Hungering for Survival:
Trends in under-5 malnutrition and attributable disease burden

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A thesis
submitted in partial fulfillment of the
requirements for the degree of

Master of Public Health

University of Washington
2012

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Program Authorized to Offer Degree:
School of Public Health – Department of Global Health

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Abstract

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Background

Child malnutrition is a known risk factor for a myriad childhood diseases and causes of death, including intestinal infectious diseases, acute respiratory infections, measles, malaria, and protein-energy malnutrition. The nutrition literature lacks estimates of deaths and disease burden attributable to each malnutrition indicator over time and at the country level. In order to make informed decisions on interventions, policymakers need to be aware of the magnitude and trends of the burden of malnutrition.

Methods and Findings

After using all available data to generate time series of wasting, stunting, and underweight, we employed the comparative risk assessment method to calculate death and disease burden attributable to these three indicators of malnutrition. Deaths attributable to stunting declined

from a peak of 3.89 (95% confidence intervals: 3.19-4.76) million in 1980 to 1.34 (1.11-1.59) million in 2011, and deaths attributable to underweight experienced a similar decrease from 3.22 (2.62-4.00) million in 1980 to 1.01 (0.83-1.22) million in 2011. Deaths from wasting declined from 2.06 (1.62-2.64) million in 1980 to 726 (588-896) thousand in 2011. DALYs attributable to stunting decreased from 278 (237-328) million in 1990 to 125 (105-148) million in 2010. DALYs attributable to wasting declined from 150 (122-186) million in 1990 to 70 (58-86) million. Finally, DALYs attributable to underweight experienced a large decrease from 226 (191-271) million in 1990 to 97 (78-116) million. At the regional level, Latin America has seen improvements, but the majority of the decrease in deaths can be attributed to changes in South Asia, driven primarily by India. While progress in sub-Saharan Africa on the whole has been slow, some countries have still enjoyed large decreases.

Conclusions

There have been encouraging declines between 1980 and 2011 in the burden of deaths and DALYs attributable to malnutrition at the global level. At the regional-level, Asia has experienced much improvement, but there has been a discouraging stagnation of progress in sub-Saharan Africa. Countries such as China, Brazil, and Botswana have commendably reduced burden attributable to malnutrition over the past 3 decades, and the global community should examine these cases to apply lessons from these success stories to other settings.

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Introduction

In a world where obesity abounds due to overconsumption, there are still paradoxically high levels of undernutrition. Child malnutrition is a known risk factor for a myriad childhood diseases and causes of death, including intestinal infectious diseases, acute respiratory infections, measles, malaria, and protein-energy malnutrition (PEM).[1] Despite the well-understood ill outcomes of undernourishment, reducing child malnutrition has remained a global challenge, particularly for developing countries.

Underscoring the importance of this health condition, Target 1C of the first Millennium Development Goal (MDG) is to "Halve, between 1990 and 2015, the proportion of people who suffer from hunger," which is measured by the prevalence of underweight children under the age of five.[2] Malnutrition is defined here as the fraction of the population age 0 to 59 months below -2 standard deviations (SD) of the 2006 WHO Child Growth Standard.[3] It is commonly measured using three indicators: weight-for-height (wasting, which captures acute effects of undernourishment), height-for-age (stunting, which captures long-term effects of undernourishment), and weight-for-age (underweight, which cannot distinguish between short-term and long-term malnutrition, but is a composite of the above two).[4]

Several studies have generated point estimates of wasting, stunting, and underweight,[5,6] and recent studies[7,8] have generated estimates of some measures of malnutrition over time. However, no study has created full time series of all three malnutrition indicators for all 187 Global Burden of Disease (GBD) countries, for ages 0 to 59 months.

More importantly, the nutrition literature lacks estimates of deaths and disease burden attributable to each malnutrition indicator over time and at the country level. Although the *Comparative Quantification of Health Risks*[4] produced estimates of deaths and disability-adjusted life-years (DALYs) attributable to underweight for the year 2000, and Black et al[9] generated burden estimates for all three indicators of malnutrition for the year 2004, no study provides a time series of attributable burden estimates at the country level, using the most up-to-date relative risks (RRs), prevalence estimates calculated using the latest WHO Child Growth Standards, and updated death and disease burden estimates. In order to make informed decisions on interventions, policymakers need to be aware of the magnitude and trends of the burden of malnutrition to facilitate emulation of success stories and identification of intervention target areas. The objectives of this study are to fill these key information gaps in malnutrition research.

Methods

Data Sources

Data for the malnutrition prevalence time series consist of both estimates from our own microdata analysis and from tabulated data sources where microdata was unavailable. Our underweight database contains 1,359 data points, covering 1,001 country-years. Our stunting database contains 1,417 data points, covering 951 country-years. The wasting database contains 1,600 data points, covering 974 country-years. The complete list of country-years of data can be found in Tables 1a-1c, and details on data sources and data adjustments are in the Appendix.

Calculations of deaths and disability due to malnutrition require inputs of cause-specific deaths and DALYs for children ages 1-59 months (we make the assumption that children do not die of malnutrition in the first month of life). For this, we used the GBD 2010 study estimates of deaths from malaria, measles, acute respiratory infections, intestinal infectious diseases, and PEM from 1980 to 2011.[10] The GBD 2010 study modeling process used for disability only produces estimates for 1990, 2005, and 2010, meaning that our estimation of attributable DALYs is restricted to these three years.[11]

Comparative Risk Assessment Method

The methods used to generate the time series of underweight, wasting, and stunting are found in the Appendix. The comparative risk assessment method for attribution of burden to risk factors is a counterfactual analysis that allows us to examine each risk factor in the absence of other risk factors.[12] It uses observed risk factor prevalence, a counterfactual exposure distribution, and estimates of the risk of death or disability in an exposed individual as opposed to an unexposed

individual who is otherwise similar (relative risk). In this study, we calculated population attributable fractions (PAFs) of deaths and disability from malaria, measles, acute respiratory infections, intestinal infectious diseases, and PEM due underweight, stunting, and wasting.

Severity-Level Crosswalk

The relative risks (RRs) of malnutrition are reported for different parts of the 2006 WHO reference population: 1) individuals less than 3SD below the median (<-3SD); 2) individuals between 3SD and 2SD below the median (-3SD to -2SD); and individuals between 2SD and 1SD below the median (-2SD to -1SD). To determine the prevalence of malnutrition in each of these categories, we developed a crosswalk between the fraction of the population less than 2SD below the median (<-2SD) of the reference population (for which we had a full time series) and each of these three.

Theoretical Minimum Risk Exposure Distribution

The theoretical minimum risk exposure distribution is based on the WHO Multicenter Growth Reference Study (MGRS),[13] which is the basis of the 2006 WHO Child Growth Standards. The growth curves are based on a population of healthy children, so the theoretical minimum malnutrition prevalence is not zero; rather, it is the fraction of the reference population that falls in each of the <-3SD, -3SD to -2SD and -2SD to -1SD categories. We approximate the distribution of the MGRS reference population by using a standard normal distribution with the following percentages of children under 5 years in each of the three exposure categories:

0.1% < -3 SD

2.1% -3 to -2 SD

13.6% -2 to -1 SD

Effect Size Estimates

Effect size estimates were based on a published meta-analysis of 8 studies examining the effect of malnutrition on causes of mortality.[9] We assumed that these risk estimates applied equally to morbidity and mortality. Mortality and morbidity from protein-energy malnutrition (ICD-10 code A18.1) is assumed to be 100% attributable to each of the three definitions of malnutrition. Table 2 shows the causes included and the corresponding relative risks. Following the methodology used in the GBD 2010 study,[1] we included risk-cause pairs only if the relative risk for at least one exposure category is statically significant, e.g. the RR for -3SD is statistically significant but the RR for -3SD to -2SD or -2SD to -1SD may not be statistically significant. Based on these criteria, we excluded the underweight-malaria RR for severity level -2SD to -1SD. For stunting, we excluded the malaria RR for severity levels -2SD to -1SD and -3SD to -2SD, and the acute respiratory infection and measles RRs for severity level -2SD to -1SD. We also excluded the wasting-malaria RR for severity level -2SD to -1SD.

Burden Attribution

We calculated the PAFs of deaths and disability due to malnutrition using the following formula:

$$PAF = \frac{\sum_{i=1}^{n} P_i\, RR_i - \sum_{i=1}^{n} P_i'\, RR_i}{\sum_{i=1}^{n} P_i\, RR_i}$$

Where P_i is the prevalence of malnutrition severity group i, RR_i is the relative risk of death/disability for severity group i, and P_i' is the prevalence of severity group i in a counterfactual population. In the case of the PAF of intestinal infectious diseases mortality due to underweight, this translates to:

$$PAF = \frac{(9.5WfA_{<-3} + 3.4WfA_{-3--2} + 2.1WfA_{-2--1} + 1WfA_{\geq 1}) - (9.5(.001) + 3.4(.021 + 1.8(.136) + 1(.841)}{(9.5WfA_{<-3} + 2.1WfA_{-3--2} + 2.1WfA_{-2--1} + 1WfA_{\geq 1})}$$

Where $WfA_{<-3}$ corresponds to the prevalence of severe underweight (<-3SD), and 9.5 corresponds to the associated RR, and so on. These calculations provide us with an estimate for each country-year of the proportion of cause-specific deaths/disability that is attributable to each malnutrition indicator in children age 1-59 months. Using the PAFs from this calculation, we can calculate the count of deaths and disability-adjusted life-years attributable to these risk factors. We obtained means and confidence intervals for the burden attributable to malnutrition by using the 2.5^{th} and 97.5^{th} percentiles of 1000 draws of each data input.

Results

Trends in Malnutrition Prevalence

Malnutrition prevalence as measured by each of the three indicators is quite different, yet all three metrics indicate declines at the global level. Stunting, which is the most prevalent of all indicators, declined from 38.9% (95% confidence intervals: 36.0-41.5%) in 1980 to 22.6% (21.6-23.7%) in 2011. Underweight, which is second most prevalent, declined from 24.9% (23.0-26.9%) in 1980 to 12.9% (12.3-13.6%). Wasting is most rare, and only decreased from 9.6% (8.2-11.1%) to 6.9 (5.8-8.1%) between 1980 and 2011. At the regional-level, the prevalence of wasting and underweight in Latin America are quite low, while stunting prevalence remains above 20% even in 2011 in some parts of the region. While malnutrition prevalence remains relatively constant across the study period in sub-Saharan Africa, the Asian regions enjoy precipitous declines, particularly in stunting and underweight.

Global Trends in Attributable Deaths

Similar to the trends in prevalence, deaths attributable to malnutrition have experienced large downward trends on the global level between 1980 and 2011. Deaths attributable to stunting declined from a peak of 3.89 (95% confidence intervals: 3.19-4.76) million (comprising 67.5% of all deaths from age 1 month to 59 months) in 1980 to 1.34 (1.11-1.59) million (57.4% of deaths from age 1-59 months) in 2011, and deaths attributable to underweight experienced a similar decrease from 3.22 (2.62-4.00) million (55.9% of all deaths from age 1-59 months) in 1980 to 1.01 (0.83-1.22) million (43.5% of deaths from age 1-59 months) in 2011. With fewer attributable deaths at all time points, deaths from wasting declined from 2.06 (1.62-2.64) million

(35.8% of deaths from age 1-59 months) in 1980 to 726 (588-896) thousand (31.2% of deaths from age 1-59 months) in 2011.

Global Trends in Attributable DALYs

DALYs attributable to malnutrition have also declined between 1990 and 2010. DALYs attributable to stunting decreased from 278 (95% confidence intervals: 237-328) million (comprising 65.7% of all DALYs in children from age 1 to 59 months) in 1990 to 125 (105-148) million (57.9% of DALYs from age 1-59 months) in 2010. DALYs attributable to wasting declined from 150 (122-186) million (35.4% of DALYs from age 1-59 months) in 1990 to 70 (58-86) million (32.4% of DALYs from age 1-59 months). Finally, DALYs attributable to underweight experienced a large decrease from 226 (191-271) million (53.4% of DALYs from age 1-59 months) in 1990 to 97 (78-116) million (44.6% of DALYs from age 1-59 months).

Regional Trends in Attributable Deaths and DALYs

At the regional level, the majority of the decrease in deaths can be attributed to changes in South Asia, driven primarily by India. Despite large declines, South Asia remains the region with the largest number of deaths attributable to malnutrition, as it was in 1980. In 2011, the single region of South Asia comprised one quarter of all malnutrition-attributable deaths worldwide. In contrast to South Asia's vast declines, sub-Saharan Africa has experienced a sad stagnation of progress, with very little reduction in deaths attributable to malnutrition over the past 3 decades. Deaths attributable to underweight decreased by an order of magnitude between 1980 and 2011 in the Latin American regions, led by large declines in Brazil (from over 42,000 attributable

deaths to just over 840) and Mexico (greater than 27,000 to just above 950). Figures 1a-1c and 2a-2c show the changes in deaths and DALYs attributable to the three indicators of malnutrition, respectively, stratified by region. Tables 3a-3c show changes in deaths and disability by region for 1990, 2005, and 2010.

Country Trends in Attributable Deaths and DALYs

At the country level, India had the largest number of deaths attributable to malnutrition of all countries in 1980, followed by (in various orderings depending on the indicator) China, Nigeria, Indonesia, and Bangladesh (Table 4a). In 2011, India still led the globe and contributed nearly 20% of all deaths attributable to malnutrition. However, vast improvements in mortality and malnutrition prevalence in China, Bangladesh, and Indonesia mean these countries are no longer even in the top 10 by 2011 (Table 4b). Exemplifying the lack of progress in sub-Saharan Africa, this region has the only countries that had more deaths attributable to underweight in 2011 than they did in 1980 (Burkina Faso, Central African Republic, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, the Chad, and Zambia). Since reductions in deaths and DALYs attributable to malnutrition are reflective of both changes in malnutrition prevalence and in underlying child mortality and disease burden rates, some countries that have experienced an increase in malnutrition prevalence may still appear to be improving. For example, malnutrition prevalence in Somalia increased between 1980 and 2011, but since deaths from malaria, measles, PEM, acute respiratory infections, and intestinal infectious diseases decreased, Somalia still experienced a decline in deaths attributable to malnutrition.

