimates.

Note: See Table 3.2 for definitions and sources of variables.

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Another striking feature of African underdevelopment is its appalling health outcomes: The number of DALYs lost to infectious diseases (per 1,000 people) is four times as high in Africa as in South Asia. Around half of these DALYs are lost because of HIV/AIDS, but diarrheal diseases—major comorbidities of malnutrition—account for around 11 percent of the DALYs lost to all infectious diseases, and malaria is another significant problem (Table 5.4).

Table 5.4 Disability-adjusted life years (DALYs) lost to infectious diseases in Africa

Sources of DALYs lost	DALYs (1000s) lost to	As % of total DALYs lost
HIV/AIDS	13,824	54.4
Noncommunicable diseases	3,634	14.3
Diarrheal diseases	2,860	11.3
Tuberculosis	1,737	6.8
Sexually transmitted diseases excluding HIV	1,035	4.1
Malaria	717	2.8
Maternal, perinatal, and childhood conditions	563	2.2
Unintentional injuries	358	1.4
Intentional injuries	250	1.0
Respiratory infections	157	0.6
Tropical-cluster diseases	147	0.6
Other diseases	121	0.5
Total	*25,403*	*100*

Source: WHO (2008).

Given the poor food and health security in Africa, it is not surprising that nutrition security is generally poor, although regional variation is substantial. Stunting prevalence is high throughout (unsurprising given that low incomes and poor health outcomes prevail throughout also), but acute malnutrition varies substantially across region, being particularly high in the more drought-affected regions of East Africa and the Sahel. Only South Africa has a sizable problem with obesity.

South Asia is the next most underdeveloped region on all fronts. Agricultural labor productivity is very low in Asia, despite the yield growth of the Green Revolution. Part of the explanation for this is small farm size and the overestimation of agricultural employment in Asia (where rural nonfarm diversification is common; see Headey, Hazell, and Bezemer 2010). Moreover, at the macro level, Asian economies are generally less dependent on food aid and food imports, although this is not true for several countries in South Asia, which remain highly vulnerable to natural disasters (for example, Pakistan and Bangladesh). Governance scores are generally low in both South Asia and Southeast Asia, but there is a major difference in education levels between the two subregions, with Southeast Asia having much higher literacy levels than South Asia.

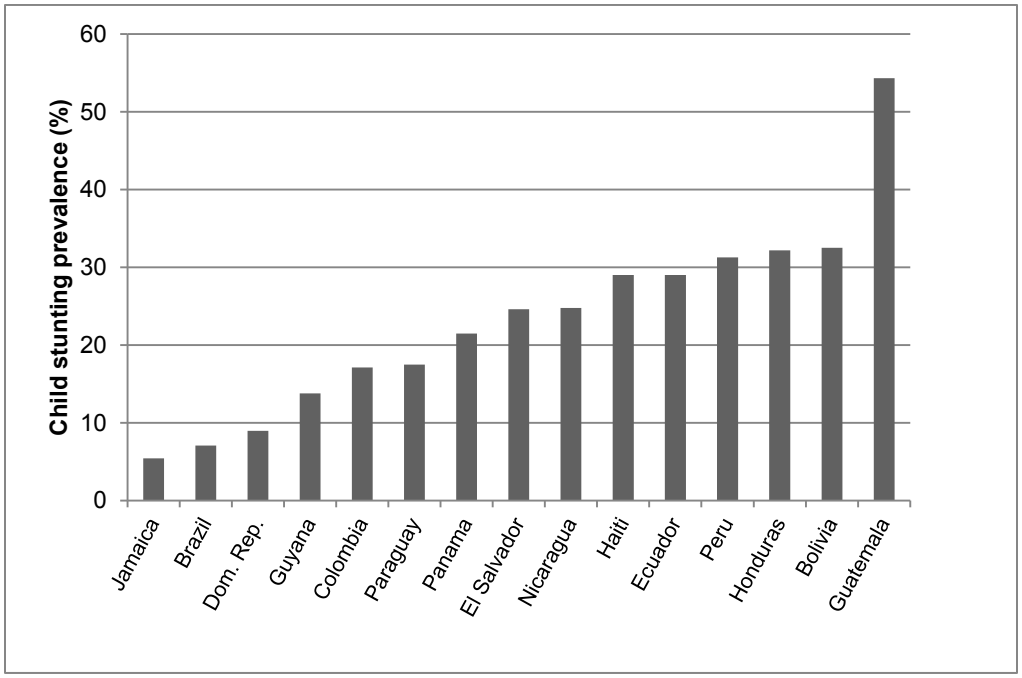
In terms of food security, mean calorie supply is still fairly low and diets are undiversified, particularly in South Asia. Poverty rates are under 30 percent in most of East Asia, but closer to 40 percent in South Asia. However, self-assessed hunger is much lower in East Asia (in China, just 4 percent). Nutrition-relevant health outcomes also vary in a similar way, being relatively good in China, moderate in Southeast Asia and fairly bad in India and South Asia as a whole. DALYs lost to infectious disease, for example, are four times higher in the rest of Asia compared with China, and DALYs lost to maternal conditions are 10 times higher in other South Asian countries (excluding India) relative to China.

In terms of nutrition security indicators, sharp distinctions are found across subregions. As was intimated in the previous section, low adult BMI almost 40 percent) and wasting prevalence (17 percent) are exceptionally high in South Asia. Stunting is also high in South Asia (38 percent in India and 46 percent in the rest of South Asia), but less paradoxically so. Southeast Asia also has relatively high rates of maternal undernutrition (18 percent) and wasting (11 percent), and stunting characterizes around one-third of Southeast Asian children. China still has reasonably high rates of stunting (22 percent), but

obesity is a rapidly emerging problem in China, with around one-quarter of women classified as overweight or obese.

Latin America, the Middle East, Eastern Europe, and Central Asia are the remaining regions, and all have relatively similar levels of income, though plenty of nuances and a few outliers are within each region. Latin America has relatively high agricultural labor productivity, for example, but Central America is quite dependent on food imports. Brazil is the largest country in the region and is something of a positive outlier, notwithstanding large spatial inequality within the country. Poverty is generally less than 20 percent, calorie supply is relatively high, and diets are diverse, and health security is better than in Asia and Africa but lags behind MENA and Eastern Europe (two regions with comparable incomes). Acute malnutrition and hunger are fairly rare in most of Latin America, though Haiti is an exception. But with chronic malnutrition, around 25 percent of children are stunted. However, this mean masks huge variation within the region, as Figure 5.1 demonstrates, Guatemala being a clear outlier. Overweight prevalence and obesity are now very high in many countries, with 40–50 percent of adult women overweight in many Latin American countries (including Guatemala).

Figure 5.1 Marked variation in stunting prevalence within Latin America and the Caribbean



Source: DHS (2012) and WHO (2010).
Note: Dom. Rep. = Dominican Republic.

Eastern Europe and Central Asia share a common institutional history (they are often called transition regions), but Eastern Europe is somewhat more developed than Central Asia (incomes are about 20 percent lower in the latter, for example). The region is moderately dependent on food imports but much exposed to natural disasters. Central Asia has very low governance scores, but literacy through the region approaches 100 percent. On food security, calorie consumption is quite high but diets are only moderately diverse. Chronic poverty is only really prevalent in Central Asia (25.5 percent), but self-reported hunger is very low (6–8 percent). Nutrition-relevant health outcomes are somewhat worse than expected, given income and literacy levels. As in Latin America, acute malnutrition is quite low (6–8 percent), but around a quarter of Central Asian children are stunted. Obesity and overweight prevalence are only moderately prevalent so far. We note that Tajikistan is something of an outlier, with lower incomes and worse food and nutrition security outcomes than other Central Asian countries.