The absolute changes over time in the fraction of deaths (Table 5a and Figures 4a-4f) and DALYs (Table 5b) attributable to malnutrition in children age 1-59 months have been large in several countries. The similarities across the list of top performers within each metric of malnutrition indicate that improvements in wasting, stunting, and underweight often go hand-in-hand. For example, China, Mauritius, Iran, and Bosnia and Herzegovina are on the top-10 improvement list for all three indicators of malnutrition. However, countries such as Turkey, Benin, Sri Lanka, and Chile have only experienced large declines in one measure of malnutrition. China's absolute reduction in deaths attributable to underweight of greater than 40% between 1980 and 2011 is the largest improvement in any indicator. Botswana, Tanzania, and Benin, which find themselves on the top-10 list for absolute improvements in attributable deaths, stand out as countries in sub-Saharan Africa that have defied the region's trend of stagnation.

Attributable Burden by Cause

The cause-specific breakdowns (Figures 3a-3c) of deaths attributable to malnutrition are similar across the three indicators. Reflecting the actual ranking of childhood causes of death, intestinal infectious diseases and acute respiratory infections comprise the majority of the deaths. There have been substantial reductions in attributable deaths from intestinal infectious diseases, measles, acute respiratory infections, and PEM between 1980 and 2011, but deaths from malaria mirror this disease's more unimodal trend.[14]

Discussion

In this study, we have not only generated the first time series of malnutrition prevalence as measured by each of the three indicators, but also, we have created the first comprehensive set of estimates of the burden of death and disease attributable to each indicator of malnutrition across time and at the country level. Our work uses the most up-to-date prevalence, mortality, and disease burden numbers in a systematic way to generate attributable burden estimates that are comparable across countries and years.

Our research shows that there have been encouraging declines in the burden of deaths and DALYs attributable to malnutrition at the global level. Asia has experienced much improvement, but despite declines, this region still contributes more burden attributable to malnutrition than any other region. In contrast to Asia's steady improvements, there has been discouragingly slow progress in sub-Saharan Africa; there have been only minor decreases in burden attributable to malnutrition between 1980 and 2011. Malnutrition is still responsible for at least 43% of all deaths in children age 1-59 months worldwide, which is unacceptably high given the importance of adequate food and nutrition in development.

When examining the results of this analysis, it is important to recall that the burdens attributable to underweight, wasting, and stunting are not additive. Since a child can be wasted, stunted, and underweight at the same time, the overall burden of malnutrition is not equivalent to the sum of the three burdens. These burdens are calculated independently of one another and must be considered independently.

High-Burden Target Countries

We find that the top 10 countries with the largest number of deaths attributable to malnutrition in 2011 include India, the Democratic Republic of the Congo, Nigeria, Pakistan, and Ethiopia (Table 4b). Policies and interventions addressing malnutrition are especially important in these countries, and controlling malnutrition in these nations would vastly reduce the globe's total malnutrition burden. Moving forward, policymakers and donors interested in rolling out country-level interventions should first focus on these 10 countries to affect the most change.

Success Stories

There are several countries that have commendably reduced burden attributable to malnutrition over the past 3 decades, and the global community should examine these cases to apply lessons from these success stories to other settings. China, for example, was ranked in the top 3 for the number of deaths attributable to malnutrition in 1980, but by 2011 was not even in the top 10. China took the problem of malnutrition seriously and established a nutritional surveillance program in the 1990s.[15] Although China has made great improvements at the national level, research shows that this masks serious disparities within the country; malnutrition prevalence in poor, rural areas may have actually increased at the same time that the national trend appeared to show improvement.[15] To address these issues, China is rolling out a $2.5 billion school meal program, and is doubling the size of their Institute for Nutrition and Health this year.[15] The results of these efforts will help inform whether such policies and interventions should be rolled out in other settings.

Similarly, Brazil was in the top 10 countries with the largest number of deaths attributable to stunting in 1980, and was no longer as of 2011. Brazil's approach to reducing the burden of malnutrition was to develop the Federal Law for Food and Nutrition Security in 2006, which declared the "universal right to regular and permanent access to good quality food in sufficient quantities, based on healthy food practices which respect cultural diversity and which are environmentally, culturally, socially and economically sustainable."[16] In addition, Brazil has rolled out policies to strengthen local agriculture, subsidize food banks, and support school meals, among others.[16] Brazil's approach makes access to adequate nutrition a human right that is enforced by the State.

In a region where malnutrition has remained sadly constant, Botswana shows encouraging change. It is one of the top 10 countries that have experienced the largest absolute declines in the fraction of deaths/disease burden attributable to underweight and wasting, and its prevalence of malnutrition has dropped quickly in the past few decades. In Botswana, leaders in the Department of Public Health recognized the importance of controlling malnutrition, particularly in people living with HIV/AIDS, so they developed nutrition guidelines for service providers.[17] The government has also promoted the distribution of food baskets to at-risk groups.[17] What exactly is driving Botswana's improvement in its malnutrition situation remains a topic for future research.

Interventions

Deaths attributable to malnutrition are especially tragic given that they can be prevented by a number of interventions. Intrauterine growth restriction and low prevalence of breastfeeding

have a clear association with malnutrition in children.[18] Malnutrition also has a circular relationship with infectious diseases: for example, diarrhea leads to malnutrition, and malnutrition in turn leads to a higher risk of suffering from diarrhea. Therefore, habits such as hand-washing and zinc/ORS treatment for diarrhea will also reduce the prevalence of malnutrition.[18] Given the importance of malnutrition as a risk factor, these interventions should gain more attention from donors and policymakers.

Limitations

There are several limitations to this study. First, the RRs used in this study are only based on 8 studies in developing countries.[9] When we use these RRs in the calculation of every country's PAFs, we are assuming, for example, that the risk of death from diarrhea in a malnourished child is the same in Uganda as it is in the United States, and the same in 1980 as in 2011. This is unlikely to be accurate, and would increase estimates of burden attributable to malnutrition in developed countries. Second, due to lack of available data, 61 of 187 countries have fewer than 3 data points in the database we use to calculate malnutrition prevalence. These are primarily developed countries where malnutrition is not a concern and so is infrequently measured in surveys. Because of this, our ability to accurately predict malnutrition trends in these countries is reduced. However, this is a minor issue given that global attention should remain on malnutrition in developing countries where it is a far more devastating problem. Finally, it continues to be a source of informal debate whether the international WHO Child Growth Standards should be used in all settings. For example, perhaps Asian children are just "naturally more slight" than those in other regions of the world and that this does not necessarily imply nutritional deficiency; yet the international community (and this analysis) continues to cite Asian countries as the most

malnourished. Despite these limitations, the comprehensiveness of this study lends valuable new information to the malnutrition field.

Conclusions

We hope that this research will be used to draw further attention to the disconcertingly high burden of malnutrition around the world. We found large variation in burden attributable to malnutrition across countries and regions; this variation may be mimicked within countries, meaning that even in places that have seen considerable success in reducing the effects of malnutrition, national trends may mask subnational inequalities. Further research is required to identify within-country inequalities and how to target populations in need. We hope that the trends presented in this study will spark further investigation into effective malnutrition policies and interventions. Malnutrition is key to economic development and human capital, and we must treat it as a core aspect of increasing health equity and reducing global disease burden.

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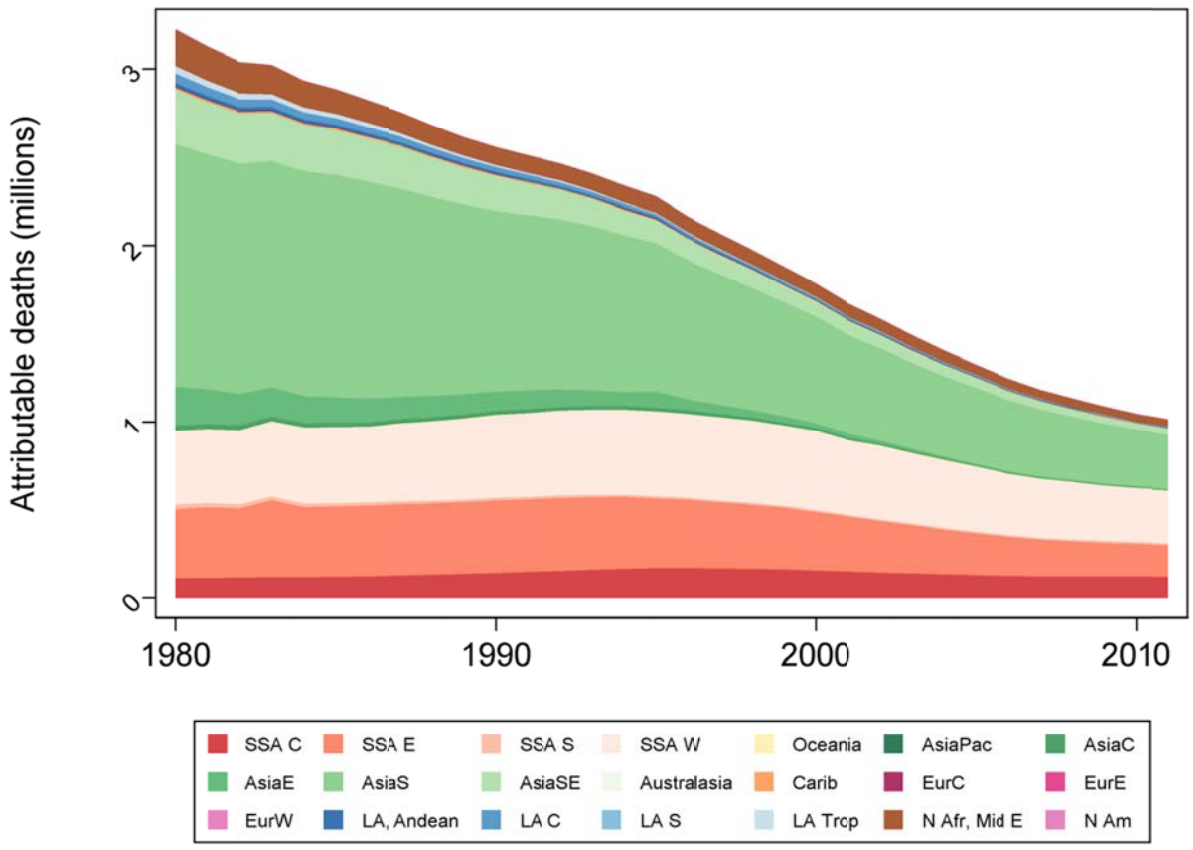

Figure 1a: Deaths attributable to underweight, by region, from 1980 to 2011

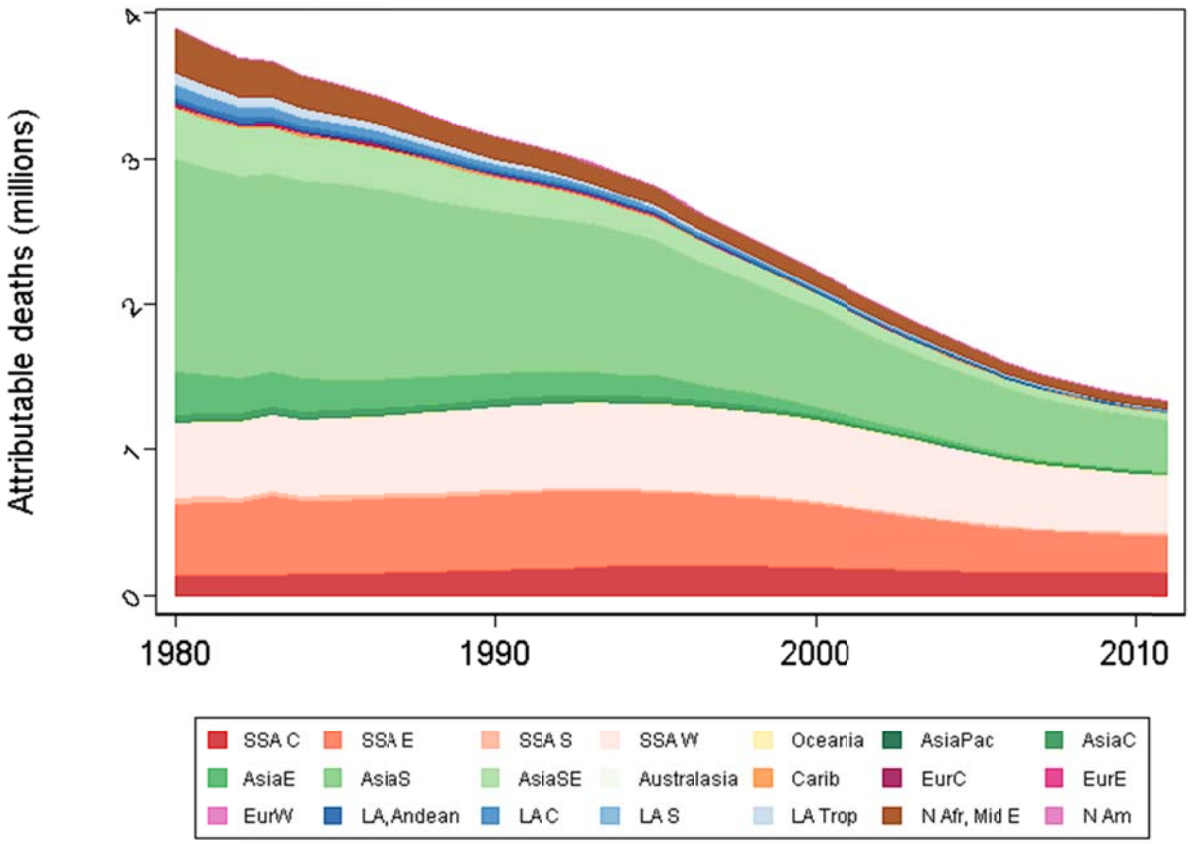

Figure 1b: Deaths attributable to stunting, by region, from 1980 to 2011

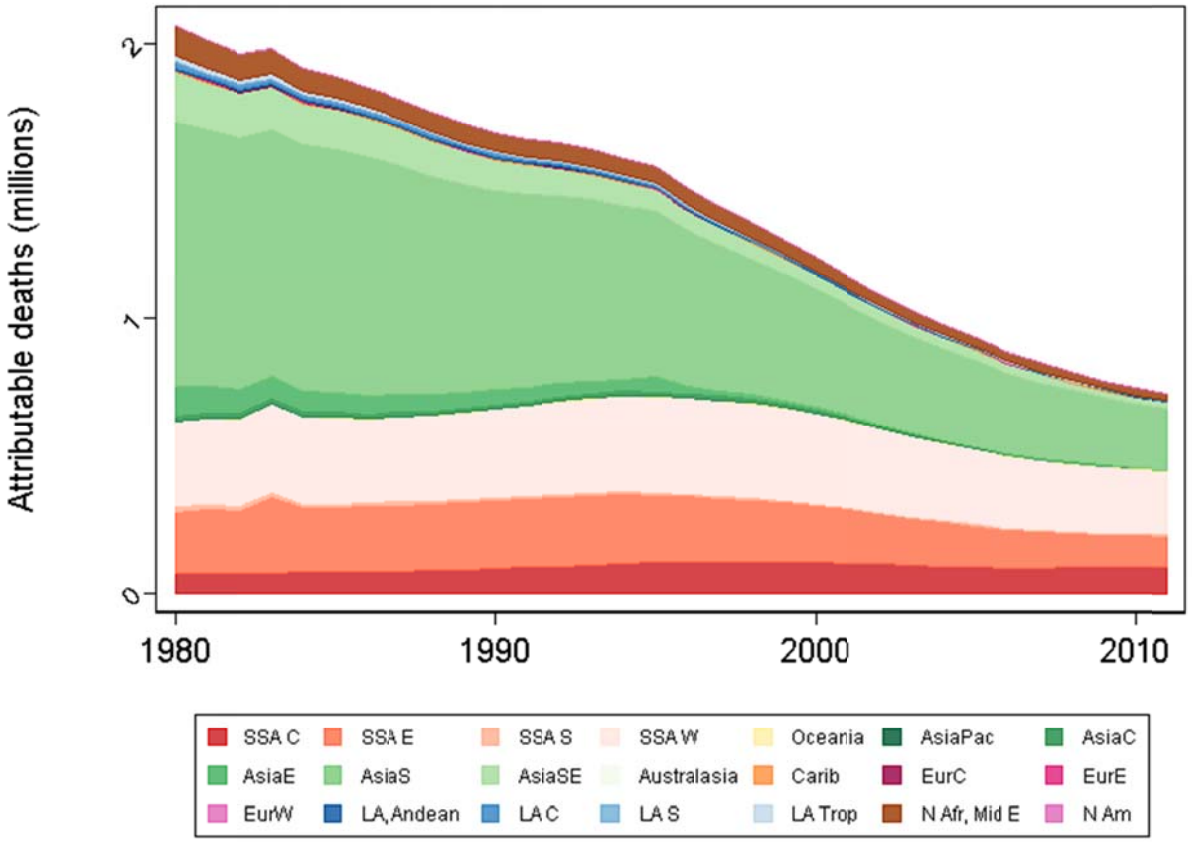

Figure 1c: Deaths attributable to wasting, by region, from 1980 to 2011

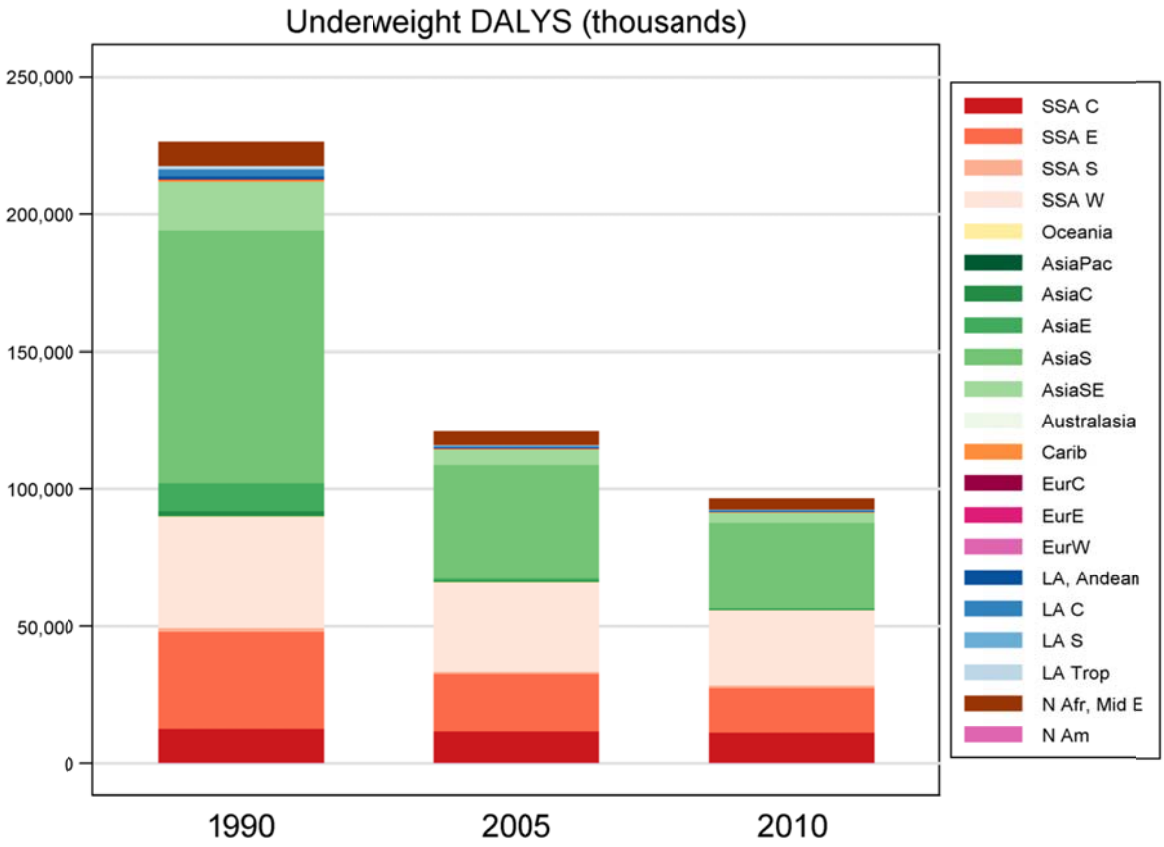

Figure 2a: DALYs attributable to underweight, by region, for 1990, 2005, and 2010