MENA shares similarities to Latin America, Eastern Europe, and Central Asia. Most countries are middle income with relatively high agricultural productivity. However, literacy levels are much lower than in these other regions, and Yemen is a low-income country with very high levels of food security. Moreover, many countries in the MENA region are highly dependent on food imports. Governance is also regarded as fairly poor, recent regime changes notwithstanding. Calorie supply is mostly high and diets are relatively diverse, but the data suggest that part of this diversity relates to high consumption of oils and fats. Obesity is therefore a significant problem in many MENA countries, but self-reported hunger is surprisingly high (20 percent) and even significantly higher than poverty (which is under 7 percent in all but Yemen). This would appear to point to high inequality, or at least to perceptions of significant food insecurity. As in the other predominantly middle-income regions, acute malnutrition is fairly low in the MENA region, although stunting prevalence is fairly high (20–25 percent), and obesity is a major problem. Around 70 percent of Egyptian women are overweight, while 50 percent of Turkish and Tunisian women are overweight. Projections also suggest that 25–30 percent of MENA children will be overweight by 2020. As was implied above, however, Yemen is a major exception: 50 percent of children are stunted, 13 percent wasted, and 25 percent of women are underweight. Thus Yemen's nutritional profile is more similar to African or South Asian countries than to its MENA neighbors.

In summary, Africa is clearly the poorest and most food-insecure region, and large parts of the continent are highly exposed to extreme weather events and severe health problems. However, South Asia is equally poor on many fronts and generally has higher rates of acute malnutrition than Africa. Being much more populous, Africa also has the bulk of the world's wasted children and undernourished mothers. Southeast Asia also still has a sizable population of food- and nutrition-insecure people, as well as rising obesity levels in China. The remaining regions are largely middle income and have limited problems with acute food and nutrition insecurity, with the exception of often substantial exposure to food price hikes. However, even these largely middle-income regions have pockets of severe food and nutrition insecurity, and a general persistence of stunting as well as high or rising levels of obesity.

6. SUMMARY OF FINDINGS

In this paper we sought to explore the conceptual and empirical relationships between different dimensions of human welfare in developing countries, with a particular focus on the interrelationships between poverty, food security, and nutrition outcomes, as well as their linkages to some more generic development processes. Conceptually, we argued that food insecurity can be thought of as a subset of poverty and a subset of malnutrition, yet both poverty and malnutrition can exist even in contexts where basic food security is achieved. For example, nonpoor populations could still have inadequate healthcare or childcare practices. We also emphasized the important distinction between chronic and acute forms of ill-being, such as the conceptual difference between poverty and vulnerability. And finally, we suggested a number of important drivers of changes in food and nutrition security and poverty.

Our empirical exploration into some of the relationships between these variables is broadly consistent with the conceptual framework, though many nuances are involved. Indeed, although strong relationships exist between welfare indicators, some surprisingly weak ones do also. Calorie availability, for example, is not significantly correlated with maternal underweight prevalence or child wasting nor with dietary diversity. However, this new but very simple indicator of dietary diversity proved to be a very robust correlate of every single nutrition and food security indicator examined. Another striking result is how weakly the two common indicators of acute malnutrition—wasting and low female BMI—are correlated with other indicators, most of which represent chronic ill-being. Hence in addition to the distinctions between poverty, food security, and nutrition security, the distinction between chronic and acute dimensions of these different forms of ill-being proves to be a crucial one.

What about the multivariate correlations between these welfare indicators and some of the underlying developmental drivers? We observed that per capita incomes are the strongest and most robust correlates, with literacy rates a close second. Because GDP per capita is something of a catchall development indicator (and one that causes multicollinearity problems), we decided to measure several other variables in terms of relativity to GDP through the residual-generated regressor approach. This approach showed that even after controlling for GDP per capita, countries with relatively high agricultural productivity and relatively low fertility rates tend to be associated with much better welfare outcomes.

For nutrition outcomes, we found that dietary diversity is indeed a fairly robust predictor of all three indicators of malnutrition, though average calorie supply is not. Literacy and fertility rates predict stunting but not wasting. Nutrition-relevant health indicators also do a fairly good job of predicting both stunting and wasting. Hence health, education, and family planning outcomes all seem to be highly relevant to nutritional strategies.

Finally, in addition to understanding some of the relationships between these variables, we also tried to understand how different measures of well-being and development vary across regions, with a particular focus on subregions. Africa clearly emerges as the region with the highest levels of poverty and food and nutrition insecurity, as well as strikingly poor health outcomes. However, South Asia also stands out as having tremendous numbers of poor and food-insecure people and unusually high levels of both child and maternal wasting (the so-called Asian enigma).