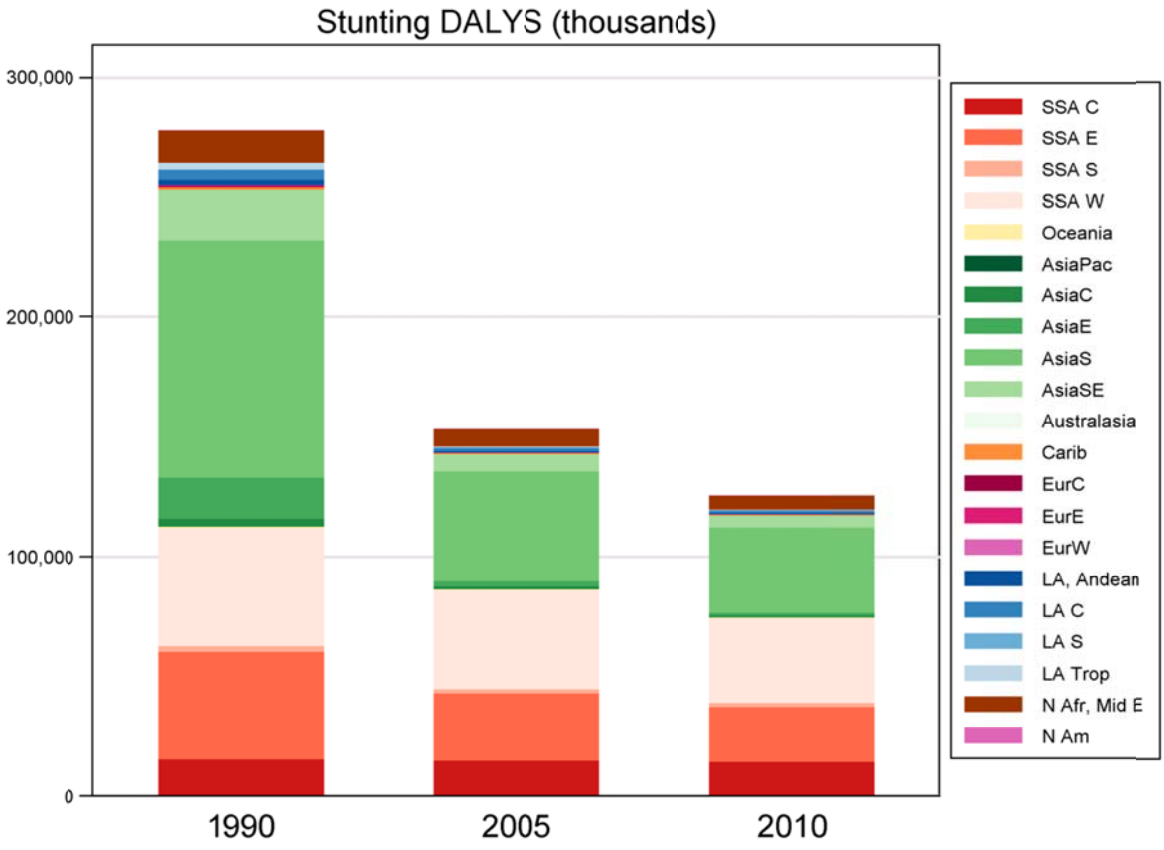

Figure 2b: DALYs attributable to stunting, by region, for 1990, 2005, and 2010

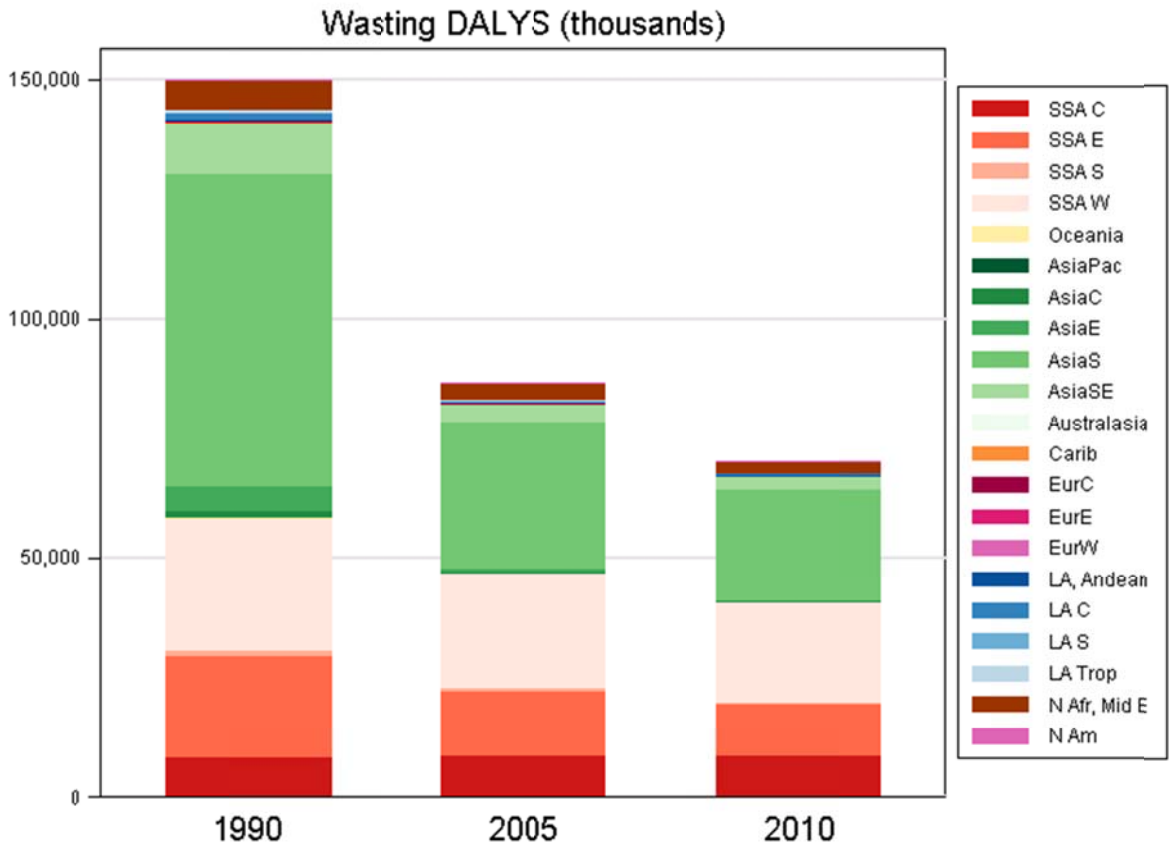

Figure 2c: DALYs attributable to wasting, by region, for 1990, 2005, and 2010

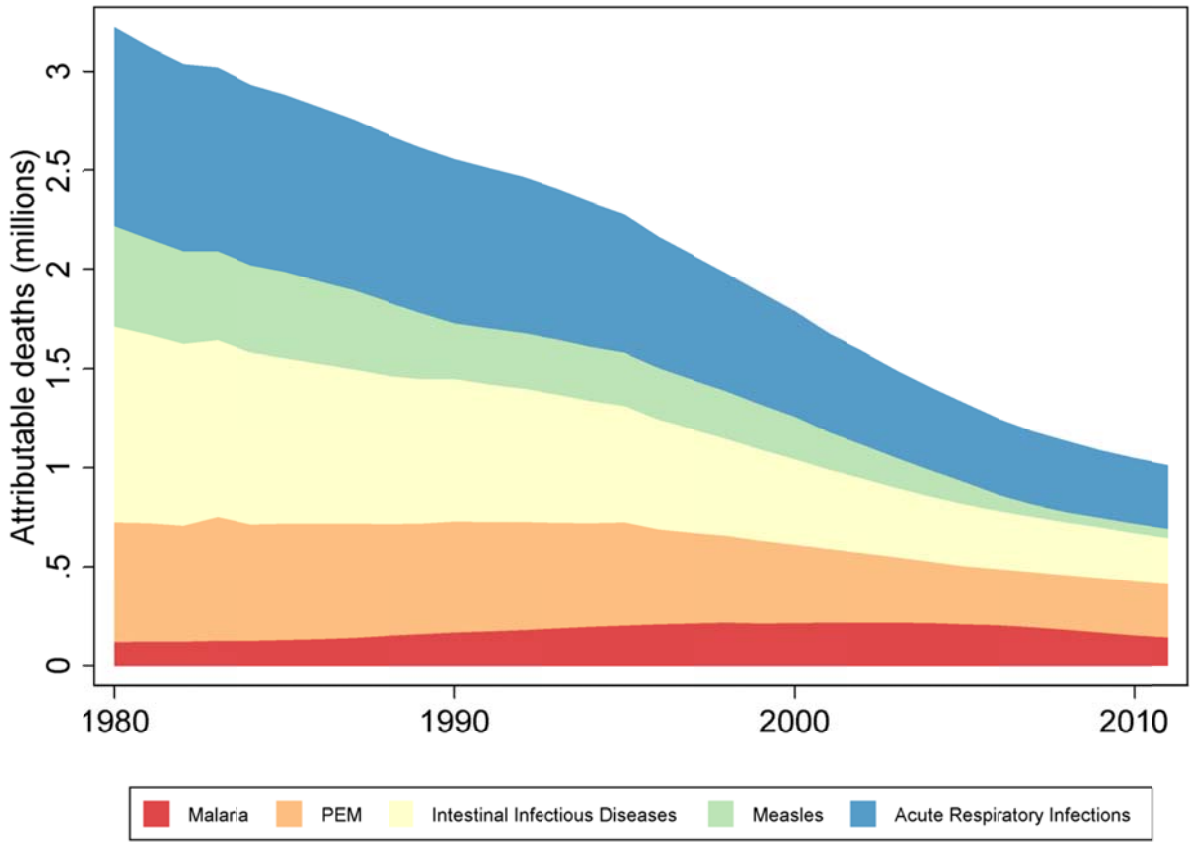

Figure 3a: Cause-specific deaths attributable to underweight, from 1980 to 2011

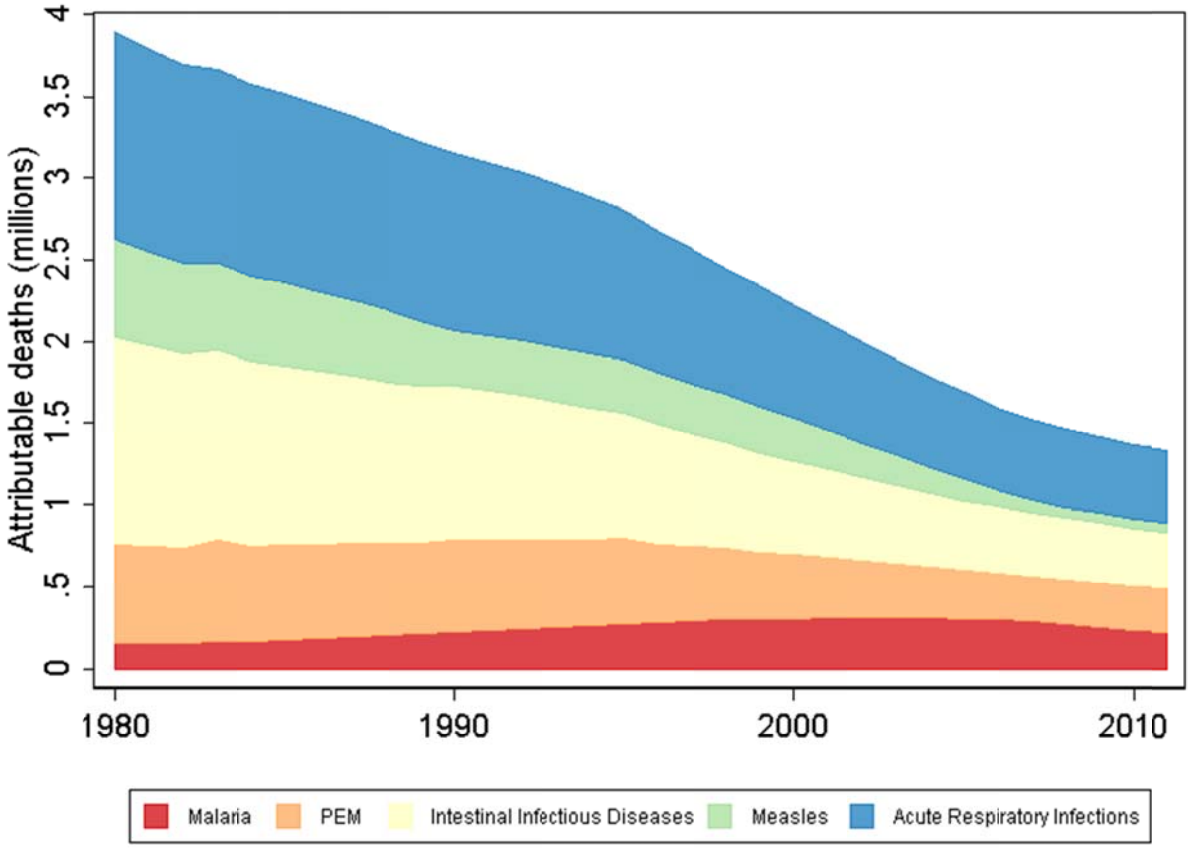

Figure 3b: Cause-specific deaths attributable to stunting, from 1980 to 2011

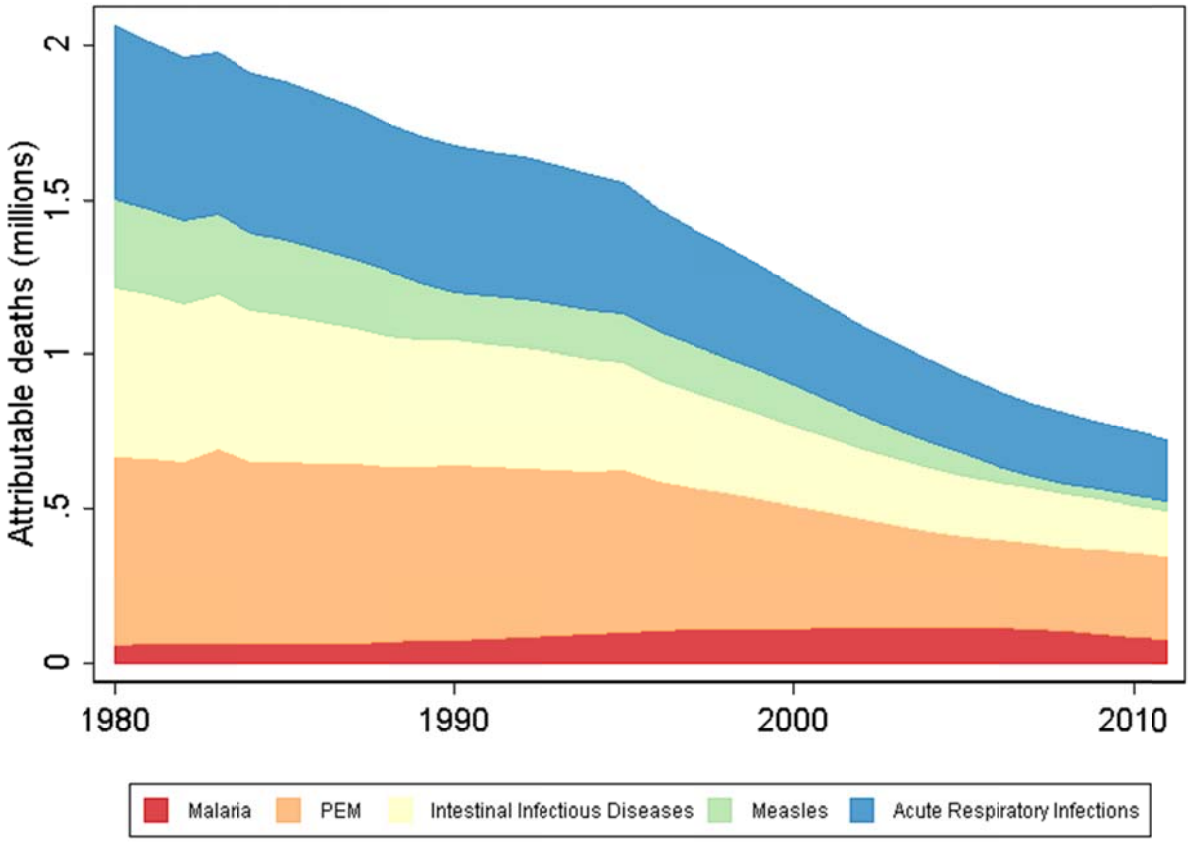

Figure 3c: Cause-specific deaths attributable to wasting, from 1980 to 2011

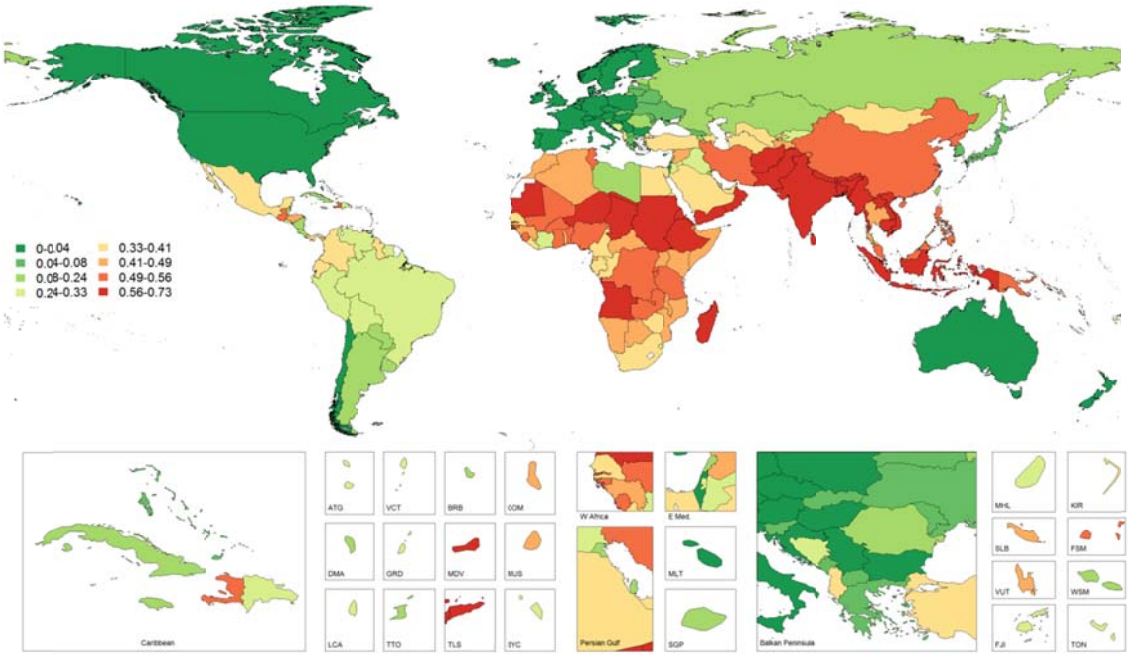

Figure 4a: Fraction of deaths among children age 1-59 months that are attributable to underweight, 1980

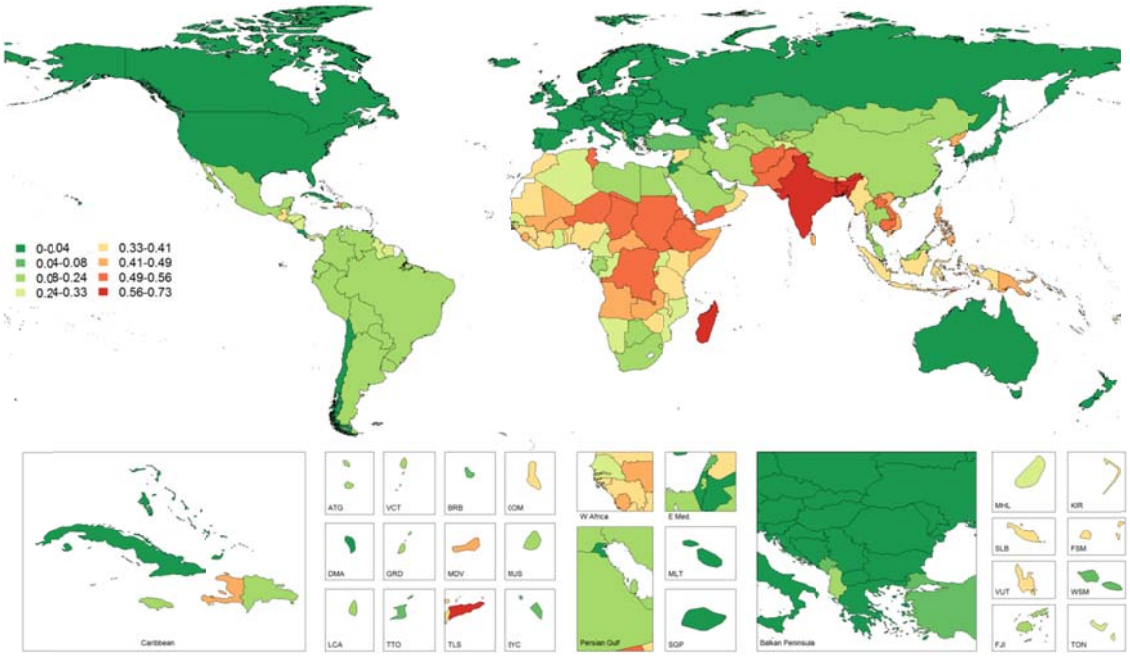

Figure 4b: Fraction of deaths among children age 1-59 months that are attributable to underweight, 2011

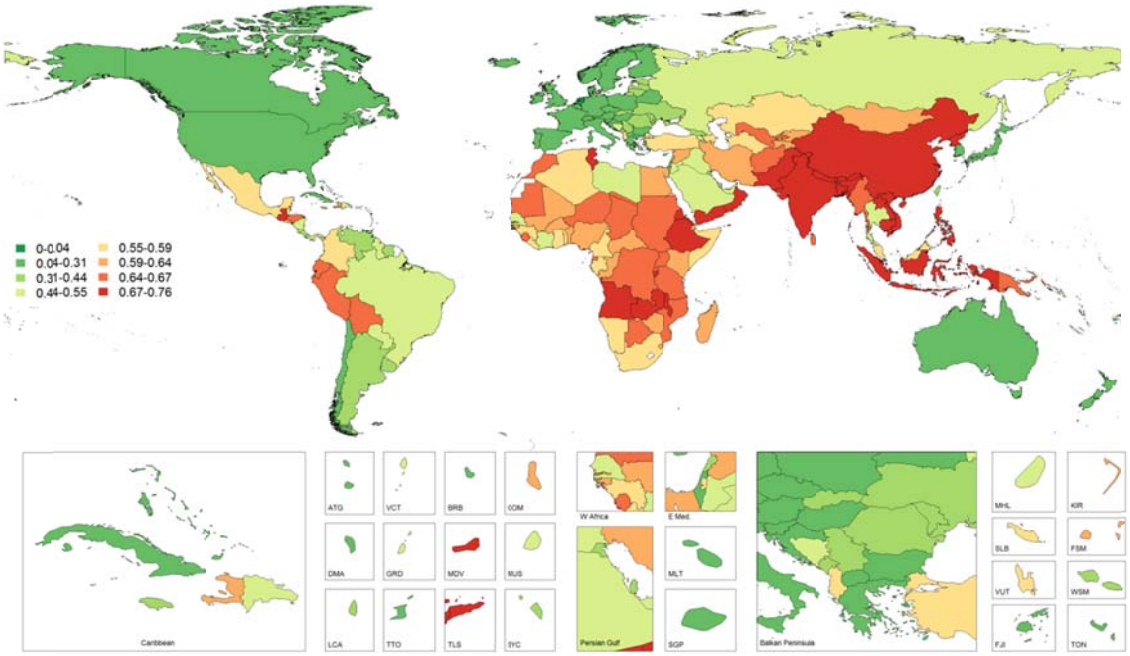

Figure 4c: Fraction of deaths among children age 1-59 months that are attributable to stunting, 1980

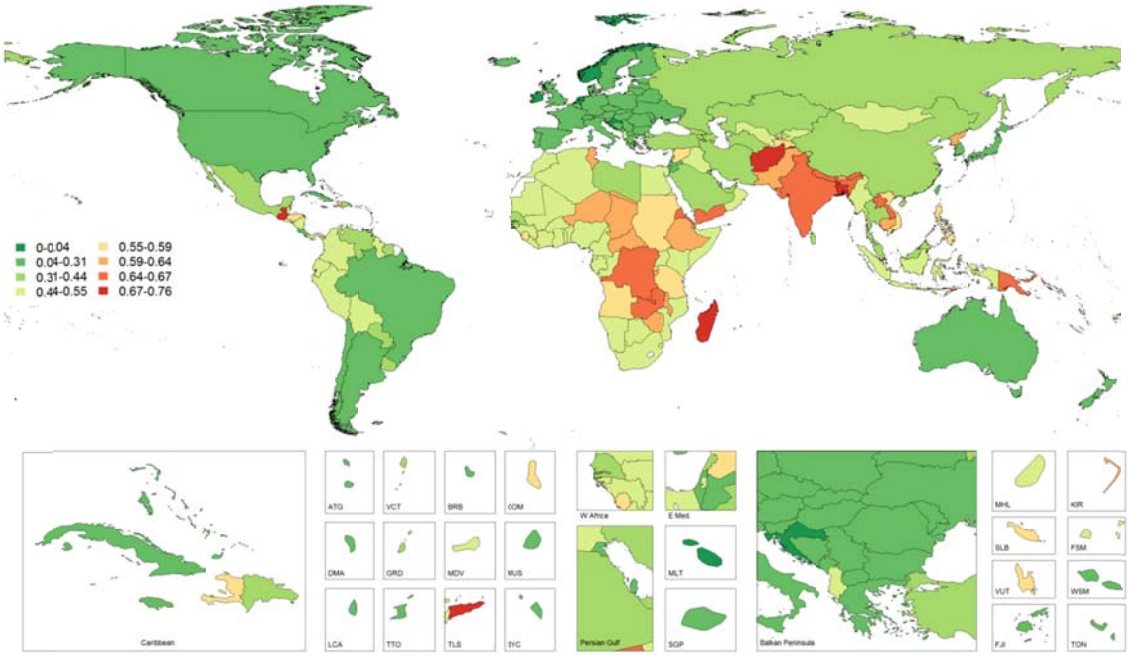

Figure 4d: Fraction of deaths among children age 1-59 months that are attributable to stunting, 2011

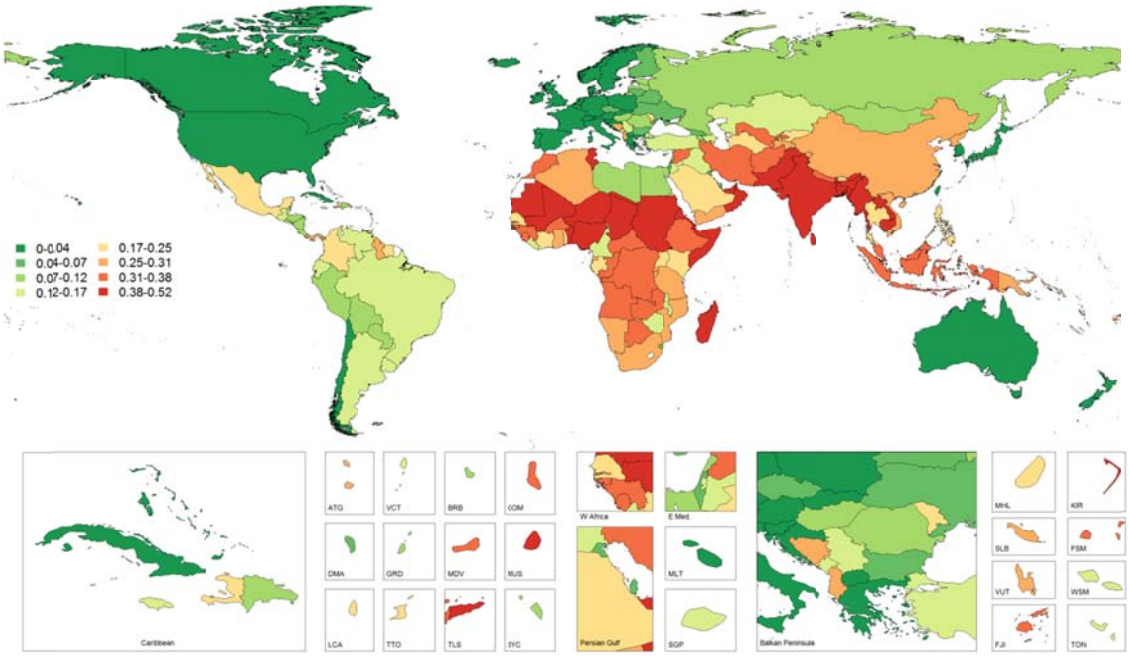

Figure 4e: Fraction of deaths among children age 1-59 months that are attributable to wasting, 1980

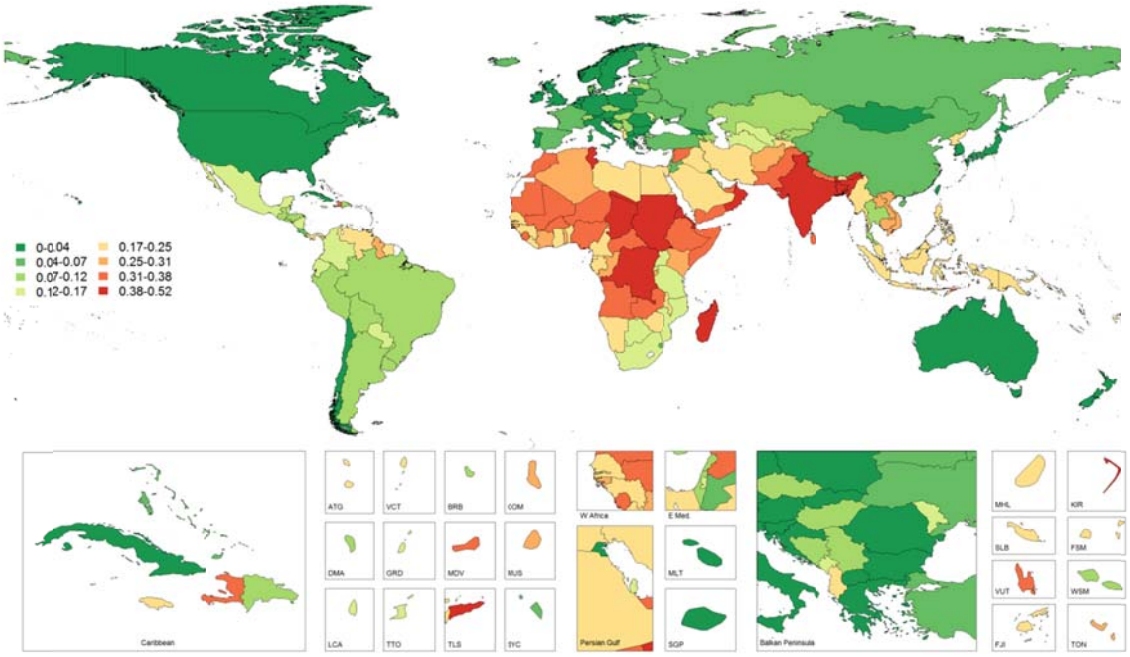

Figure 4f: Fraction of deaths among children age 1-59 months that are attributable to wasting, 2011

Table 1a: Count of data sources by country-year for underweight

GBD Region	Country	Number of Sources	Years of Sources
Asia Pacific, High Income	Japan	2	1978
	Korea, Republic of	2	1984, 2003
	Singapore	2	1970, 2000
Asia, Central	Armenia	6	1993, 1998, 2000, 2005, 2010
	Azerbaijan	5	1996, 1999, 2000, 2001, 2006
	Georgia	7	1999, 2000, 2005, 2009
	Kazakhstan	4	1995, 1996, 1999, 2006
	Kyrgyzstan	3	1997, 1998, 2005
	Mongolia	10	1992, 1997, 1999, 2000, 2001, 2004, 2005
	Tajikistan	24	1994, 1996, 2005, 2007
	Turkmenistan	3	2000, 2005
	Uzbekistan	3	1996, 2002, 2006
Asia, East	China	68	1961, 1962, 1963, 1987, 1989, 1990, 1991, 1992, 1993, 1995, 1997, 1998, 1999, 2000, 2002, 2004, 2005, 2006, 2008, 2009, 2010
	Korea, Democratic People's Republic of	7	1998, 2000, 2002, 2004, 2009
Asia, South	Bangladesh	50	1982, 1984, 1985, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007
	Bhutan	4	1986, 1999, 2008, 2010
	India	66	1974, 1981, 1982, 1983, 1987, 1988, 1991, 1992, 1993, 1995, 1996, 1998, 1999, 2001, 2004, 2005, 2009
	Nepal	9	1975, 1978, 1995, 1996, 1997, 2001, 2006, 2011
	Pakistan	14	1977, 1985, 1986, 1990, 1991, 1992, 1994, 1995, 1998, 2001
Asia, Southeast	Cambodia	9	1993, 1994, 1996, 2000, 2005, 2008, 2010
	Indonesia	39	1977, 1987, 1989, 1991, 1992, 1993, 1995, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2007

Table 1a Cont.

	Lao People's Democratic Republic	11	1984, 1993, 1994, 1995, 1997, 2000, 2001, 2006
	Malaysia	27	1980, 1982, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1999, 2001, 2003, 2005, 2006
	Maldives	10	1981, 1994, 1995, 1996, 1997, 2001, 2009
	Mauritius	5	1982, 1985, 1995
	Myanmar	15	1980, 1983, 1990, 1991, 1994, 1995, 1997, 2000, 2003
	Philippines	19	1971, 1982, 1987, 1989, 1990, 1991, 1992, 1993, 1996, 1998, 2001, 2003, 2008
	Seychelles	1	1987
	Sri Lanka	16	1975, 1977, 1978, 1987, 1993, 1995, 2000, 2001, 2005, 2006, 2009
	Thailand	14	1982, 1983, 1984, 1987, 1990, 1991, 1993, 1995
	Timor-Leste	22	2002, 2003, 2007, 2009
	Viet Nam	28	1983, 1987, 1992, 1994, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006, 2007, 2008
Australasia	Australia	1	1995
	New Zealand	1	1979
Caribbean	Antigua and Barbuda	2	1981
	Barbados	1	1981
	Belize	5	1979, 1992, 2002, 2006
	Cuba	9	1972, 1982, 1993, 1994, 1996, 2000, 2005
	Dominica	2	1983, 1984
	Dominican Republic	8	1976, 1986, 1991, 1996, 2000, 2002, 2006, 2007
	Guyana	11	1971, 1981, 1993, 1997, 2000, 2006, 2009
	Haiti	17	1978, 1990, 1994, 1995, 2000, 2005
	Jamaica	22	1978, 1989, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2004, 2006, 2007
	Saint Lucia	2	1976
	Saint Vincent and the Grenadines	1	1967

Table 1a Cont.

	Suriname	2	1999, 2006
	Trinidad and Tobago	4	1976, 1987, 2000
Europe, Central	Albania	8	1996, 1997, 2000, 2002, 2005, 2008
	Bosnia and Herzegovina	2	2000, 2006
	Bulgaria	1	2004
	Croatia	6	1968, 1973, 1990, 1993, 1994, 1995
	Czech Republic	2	1991, 2001
	Hungary	2	1980
	Macedonia, the Former Yugoslav Republic of	3	1999, 2004, 2005
	Montenegro	2	2000, 2005
	Romania	7	1991, 1994, 1999, 2000, 2001, 2002
	Serbia	2	2000, 2005
Europe, Eastern	Belarus	1	2005
	Moldova	2	1996, 2005
	Russian Federation	5	1993, 1995, 2000, 2001
	Ukraine	3	2000, 2002
Europe, Western	France	1	1975
	Germany	1	2003
	Greece	1	2010
	Italy	3	1973, 1975
	Netherlands	1	1980
	Portugal	2	2001, 2002
	Spain	2	1985, 2000
	United Kingdom	2	1973
Latin America, Andean	Bolivia	29	1977, 1981, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1996, 1998, 2003, 2008
	Ecuador	6	1986, 1998, 1999, 2000, 2004
	Peru	8	1975, 1984, 1991, 1996, 2000, 2003, 2004, 2009
Latin America, Central	Colombia	11	1965, 1977, 1986, 1989, 1995, 2000, 2004, 2009
	Costa Rica	17	1965, 1982, 1989, 1990, 1991, 1992, 1993, 1994, 1996, 2008
	El Salvador	12	1965, 1975, 1988, 1993, 1994, 1998, 2002, 2008

Table 1a Cont.

	Guatemala	26	1965, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1983, 1985, 1987, 1988, 1995, 1996, 1998, 2000, 2002, 2006, 2008
	Honduras	14	1965, 1973, 1987, 1991, 1992, 1993, 1996, 2001, 2005
	Mexico	22	1974, 1979, 1984, 1988, 1989, 1991, 1994, 1995, 1996, 1997, 1998, 2002, 2006
	Nicaragua	17	1965, 1966, 1980, 1988, 1990, 1993, 1997, 1998, 2001, 2003, 2006
	Panama	6	1965, 1980, 1992, 1997, 2003
	Venezuela	35	1981, 1985, 1987, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2004, 2005, 2007
Latin America, Southern	Argentina	34	1985, 1994, 1995, 1996, 2004, 2006
	Chile	28	1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008
	Uruguay	6	1987, 1992, 1995, 2002, 2004
Latin America, Tropical	Brazil	30	1973, 1975, 1980, 1981, 1982, 1984, 1986, 1987, 1989, 1990, 1991, 1995, 1996, 2002, 2006
	Paraguay	4	1990, 1998, 2001, 2005
North Africa / Middle East	Afghanistan	18	1990, 1997, 2000, 2002, 2004
	Algeria	11	1987, 1992, 1995, 1997, 2000, 2001, 2002, 2005, 2006
	Bahrain	4	1989, 1995
	Egypt	21	1978, 1980, 1988, 1989, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 1998, 2000, 2003, 2005, 2008
	Iran, Islamic Republic of	7	1980, 1982, 1995, 1998, 2002, 2004
	Iraq	52	1991, 1995, 1996, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2006

Table 1a Cont.