Some of the cross-country relationships explored in this paper present important questions for future research. To what extent should dietary diversity be targeted for agricultural interventions rather than calorie availability? Why is acute malnutrition so high in South Asia relative to other regions? To what extent should developmental drivers of food security and nutrition—such as health, education, and family planning interventions—be targeted in development strategies? Existing literatures attempt to answer each of these questions but have few emphatic answers.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 Country classifications by region and subregion

Region	Country	Region	Country	Region	Country
Africa		**Asia**		**Latin America and Caribbean**	
Central Africa	Cameroon	**Southeast Asia and Pacific**	China	**Central America and Caribbean**	Dominican Republic
	CAR*		Cambodia		El Salvador
	Congo, D.R.		Indonesia		Guatemala
	Congo, Rep.		Lao PDR		Haiti
Sahelian Africa	Burkina Faso		Myanmar		Honduras
	Chad		PNG		Jamaica
	Mali		Philippines		Nicaragua
	Mauritania		Solomon Islands	**South America**	Panama
	Niger		Thailand		Bolivia
	Sudan		Vietnam		Colombia
Coastal West Africa	Benin	**South Asia**	India		Ecuador
	Cape Verde		Afghanistan		Guyana
	Cote d'Ivoire		Bangladesh		Paraguay
	Gambia, The		Bhutan		Peru
	Ghana		Maldives		Brazil
	Guinea		Nepal	**Middle East and North Africa**	
	Guinea-Bissau		Pakistan	**North Africa**	Algeria
	Liberia		Sri Lanka		Egypt
	Nigeria				Morocco
	Senegal	**Central Asia**	Tajikistan		Tunisia
	Togo		Uzbekistan	**Middle East**	Iraq
	Sao Tome and Principe		Kazakhstan		Jordan
	Sierra Leone		Mongolia		Syria
Eastern Africa	Djibouti		Turkmenistan		Turkey
	Eritrea				Yemen
	Ethiopia				
	Kenya				
	Somalia				
	Uganda				
Southern Africa	Angola				
	Burundi				
	Rwanda				
	Lesotho				
	Madagascar				
	Malawi				
	Mozambique				
	Namibia				
	Swaziland				
	Tanzania				
	Zambia				
	Zimbabwe				
	South Africa				

Source: Author.
Notes: CAR = Central African Republic.

Table A.2 Population-weighted averages of underlying determinants of food and nutrition security by regions and subregions