	Jordan	7	1975, 1990, 1991, 1997, 2002, 2007, 2009
	Kuwait	25	1983, 1994, 1996, 1998, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009
	Lebanon	5	1985, 1996, 1997, 2004, 2005
	Libyan Arab Jamahiriya	4	1970, 1995, 2007
	Morocco	5	1987, 1991, 1992, 1996, 2003
	Occupied Palestinian Territory	18	1974, 1975, 1978, 1984, 1990, 1995, 1996, 1998, 2000, 2002, 2003, 2004, 2006, 2008
	Oman	8	1991, 1994, 1995, 1998, 1999, 2009
	Qatar	1	1995
	Saudi Arabia	6	1979, 1980, 1994, 1996, 2004
	Syrian Arab Republic	9	1993, 1995, 2000, 2001, 2006, 2009
	Tunisia	7	1973, 1988, 1994, 1996, 2000, 2006
	Turkey	6	1993, 1995, 1998, 2003, 2008
	United Arab Emirates	1	1995
	Yemen	9	1979, 1982, 1991, 1993, 1996, 1997, 2003, 2005
North America, High Income	Canada	2	1970
	United States	6	1963, 1988, 1991, 1999
Oceania	Fiji	2	1993
	Kiribati	3	1979, 1985, 1999
	Micronesia, Federated States of	1	1997
	Papua New Guinea	5	1969, 1982, 1986, 1996, 2005
	Samoa	3	1976, 1978, 1999
	Solomon Islands	5	1970, 1980, 1983, 1989, 2006
	Vanuatu	3	1983, 1996, 2007
Sub-Saharan Africa, Central	Angola	4	1996, 2001, 2007
	Central African Republic	6	1994, 1995, 2000, 2006
	Congo	6	1986, 1987, 1999, 2005
	Congo, the Democratic Republic of the	25	1975, 1976, 1979, 1983, 1985, 1986, 1987, 1990, 1995, 2001, 2007
	Equatorial Guinea	4	1992, 1997, 2000, 2004

Table 1a Cont.

	Gabon	4	1982, 1984, 2000
Sub-Saharan Africa, East	Burundi	13	1979, 1983, 1984, 1985, 1986, 1987, 1994, 1995, 2000, 2005
	Comoros	6	1991, 1995, 1996, 2000, 2004
	Djibouti	9	1989, 1990, 1995, 1996, 2002, 2006, 2007
	Eritrea	4	1993, 1994, 1995, 2002
	Ethiopia	10	1980, 1983, 1984, 1992, 1994, 1997, 1998, 2000, 2005, 2010
	Kenya	11	1993, 1994, 1998, 2000, 2003, 2005, 2008
	Madagascar	18	1983, 1985, 1986, 1988, 1992, 1993, 1995, 1997, 2000, 2003, 2008
	Malawi	12	1981, 1992, 1995, 1997, 2000, 2002, 2004, 2006, 2009, 2010
	Mozambique	9	1989, 1995, 1997, 2000, 2003, 2008
	Rwanda	21	1976, 1991, 1992, 1996, 2000, 2005, 2010
	Somalia	7	1975, 1997, 1999, 2000, 2006
	Sudan	7	1983, 1988, 1992, 1993, 1995, 2000, 2006
	Tanzania, United Republic of	21	1969, 1985, 1991, 1992, 1993, 1996, 1999, 2004, 2008, 2009
	Uganda	9	1985, 1987, 1988, 1995, 1998, 2000, 2006
	Zambia	11	1970, 1990, 1992, 1995, 1996, 1998, 1999, 2001, 2002, 2004, 2007
Sub-Saharan Africa, Southern	Botswana	10	1978, 1979, 1980, 1981, 1985, 1996, 2000, 2007
	Lesotho	11	1976, 1981, 1992, 1993, 1994, 1996, 2000, 2004, 2007, 2009
	Namibia	4	1990, 1992, 2000, 2006
	South Africa	23	1976, 1978, 1979, 1980, 1981, 1984, 1986, 1993, 1994, 1995, 1999, 2003, 2008
	Swaziland	4	1983, 2000, 2006, 2008
	Zimbabwe	12	1987, 1988, 1994, 1997, 1999, 2003, 2005, 2009, 2010
Sub-Saharan Africa, West	Benin	7	1989, 1990, 1991, 1996, 2001, 2006

Table 1a Cont.

	Burkina Faso	11	1973, 1974, 1987, 1992, 1995, 1998, 2003, 2006, 2007, 2009
	Cameroon	8	1977, 1990, 1991, 1998, 2004, 2006
	Cape Verde	15	1983, 1985, 1990, 1994, 2006
	Chad	3	1996, 2000, 2004
	Côte d'Ivoire	10	1985, 1986, 1987, 1994, 1998, 2004, 2006, 2007
	Gambia	6	1981, 1982, 1996, 2005
	Ghana	9	1987, 1988, 1991, 1993, 1998, 2003, 2006, 2008
	Guinea	9	1990, 1994, 1999, 2000, 2002, 2005, 2007
	Guinea-Bissau	6	1978, 1987, 2000, 2006, 2008
	Liberia	4	1976, 1999, 2006
	Mali	16	1987, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 2001, 2006
	Mauritania	7	1990, 1995, 1996, 2000, 2007, 2008
	Niger	17	1976, 1980, 1985, 1986, 1987, 1990, 1992, 1993, 1998, 1999, 2000, 2001, 2003, 2006, 2008
	Nigeria	8	1986, 1990, 1993, 1999, 2003, 2007, 2008
	Sao Tome and Principe	6	1986, 2000, 2006, 2008
	Senegal	9	1984, 1986, 1991, 1992, 1996, 2000, 2005
	Sierra Leone	8	1974, 1977, 1989, 1990, 2000, 2005, 2008
	Togo	13	1973, 1976, 1988, 1996, 1998, 2006, 2008

Table 1b: Count of data sources by country-year for stunting

GBD Region	Country	Number of Sources	Years of Sources
Asia Pacific, High Income	Japan	2	1978
	Korea, Republic of	2	1984, 2003
	Singapore	2	1970, 2000
Asia, Central	Armenia	6	1993, 1998, 2000, 2005, 2010
	Azerbaijan	5	1996, 1999, 2000, 2001, 2006
	Georgia	6	1999, 2000, 2005, 2009
	Kazakhstan	8	1994, 1995, 1996, 1999, 2006
	Kyrgyzstan	3	1997, 1998, 2005
	Mongolia	10	1992, 1997, 1999, 2000, 2001, 2004, 2005
	Tajikistan	29	1994, 1996, 1999, 2000, 2001, 2002, 2003, 2005, 2007
	Turkmenistan	2	2000, 2005
	Uzbekistan	3	1996, 2002, 2006
Asia, East	China	66	1961, 1962, 1963, 1987, 1989, 1990, 1991, 1992, 1993, 1995, 1997, 1998, 2000, 2002, 2004, 2005, 2006, 2008, 2009, 2010
	Korea, Democratic People's Republic of	7	1997, 1998, 2000, 2002, 2004, 2009
Asia, South	Bangladesh	50	1982, 1984, 1985, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007
	Bhutan	5	1986, 1999, 2008, 2010
	India	63	1974, 1981, 1982, 1983, 1987, 1988, 1991, 1992, 1995, 1996, 1998, 1999, 2001, 2004, 2005
	Nepal	8	1975, 1995, 1996, 1997, 2001, 2006, 2011
	Pakistan	17	1977, 1985, 1986, 1990, 1991, 1992, 1998, 2001
Asia, Southeast	Cambodia	8	1993, 1994, 1996, 2000, 2005, 2008, 2010
	Indonesia	23	1977, 1991, 1993, 1994, 1995, 1996, 1997, 1999, 2000, 2001, 2004, 2007
	Lao People's Democratic Republic	12	1984, 1986, 1993, 1994, 1995, 1997, 2000, 2001, 2006
	Malaysia	9	1980, 1982, 1988, 1990, 1992, 1999, 2006
	Maldives	9	1981, 1994, 1995, 1996, 1997, 2001, 2009

Table 1b Cont.

	Mauritius	4	1985, 1995
	Myanmar	10	1980, 1983, 1991, 1994, 1997, 2000, 2003
	Philippines	14	1971, 1982, 1987, 1989, 1992, 1993, 1998, 2003, 2008
	Seychelles	2	1987
	Sri Lanka	18	1975, 1977, 1978, 1980, 1987, 1988, 1993, 1995, 2000, 2001, 2005, 2006, 2009
	Thailand	19	1978, 1981, 1982, 1983, 1984, 1987, 1990, 1991, 1993, 1995
	Timor-Leste	22	2002, 2003, 2007, 2009
	Viet Nam	24	1983, 1987, 1992, 1994, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006, 2007, 2008
Australasia	Australia	1	1995
	New Zealand	1	1979
Caribbean	Antigua and Barbuda	2	1981
	Barbados	1	1981
	Belize	2	1979, 2006
	Cuba	7	1972, 1982, 1993, 1994, 2000, 2005
	Dominica	3	1983, 1984
	Dominican Republic	8	1976, 1986, 1991, 1996, 2000, 2002, 2006, 2007
	Guyana	8	1971, 1981, 1997, 2000, 2006, 2009
	Haiti	17	1978, 1990, 1994, 1995, 2000, 2005
	Jamaica	22	1978, 1989, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2004, 2006, 2007
	Saint Lucia	2	1976
	Saint Vincent and the Grenadines	1	1967
	Suriname	2	1999, 2006
	Trinidad and Tobago	4	1976, 1987, 2000
Europe, Central	Albania	6	1996, 1997, 2000, 2005, 2008
	Bosnia and Herzegovina	2	2000, 2006
	Bulgaria	1	2004
	Croatia	6	1968, 1973, 1990, 1993, 1994, 1995
	Czech Republic	3	1991, 2001
	Hungary	2	1980
	Macedonia, the Former Yugoslav Republic of	3	1999, 2004, 2005

Table 1b Cont.

	Montenegro	1	2005
	Romania	7	1991, 1994, 1999, 2000, 2001, 2002
	Serbia	1	2005
Europe, Eastern	Belarus	1	2005
	Moldova	1	2005
	Russian Federation	4	1993, 1995, 2000, 2001
	Ukraine	4	2000, 2002
Europe, Western	France	1	1975
	Germany	1	2003
	Greece	1	2010
	Italy	3	1973, 1975
	Netherlands	1	1980
	Portugal	2	2001, 2002
	Spain	2	1985, 2000
	United Kingdom	3	1973, 1988
Latin America, Andean	Bolivia	18	1977, 1981, 1985, 1986, 1987, 1988, 1989, 1993, 1996, 1998, 2003, 2008
	Ecuador	3	1986, 1998, 2004
	Peru	19	1975, 1984, 1985, 1991, 1993, 1996, 2000, 2003, 2004, 2009
Latin America, Central	Colombia	11	1965, 1977, 1986, 1989, 1995, 2000, 2004, 2009
	Costa Rica	10	1965, 1979, 1981, 1982, 1983, 1985, 1989, 1996, 2008
	El Salvador	12	1965, 1975, 1988, 1993, 1994, 1998, 2002, 2008
	Guatemala	27	1965, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1983, 1985, 1987, 1988, 1995, 1996, 1998, 2000, 2001, 2002, 2006, 2008
	Honduras	14	1965, 1973, 1987, 1991, 1992, 1993, 1996, 2001, 2005
	Mexico	22	1974, 1979, 1984, 1988, 1989, 1994, 1995, 1996, 1997, 1998, 2002, 2006
	Nicaragua	20	1965, 1966, 1980, 1986, 1988, 1990, 1993, 1997, 1998, 2001, 2003, 2006
	Panama	12	1965, 1980, 1982, 1985, 1988, 1992, 1994, 1997, 2000, 2003
	Venezuela	33	1981, 1985, 1987, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2005, 2007
Latin America, Southern	Argentina	32	1985, 1994, 1995, 2004

Table 1b Cont.

	Chile	18	1984, 1985, 1986, 1993, 1994, 1995, 1996, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008
	Uruguay	5	1987, 1992, 2002, 2004
Latin America, Tropical	Brazil	36	1973, 1975, 1980, 1981, 1982, 1983, 1984, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1995, 1996, 2006
	Paraguay	3	1990, 2005
North Africa / Middle East	Afghanistan	29	1990, 1997, 2000, 2001, 2002, 2004
	Algeria	10	1987, 1992, 1995, 1997, 2000, 2001, 2002, 2005
	Bahrain	4	1989, 1995
	Egypt	17	1978, 1980, 1988, 1989, 1990, 1991, 1992, 1994, 1995, 1997, 1998, 2000, 2003, 2005, 2008
	Iran, Islamic Republic of	6	1980, 1982, 1995, 1998, 2002, 2004
	Iraq	50	1991, 1995, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2006
	Jordan	6	1975, 1990, 1997, 2002, 2007, 2009
	Kuwait	27	1983, 1994, 1995, 1996, 1998, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009
	Lebanon	5	1985, 1996, 1997, 2004, 2005
	Libyan Arab Jamahiriya	3	1995, 2007
	Morocco	5	1987, 1991, 1992, 1996, 2003
	Occupied Palestinian Territory	10	1974, 1975, 1978, 1984, 1990, 1995, 1998, 2003, 2006, 2008
	Oman	6	1991, 1994, 1995, 1999, 2009
	Qatar	1	1995
	Saudi Arabia	6	1979, 1980, 1994, 1996, 2004
	Syrian Arab Republic	9	1993, 1995, 2000, 2001, 2006, 2009
	Tunisia	7	1973, 1988, 1994, 1996, 2000, 2006
	Turkey	4	1993, 1998, 2003, 2008
	United Arab Emirates	1	1995
	Yemen	11	1979, 1982, 1991, 1993, 1996, 1997, 2003, 2005
North America, High Income	Canada	2	1970
	United States	4	1963, 1988, 1999
Oceania	Fiji	2	1993
	Kiribati	1	1985

Table 1b Cont.

	Micronesia, Federated States of	1	2000
	Papua New Guinea	7	1969, 1977, 1980, 1982, 1986, 1996, 2005
	Samoa	4	1976, 1978, 1999
	Solomon Islands	5	1970, 1980, 1984, 1989, 2006
	Tonga	1	1986
	Vanuatu	3	1983, 1996, 2007
Sub-Saharan Africa, Central	Angola	4	1996, 2001, 2007
	Central African Republic	6	1994, 1995, 2000, 2006
	Congo	7	1986, 1987, 1991, 1993, 1996, 2005
	Congo, the Democratic Republic of the	29	1975, 1976, 1979, 1983, 1985, 1986, 1987, 1990, 1991, 1992, 1993, 1994, 1995, 2001, 2007
	Equatorial Guinea	4	1992, 1997, 2000, 2004
	Gabon	3	1984, 2000
Sub-Saharan Africa, East	Burundi	11	1979, 1983, 1984, 1985, 1986, 1987, 1994, 1995, 2000, 2005
	Comoros	6	1991, 1995, 1996, 2000, 2004
	Djibouti	8	1989, 1995, 1996, 2002, 2006, 2007
	Eritrea	4	1993, 1994, 1995, 2002
	Ethiopia	11	1980, 1983, 1984, 1989, 1992, 1994, 1997, 2000, 2005, 2010
	Kenya	17	1978, 1982, 1985, 1987, 1993, 1994, 1998, 2000, 2001, 2003, 2005, 2008
	Madagascar	18	1983, 1985, 1986, 1988, 1992, 1993, 1995, 1997, 2003, 2008
	Malawi	19	1981, 1982, 1983, 1984, 1985, 1992, 1995, 1997, 2000, 2004, 2006, 2009, 2010
	Mozambique	9	1989, 1995, 1997, 2000, 2002, 2003, 2008
	Rwanda	22	1976, 1991, 1992, 1995, 1996, 2000, 2005, 2010
	Somalia	5	1975, 2000, 2002, 2006
	Sudan	6	1983, 1988, 1992, 1995, 2000, 2006
	Tanzania, United Republic of	21	1969, 1985, 1991, 1992, 1993, 1996, 1999, 2004, 2008, 2009
	Uganda	10	1985, 1987, 1988, 1995, 1998, 2000, 2002, 2006
	Zambia	9	1970, 1990, 1992, 1995, 1996, 1998, 1999, 2001, 2007

Table 1b Cont.

Sub-Saharan Africa, Southern	Botswana	10	1978, 1979, 1980, 1981, 1985, 1996, 2000, 2007
	Lesotho	12	1976, 1981, 1987, 1992, 1993, 1994, 1996, 2000, 2004, 2007, 2009
	Namibia	4	1990, 1992, 2000, 2006
	South Africa	24	1976, 1978, 1979, 1980, 1981, 1984, 1986, 1993, 1994, 1999, 2003, 2008
	Swaziland	5	1983, 2000, 2006, 2008
	Zimbabwe	7	1988, 1994, 1999, 2005, 2009, 2010
Sub-Saharan Africa, West	Benin	7	1989, 1990, 1991, 1996, 2001, 2006
	Burkina Faso	10	1973, 1974, 1992, 1995, 1998, 2003, 2006, 2007, 2009
	Cameroon	8	1977, 1990, 1991, 1998, 2004, 2006
	Cape Verde	16	1983, 1985, 1990, 1994, 2006
	Chad	4	1988, 1996, 2000, 2004
	Côte d'Ivoire	9	1985, 1986, 1987, 1994, 1998, 2006, 2007
	Gambia	6	1981, 1982, 1996, 2005
	Ghana	9	1987, 1988, 1993, 1998, 2003, 2006, 2008
	Guinea	10	1990, 1994, 1999, 2000, 2005, 2007
	Guinea-Bissau	4	2000, 2006, 2008
	Liberia	5	1976, 1995, 1999, 2006
	Mali	16	1987, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 2001, 2006
	Mauritania	8	1988, 1990, 1995, 1996, 2000, 2007, 2008
	Niger	17	1980, 1985, 1986, 1987, 1990, 1992, 1993, 1998, 1999, 2000, 2001, 2003, 2006, 2008
	Nigeria	8	1986, 1990, 1993, 1999, 2003, 2007, 2008
	Sao Tome and Principe	6	1986, 2000, 2006, 2008
	Senegal	13	1983, 1984, 1986, 1991, 1992, 1996, 2000, 2005
	Sierra Leone	8	1974, 1977, 1989, 1990, 2000, 2005, 2008
	Togo	12	1973, 1976, 1988, 1996, 1998, 2006, 2008

Table 1c: Count of data sources by country-year for wasting

GBD Region	Country	Number of Sources	Years of Sources
Asia Pacific, High Income	Japan	2	1978
	Korea, Republic of	2	1984, 2003
	Singapore	2	1970, 2000
Asia, Central	Armenia	6	1993, 1998, 2000, 2005, 2010
	Azerbaijan	5	1996, 1999, 2000, 2001, 2006
	Georgia	6	1999, 2000, 2005, 2009
	Kazakhstan	5	1994, 1995, 1996, 1999, 2006
	Kyrgyzstan	4	1993, 1997, 1998, 2005
	Mongolia	9	1992, 1997, 1999, 2000, 2001, 2004, 2005
	Tajikistan	29	1994, 1996, 1999, 2000, 2001, 2002, 2003, 2005, 2007
	Turkmenistan	2	2000, 2005
	Uzbekistan	3	1996, 2002, 2006
Asia, East	China	63	1961, 1962, 1963, 1987, 1989, 1990, 1991, 1992, 1993, 1995, 1997, 1998, 2000, 2002, 2004, 2005, 2006, 2008, 2009, 2010
	Korea, Democratic People's Republic of	7	1997, 1998, 2000, 2002, 2004, 2009
Asia, South	Bangladesh	50	1982, 1984, 1985, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007
	Bhutan	5	1986, 1999, 2008, 2010
	India	63	1974, 1981, 1982, 1983, 1987, 1988, 1991, 1992, 1995, 1996, 1998, 1999, 2001, 2004, 2005
	Nepal	8	1975, 1995, 1996, 1997, 2001, 2006, 2011

Table 1c Cont.

	Pakistan	27	1977, 1985, 1986, 1990, 1991, 1992, 1994, 1995, 1997, 1998, 2000, 2001, 2002
Asia, Southeast	Cambodia	8	1993, 1994, 1996, 2000, 2005, 2008, 2010
	Indonesia	22	1977, 1991, 1993, 1995, 1996, 1997, 1999, 2000, 2001, 2004, 2007
	Lao People's Democratic Republic	11	1984, 1993, 1994, 1995, 1997, 2000, 2001, 2006
	Malaysia	8	1980, 1982, 1988, 1990, 1992, 1999
	Maldives	10	1981, 1983, 1994, 1995, 1996, 1997, 2001, 2009
	Mauritius	4	1985, 1995
	Myanmar	10	1980, 1983, 1991, 1994, 1997, 2000, 2003
	Philippines	14	1971, 1982, 1987, 1989, 1992, 1993, 1998, 2003, 2008
	Seychelles	2	1987
	Sri Lanka	18	1975, 1977, 1978, 1980, 1987, 1988, 1993, 1995, 2000, 2001, 2005, 2006, 2009
	Thailand	19	1981, 1982, 1983, 1984, 1987, 1990, 1991, 1993, 1995
	Timor-Leste	22	2002, 2003, 2007, 2009
	Viet Nam	22	1983, 1987, 1992, 1994, 1998, 1999, 2000, 2002, 2003, 2004, 2005, 2006, 2007, 2008
Australasia	Australia	1	1995
	New Zealand	1	1979
Caribbean	Antigua and Barbuda	2	1981
	Barbados	1	1981
	Belize	2	1979, 2006
	Cuba	11	1972, 1982, 1984, 1985, 1986, 1987, 1993, 1994, 2000, 2005
	Dominica	2	1983, 1984
	Dominican Republic	8	1976, 1986, 1991, 1996, 2000, 2002, 2006, 2007
	Guyana	7	1981, 1997, 2000, 2006, 2009

Table 1c Cont.

	Haiti	17	1978, 1990, 1994, 1995, 2000, 2005
	Jamaica	22	1978, 1989, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2004, 2006, 2007
	Saint Lucia	2	1976
	Suriname	2	1999, 2006
	Trinidad and Tobago	4	1976, 1987, 2000
Europe, Central	Albania	6	1996, 1997, 2000, 2005, 2008
	Bosnia and Herzegovina	6	1993, 2000, 2006
	Bulgaria	1	2004
	Croatia	6	1968, 1973, 1990, 1993, 1994, 1995
	Czech Republic	3	1991, 2001
	Hungary	2	1980
	Macedonia, the Former Yugoslav Republic of	3	1999, 2004, 2005
	Montenegro	1	2005
	Romania	7	1991, 1994, 1999, 2000, 2001, 2002
	Serbia	1	2005
Europe, Eastern	Belarus	1	2005
	Moldova	1	2005
	Russian Federation	4	1993, 1995, 2000, 2001
	Ukraine	2	2000, 2002
Europe, Western	Germany	1	2003
	Greece	1	2010
	Italy	3	1973, 1975
	Netherlands	1	1980
	Portugal	2	2001, 2002
	Spain	2	1985, 2000
	United Kingdom	2	1973
Latin America, Andean	Bolivia	10	1977, 1981, 1985, 1989, 1993, 1996, 1998, 2003, 2008
	Ecuador	3	1986, 1998, 2004
	Peru	16	1975, 1984, 1985, 1991, 1996, 2000, 2003, 2004, 2009

Table 1c Cont.

Latin America, Central	Colombia	11	1965, 1977, 1986, 1989, 1995, 2000, 2004, 2009
	Costa Rica	5	1965, 1982, 1996, 2008
	El Salvador	10	1965, 1975, 1988, 1993, 1994, 1998, 2002, 2008
	Guatemala	27	1965, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1983, 1985, 1987, 1988, 1995, 1996, 1998, 2000, 2002, 2006, 2008
	Honduras	14	1965, 1973, 1987, 1991, 1992, 1993, 1996, 2001, 2005
	Mexico	14	1984, 1988, 1989, 1994, 1995, 1996, 1997, 1998, 2002, 2006
	Nicaragua	15	1965, 1966, 1980, 1988, 1990, 1993, 1997, 1998, 2001, 2003, 2006
	Panama	6	1965, 1980, 1992, 1997, 2003
	Venezuela	33	1981, 1985, 1987, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2005, 2007
Latin America, Southern	Argentina	30	1985, 1994, 1995, 2004
	Chile	17	1984, 1985, 1986, 1993, 1994, 1995, 1996, 1998, 1999, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008
	Uruguay	4	1987, 1992, 2002, 2004
Latin America, Tropical	Brazil	32	1973, 1975, 1980, 1981, 1982, 1983, 1984, 1986, 1987, 1988, 1989, 1990, 1991, 1995, 1996, 2006
	Paraguay	3	1990, 2005
North Africa / Middle East	Afghanistan	49	1983, 1990, 1996, 1997, 1999, 2000, 2001, 2002, 2004
	Algeria	10	1987, 1992, 1995, 1997, 2000, 2001, 2002, 2005
	Bahrain	4	1989, 1995
	Egypt	17	1978, 1980, 1988, 1989, 1990, 1991, 1992, 1994, 1995, 1997, 1998, 2000, 2003, 2005, 2008

Table 1c Cont.

	Iran, Islamic Republic of	6	1980, 1982, 1995, 1998, 2002, 2004
	Iraq	51	1991, 1995, 1997, 1998, 1999, 2000, 2002, 2003, 2004, 2006
	Jordan	6	1975, 1990, 1997, 2002, 2007, 2009
	Kuwait	27	1983, 1994, 1995, 1996, 1998, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009
	Lebanon	5	1985, 1996, 1997, 2004, 2005
	Libyan Arab Jamahiriya	3	1995, 2007
	Morocco	5	1987, 1991, 1992, 1996, 2003
	Occupied Palestinian Territory	10	1974, 1975, 1978, 1984, 1990, 1995, 1998, 2003, 2006, 2008
	Oman	6	1991, 1994, 1995, 1999, 2009
	Qatar	1	1995
	Saudi Arabia	6	1979, 1980, 1994, 1996, 2004
	Syrian Arab Republic	9	1993, 1995, 2000, 2001, 2006, 2009
	Tunisia	6	1973, 1988, 1994, 1996, 2000, 2006
	Turkey	4	1993, 1998, 2003, 2008
	United Arab Emirates	1	1995
	Yemen	10	1979, 1982, 1991, 1993, 1996, 1997, 2003, 2005
North America, High Income	Canada	2	1970
	United States	4	1963, 1988, 1999
Oceania	Fiji	2	1993
	Kiribati	1	1985
	Micronesia, Federated States of	1	2000
	Papua New Guinea	7	1969, 1977, 1980, 1982, 1986, 1996, 2005
	Samoa	3	1978, 1999
	Solomon Islands	5	1970, 1980, 1984, 1989, 2006
	Tonga	1	1986

Table 1c Cont.

	Vanuatu	2	1996, 2007
Sub-Saharan Africa, Central	Angola	7	1994, 1995, 1996, 2001, 2007
	Central African Republic	6	1994, 1995, 2000, 2006
	Congo	8	1986, 1987, 1991, 1993, 1996, 2005
	Congo, the Democratic Republic of the	36	1975, 1976, 1979, 1983, 1985, 1986, 1987, 1990, 1991, 1992, 1993, 1994, 1995, 2001, 2007
	Equatorial Guinea	4	1992, 1997, 2000, 2004
	Gabon	2	2000
Sub-Saharan Africa, East	Burundi	11	1979, 1983, 1984, 1985, 1986, 1987, 1994, 1995, 2000, 2005
	Comoros	6	1991, 1995, 1996, 2000, 2004
	Djibouti	8	1989, 1995, 1996, 2002, 2006, 2007
	Eritrea	4	1993, 1994, 1995, 2002
	Ethiopia	12	1980, 1983, 1984, 1989, 1992, 1994, 1997, 2000, 2005, 2010
	Kenya	18	1978, 1982, 1985, 1987, 1993, 1994, 1997, 1998, 2000, 2001, 2003, 2005, 2008
	Madagascar	17	1983, 1985, 1986, 1988, 1992, 1993, 1995, 1997, 2003, 2008
	Malawi	19	1981, 1982, 1983, 1984, 1985, 1992, 1995, 1997, 2000, 2004, 2006, 2009, 2010
	Mozambique	10	1989, 1995, 1997, 2000, 2002, 2003, 2008
	Rwanda	22	1976, 1991, 1992, 1995, 1996, 2000, 2005, 2010
	Somalia	48	1975, 1994, 1995, 1999, 2000, 2001, 2002, 2003, 2006
	Sudan	112	1983, 1986, 1987, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1998, 2000, 2006

Table 1c Cont.