Country/Region	Number of observations	Population sums (millions)	Agricultural output per worker (US$2,000)	Freshwater per capita (meters^3)	Soil constraints (% agricultural land)	GDP per capita, 2005 PPP$	Urban population share (%)	Governance (–2.5 to +2.5)	Adult literacy (%)	Disasters per 1,000 people
Whole sample	**96**	**4702.2**	**1,275**	**14,906**	**45.4**	**2,790**	**49**	**–0.6**	**71.4**	**1.8**
Africa	**41**	**676.7**	**419**	**7,805**	**46.6**	**1,311**	**35**	**–0.7**	**57.8**	**2.3**
West and Central	*23*	*384.7*	*481*	11,573	47.5	*1,207*	*40*	*–0.7*	*50.8*	*1.9*
Central	4	79.9	403	29,308	71.9	1,503	45	–1.2	67.1	0.4
Sahelian	6	84.3	400	1,206	20.1	1,160	28	–0.6	35.5	4.2
Coastal	13	220.5	548	10,901	53.6	1,137	44	–0.6	53.2	1.3
East and South	*18*	*292*	*338*	2,990	45.6	*1,461*	*28*	*–0.7*	*67.7*	*2.8*
East	6	145.1	185	797	30.9	1,041	31	–1.0	58.8	3
South (exc. South Africa)	12	147	402	4,086	53.0	1,652	27	–0.5	69.9	2.7
South Africa	1	45.8	3,297	908	24.9	8,008	58	0.3	82.4	0.4
Latin America	**14**	**152.8**	**2,465**	**43,210**	**60.0**	**4,691**	**56**	**–0.4**	**84.8**	**1.6**
Central/Caribbean	*8*	*54.4*	*2,826*	13,286	60.0	*4,648*	*54*	*–0.3*	*80.7*	*1.7*
South. America (exc. Brazil)	*6*	*98.4*	*2,045*	83,109	60.0	*4,748*	*59*	*–0.5*	*90.4*	*1.3*
Brazil	1	182	3,426	28,037	71.8	8,197	83	0.0	87.5	1.3
Asia*	**18**	**3230.1**	**802**	**22,863**	**52.4**	**2,420**	**27**	**–0.7**	**72**	**2.6**
Southeast (exc. China)	*9*	*511.6*	*752*	31,867	62.2	*2,360*	*29*	*–0.7*	*81.9*	*2.2*
China	1	1290	471	2,113	38.4	3,484	39	–0.5	90.9	3
India	1	1060	457	1,252	47.8	1,985	28	–0.2	61	5.9
South Asia (exc. India)	*7*	368.5	*982*	17,337	40.9	*2,405*	*22*	*–0.7*	*59.6*	*2.5*
Central Asia	**5**	**54.6**	**1,567**	**5,641**	**13.7**	**4,075**	**45**	**–0.9**	**98.9**	**1.4**
MENA	**9**	**277.6**	**2,621**	**724**	**18.9**	**4,560**	**58**	**–0.7**	**72.9**	**0.2**
North Africa	*4*	*141.6*	*2,681*	416	14.3	*4,839*	*57*	*–0.5*	*67*	*0.1*
Middle East	*5*	*136.1*	*2,573*	971	22.6	*4,280*	*58*	*–0.8*	*77.6*	*0.2*

Source: Author's creation from variables listed in Table 2.2.

Notes: See Table A.1 for a list of countries by region and subregion.. GDP = gross domestic product; MENA = Middle East, North Africa. *Southeast Asia includes the Pacific countries of Papua New Guinea and the Solomon Islands. All averages are population weighted, but note that the second column of population figures are sums, not averages. For those variables with missing data, missing observations were imputed via regression analysis.

Table A.3 Population-weighted averages of food security indicators by regions and subregions

Country/Region	Number of observa-tions	Mean calorie supply (kcal)	Calories from nutrient-rich foods (% total)	$1.25/day poverty head count (%)	Self-assessed hunger (%)	Food aid dependence (kg/capita)	Food imports as % exports + remittances
Whole sample	**96**	**2,396**	**38.1**	**29.5**	**29.9**	**6.5**	**13.8**
Africa	**41**	**2,233**	**34.4**	**48.5**	**49.4**	**8**	**20.7**
West and Central	*23*	*2,365*	*34.6*	*45.2*	*52.8*	*7.8*	*21.1*
Central	4	2,079	33.6	59.3	79	1.3	11.8
Sahelian	6	2,359	35.5	46.9	46.2	5.2	18.9
Coastal	13	2,456	34.4	40.1	53.7	10.9	25.2
East and South	*18*	*2,063*	*34.2*	*53.5*	*45.8*	*8.2*	*20.1*
East	6	1,947	42.3	34.1	40.3	12.8	35.4
South (exc. South Africa)	12	2,121	30.2	60.5	47.7	5.9	13.8
South Africa	1	2,915	38.9	13.8	39	1.0	3.0
Latin America	**14**	**2,429**	**50.9**	**14.8**	**26.2**	**8.1**	**9.0**
Central/Caribbean	*8*	*2,334*	*50.4*	*16.9*	*30.5*	*6.2*	*11.9*
South. America (exc. Brazil)	*6*	*2,554*	*51.6*	*12*	*20.5*	*10.5*	*5.1*
Brazil	1	3,002	62.9	9	4	0	2.3
East and South Asia*	**18**	**2,405**	**32.3**	**25.2**	**19.2**	**3.1**	**9.2**
Southeast (exc. China	*9*	*2,423*	*30.2*	*24.4*	*17.5*	*1.1*	*7.7*
China	1	2,969	38.5	16.5	4	0.1	0.9
India	1	2,488	37.3	41.6	26	0.1	1.3
South Asia (exc. India)	*7*	*2,269*	*33.7*	*22.6*	*19.8*	*6.5*	*13.1*
Central Asia	**5**	**2,226**	**42**	**19.5**	**7.5**	**7.2**	**7.4**
MENA	**9**	**2,894**	**40.8**	**3.9**	**16.3**	**4.7**	**8.9**
North Africa	*4*	*3,161*	*38.8*	*3.1*	*23.5*	*1*	*7.6*
Middle East	*5*	*2,680*	*42.3*	*4.5*	*9*	*7.7*	*10.3*

Source: Author's creation from variables listed in Table 2.2.

Notes: See Table A.1 for a list of countries by region and subregion. kcal = kilocalorie; kg = kilogram; MENA = Middle East and North Africa. *Southeast Asia includes the Pacific countries of Papua New Guinea and the Solomon Islands. All averages are population weighted, but note that the second column of population figures are sums, not averages. For those variables with missing data, missing observations were imputed via regression analysis.

Table A.4 Population-weighted averages of nutrition and nutrition-relevant health security indicators by regions and subregions

Country/Region	Number of obser-vations	Overweight prevalence (% mothers)	Underweight prevalence (% mothers)	Wasting prevalence (%)	Stunting prevalence (%)	DALYs lost to malnutrition	DALYs lost to infectious diseases	DALYs lost to maternal conditions
Whole sample	**96**	**2395.7**	**25**	**11.7**	**7.4**	**834**	**9,531**	**1,319**
Africa	**41**	**18.3**	**12.5**	**9.3**	**41**	**1,124**	**17,834**	**2,105**
West and Central	23	19	11.7	10.3	38	1,128	*14,357*	*2,210*
Central	4	17.8	12.7	7	39.1	903	17,756	2,445
Sahelian	6	17.2	15.2	15.1	43.8	1,255	14,639	2,493
Coastal	13	20.3	9.6	9.1	35	1,138	13,182	2,007
East and South	18	17.2	13.7	7.9	44.7	1,119	*22,276*	*1,972*
East	6	12.4	21.4	12.2	42.1	929	15,016	1,822
South (exc. South. Africa)	12	19.4	10.3	5.8	46	1,215	25,906	2,047
South Africa	1	45.1		4.7	23.9	876	22,646	715
Latin America	**14**	**42**	**4.3**	**2.4**	**24.4**	**584**	**2,785**	**641**
Central/Caribbean	8	38.3	4.8	2.7	25.1	625	*3,113*	*707*
South. America (exc. Brazil)	6	47.6	3.6	2	23.5	529	*2,348*	*554*
Brazil	1	34.8	6.2	2.3	7.1	363	1,575	290
East and South Asia*	**18**	**16.3**	**21.5**	**9.4**	**38.8**	**789**	**4,651**	**1,071**
Southeast (exc. China	*9*	*15.4*	*17.9*	*8.1*	*37.6*	*815*	*4,806*	*805*
China	1	25.6	8	2.3	21.8	253	986	118
India	1	7.9	39.9	17.1	38.4	799	4,753	702
South Asia (exc. India)	*7*	*17.4*	*24.7*	*11*	*42.7*	*832*	*4,961*	*1,601*
Central Asia	*5*	*22*	*8.4*	*6.1*	*23.8*	*427*	*2,521*	*969*
MENA	**9**	**50.5**	**7.1**	**6.7**	**23.6**	**597**	**1,697**	**532**
North Africa	*4*	*58.8*	*3*	*6.6*	*18.8*	*416*	*1,486*	*443*
Middle East	*5*	*45*	*9.8*	*6.8*	*27.5*	*742*	*1,865*	*604*

Source: Author's creation from variables listed in Table 2.2.

Notes: See Table A.1 for a list of countries by region and subregion. DALY = Disability-adjusted life years; MENA = Middle East, North Africa. *Southeast Asia includes the Pacific countries of Papua New Guinea and the Solomon Islands. All averages are population weighted, but note that the second column of population figures are sums, not averages. For those variables with missing data, missing observations were imputed via regression analysis.

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