	Tanzania, United Republic of	21	1969, 1985, 1991, 1992, 1993, 1996, 1999, 2004, 2008, 2009
	Uganda	9	1985, 1987, 1988, 1995, 1998, 2000, 2006
	Zambia	8	1970, 1990, 1992, 1996, 1998, 1999, 2001, 2007
Sub-Saharan Africa, Southern	Botswana	10	1978, 1979, 1980, 1981, 1985, 1996, 2000, 2007
	Lesotho	10	1981, 1992, 1993, 1994, 1996, 2000, 2004, 2007, 2009
	Namibia	4	1990, 1992, 2000, 2006
	South Africa	21	1976, 1978, 1979, 1980, 1981, 1984, 1986, 1993, 1994, 1999, 2003, 2008
	Swaziland	4	1983, 2000, 2006, 2008
	Zimbabwe	7	1988, 1994, 1999, 2005, 2009, 2010
Sub-Saharan Africa, West	Benin	7	1989, 1990, 1991, 1996, 2001, 2006
	Burkina Faso	10	1973, 1974, 1992, 1995, 1998, 2003, 2006, 2007, 2009
	Cameroon	8	1977, 1990, 1991, 1998, 2004, 2006
	Cape Verde	16	1983, 1985, 1990, 1994, 2006
	Chad	5	1988, 1995, 1996, 2000, 2004
	Côte d'Ivoire	14	1985, 1986, 1987, 1994, 1995, 1998, 2006, 2007
	Gambia	5	1981, 1982, 2005
	Ghana	9	1987, 1988, 1993, 1998, 2003, 2006, 2008
	Guinea	11	1990, 1994, 1999, 2000, 2005, 2007
	Guinea-Bissau	4	2000, 2006, 2008
	Liberia	5	1976, 1995, 1999, 2006
	Mali	21	1985, 1986, 1987, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 2001, 2006
	Mauritania	11	1983, 1988, 1990, 1995, 1996, 2000, 2007, 2008

Table 1c Cont.

	Niger	19	1980, 1983, 1985, 1986, 1987, 1990, 1992, 1993, 1998, 1999, 2000, 2001, 2003, 2006, 2008
	Nigeria	9	1983, 1986, 1990, 1993, 1999, 2003, 2007, 2008
	Sao Tome and Principe	6	1986, 2000, 2006, 2008
	Senegal	13	1983, 1984, 1986, 1991, 1992, 1996, 2000, 2005
	Sierra Leone	12	1974, 1977, 1989, 1990, 1992, 1995, 2000, 2005, 2008
	Togo	11	1973, 1976, 1988, 1998, 2006, 2008

Table 2. Relative risks used in PAF calculation[9]

Indicator and Disease	IDC-10 Cause	<-3SD (95% CI)	-3 to <-2SD (95% CI)	-2 to <-1 SD (95% CI)	More than -1SD
Weight-for-age					
Intestinal infectious diseases	A04	9.5 (5.5-16.5)	3.4 (2.7-4.4)	2.1 (1.6-2.7)	1.0
Acute respiratory infections	A15	6.4 (3.9-10.4)	1.3 (0.9-2.0)	1.2 (0.7-1.9)	1.0
Malaria	A12	1.6 (1.0-2.7)	1.2 (0.5-3.5)	0.8 (0.2-3.2)	1.0
Measles	A08	6.4 (4.6-9.1)	2.3 (1.7-3.2)	1.3 (1.1-1.5)	1.0
Height-for-age					
Intestinal infectious diseases	A04	4.6 (2.7-8.1)	1.6 (1.1-2.5)	1.2 (0.9-1.7)	1.0
Acute respiratory infections	A15	3.2 (1.5-6.7)	1.3 (0.9-2.1)	1.0 (0.6-1.6)	1.0
Malaria	A12	2.1 (0.9-4.9)	1.0 (0.4-2.4)	0.7 (0.5-0.9)	1.0
Measles	A08	2.8 (1.4-5.8)	1.7 (0.8-3.6)	0.7 (0.5-0.9)	1.0
Weight-for-height					
Intestinal infectious diseases	A04	6.3 (2.7-14.7)	2.9 (1.8-4.5)	1.2 (0.7-1.9)	1.0
Acute respiratory infections	A15	8.7 (4.8-15.6)	4.2 (3.2-5.5)	1.6 (1.1-2.4)	1.0
Malaria	A12	2.3 (1.6-3.2)	3.0 (1.0-8.9)	0.9 (0.3-2.6)	1.0
Measles	A08	6.0 (4.3-8.2)	3.7 (2.5-5.5)	1.8 (0.9-3.6)	1.0

Table 3a: Underweight attributable deaths and DALYs, by region, for 1990, 2005, and 2010

GBD Region	1990 Attributable Deaths (95% CIs)	2005 Attributable Deaths (95% CIs)	2010 Attributable Deaths (95% CIs)	1990 Attributable DALYs (95% CIs)	2005 Attributable DALYs (95% CIs)	2010 Attributable DALYs (95% CIs)
Asia Pacific, High Income	31 (0-83)	2 (0-11)	1 (0-7)	12341 (4021-20619)	5107 (475-9639)	4210 (177-8405)
Asia, Central	19271 (14247-25279)	4412 (3026-6073)	2717 (1606-4120)	1715620 (1279567-2227850)	412388 (295145-552415)	264336 (166568-388248)
Asia, East	111021 (80089-149591)	8849 (6223-12479)	3552 (2114-5256)	10044861 (7310536-13378229)	882750 (643120-1214220)	391876 (232872-614623)
Asia, South	1023214 (833935-1270668)	432051 (350570-538457)	322408 (253439-400797)	91938656 (75157240-113003280)	41338596 (33881592-50618124)	31313714 (24864520-38149008)
Asia, Southeast	196172 (159042-238942)	58877 (46518-73011)	37421 (28736-47601)	17631850 (14464143-21194762)	5684106 (4578307-6933507)	3768119 (2986946-4666275)
Australasia	0 (0-0)	0 (0-0)	0 (0-0)	526 (0-1714)	335 (0-1247)	336 (0-1439)
Caribbean	8470 (6383-11031)	3268 (2573-4101)	2672 (2007-3491)	741714 (560412-963412)	298739 (236111-367947)	245428 (186565-314641)
Europe, Central	941 (629-1321)	73 (6-141)	22 (0-68)	115404 (84410-150927)	28182 (17745-39908)	21322 (11897-32118)
Europe, Eastern	358 (0-826)	44 (0-147)	11 (0-74)	93422 (46509-145278)	38555 (19840-58231)	32227 (13802-53185)
Europe, Western	0 (0-4)	0 (0-0)	0 (0-0)	13955 (0-28126)	11686 (880-23690)	10705 (0-22468)
Latin America, Andean	11976 (9554-14795)	2276 (1755-2911)	1518 (1119-2014)	1036287 (827671-1285755)	201968 (155955-256662)	135466 (100154-179205)
Latin America, Central	27717 (22155-34946)	8429 (6388-10301)	5809 (4306-7305)	2471484 (1983411-3107409)	755332 (576690-921276)	526062 (395105-661236)
Latin America, Southern	782 (456-1159)	157 (79-269)	102 (21-199)	69995 (40731-104112)	14475 (6345-24258)	9046 (303-18474)
Latin America, Tropical	12682 (9050-17519)	2196 (1224-3232)	1040 (483-1724)	1117980 (799755-1538211)	195984 (111470-289958)	93663 (46221-159491)
North Africa / Middle East	99978 (81148-123400)	57626 (45776-71137)	42728 (32128-55100)	8928425 (7286187-10993736)	5275265 (4241414-6438692)	4017132 (3059441-5123277)
North America, High Income	0 (0-0)	0 (0-0)	0 (0-0)	2768 (0-13385)	2099 (0-10621)	1993 (0-10546)
Oceania	3596 (2758-4595)	3159 (2081-4645)	2773 (1669-4234)	317806 (244498-403782)	277194 (185064-403198)	243970 (149545-369546)
Sub-Saharan Africa, Central	144565 (114945-180929)	131495 (97420-172456)	126219 (95175-167285)	12447427 (9904172-15520228)	11513813 (8591638-14974425)	11047369 (8406124-14635393)
Sub-Saharan Africa, East	409227 (334569-502319)	238221 (193544-291820)	184035 (148602-226359)	35408712 (29072310-43291636)	21142730 (17303656-25795536)	16527294 (13419458-20264934)

Table 3a Cont.

Sub-Saharan Africa, Southern	15542 (11909-20110)	9562 (7315-12229)	9944 (7493-13088)	1391529 (1062501-1778561)	871594 (673984-1107017)	898198 (686581-1174562)
Sub-Saharan Africa, West	470681 (373287-582530)	366001 (266711-488774)	304282 (224527-415445)	40631736 (32253310-50180992)	32171180 (23603360-42871800)	27009334 (20041182-36605704)

Table 3b: Stunting attributable deaths and DALYs, by region for 1990, 2005, and 2010

GBD Region	1990 Attributable Deaths (95% CIs)	2005 Attributable Deaths (95% CIs)	2010 Attributable Deaths (95% CIs)	1990 Attributable DALYs (95% CIs)	2005 Attributable DALYs (95% CIs)	2010 Attributable DALYs (95% CIs)
Asia Pacific, High Income	226 (166-303)	49 (34-68)	32 (21-46)	38737 (29420-49609)	16068 (11407-22132)	13398 (9461-18635)
Asia, Central	38651 (32348-45075)	12687 (10358-15199)	9275 (7021-11913)	3389003 (2839810-3946716)	1134041 (931775-1352811)	841155 (645826-1075023)
Asia, East	186856 (147667-237471)	22524 (17142-30556)	10767 (7427-15260)	16782578 (13270625-21070238)	2194486 (1695233-2891464)	1124624 (793721-1549984)
Asia, South	1107389 (907086-1370504)	478620 (385910-596366)	371002 (292031-460400)	99215128 (81249208-121720352)	45456460 (37283676-55424660)	35665004 (28287390-43475832)
Asia, Southeast	235316 (194170-283355)	76168 (60406-92118)	51506 (39636-64671)	21035450 (17413554-25117494)	7228555 (5813302-8695874)	5050024 (3993447-6178407)
Australasia	7 (3-12)	3 (1-5)	2 (1-4)	2512 (1426-3979)	1773 (944-2829)	1737 (947-2821)
Caribbean	11556 (8813-14686)	4397 (3475-5404)	3680 (2859-4709)	1011841 (778161-1279899)	402234 (320334-488849)	339021 (267149-428191)
Europe, Central	2801 (2197-3476)	550 (410-710)	367 (270-486)	284893 (231111-345785)	74681 (59815-90593)	56713 (44866-69992)
Europe, Eastern	5241 (3783-6925)	1105 (745-1563)	849 (572-1239)	546383 (411941-695731)	145988 (108171-194696)	124203 (92536-166768)
Europe, Western	147 (106-193)	31 (22-43)	24 (17-34)	45801 (34150-59923)	27884 (19334-38696)	26420 (18130-36623)
Latin America, Andean	25814 (21160-30637)	6649 (5310-8172)	4874 (3827-6076)	2239059 (1834660-2654205)	600051 (479318-733531)	445894 (353240-554026)
Latin America, Central	46304 (37790-55292)	16166 (12868-19112)	11591 (9343-13983)	4119753 (3361228-4908385)	1483537 (1195706-1759645)	1086452 (877924-1308365)
Latin America, Southern	1722 (1332-2160)	402 (295-557)	312 (213-460)	159087 (124631-198772)	40958 (29828-55030)	32286 (22406-45673)
Latin America, Tropical	31282 (24018-39361)	5168 (3808-6669)	2903 (2089-3855)	2765138 (2138802-3466916)	483489 (362958-621919)	282661 (205501-375425)
North Africa / Middle East	152798 (126703-183605)	80199 (66153-95621)	60185 (47129-73893)	13553095 (11268142-16266608)	7312682 (6075920-8635617)	5627871 (4463287-6860732)
North America, High Income	121 (76-178)	79 (46-120)	64 (37-101)	41410 (28543-57402)	30253 (20316-43461)	28798 (18718-42203)
Oceania	4693 (3657-5920)	4680 (3177-6814)	4249 (2736-6365)	413019 (322746-517053)	410244 (281773-590169)	373459 (243230-556788)
Sub-Saharan Africa, Central	176854 (142863-217731)	167450 (129194-210977)	161347 (126139-206542)	15220750 (12352628-18643044)	14628863 (11252326-18378234)	14104885 (11082086-17994952)

Table 3b Cont.

Sub-Saharan Africa, East	518921 (433331-624280)	320698 (265133-378920)	257803 (209996-308613)	44829220 (37493540-53795676)	28343500 (23516598-33299462)	23029372 (18906650-27475314)
Sub-Saharan Africa, Southern	27664 (22129-33881)	18623 (14840-23143)	20313 (15781-25403)	2450809 (1968088-2985460)	1668549 (1338052-2054178)	1806259 (1408885-2247082)
Sub-Saharan Africa, West	575122 (467320-697138)	472137 (356628-611096)	397931 (301545-526985)	49571428 (40444696-59861060)	41346496 (31502044-53213664)	35165844 (26794832-46239444)

Table 3c: Wasting attributable deaths and DALYs, by region, for 1990, 2005, and 2010

GBD Region	1990 Attributable Deaths (95% CIs)	2005 Attributable Deaths (95% CIs)	2010 Attributable Deaths (95% CIs)	1990 Attributable DALYs (95% CIs)	2005 Attributable DALYs (95% CIs)	2010 Attributable DALYs (95% CIs)
Asia Pacific, High Income	42 (28-59)	11 (8-15)	7 (5-11)	13456 (9466-18669)	7721 (5072-11289)	6777 (4470-10159)
Asia, Central	14084 (8397-20893)	4227 (2388-6425)	2741 (1161-4745)	1269181 (780781-1848951)	396171 (231214-583256)	266336 (130823-447162)
Asia, East	54892 (31170-86553)	4344 (2393-7356)	1960 (1137-3596)	5081721 (3001965-7920009)	460376 (272196-740603)	236285 (126629-445703)
Asia, South	721149 (552853-921768)	314642 (239147-403408)	233256 (171857-309882)	65576540 (50901072-83028520)	30822150 (24020488-38646740)	23245476 (17422578-29998486)
Asia, Southeast	114120 (85655-147528)	35703 (25504-48308)	22983 (15930-32464)	10469091 (8000525-13305435)	3616471 (2721474-4716243)	2455741 (1775134-3287083)
Australasia	1 (1-2)	1 (1-1)	1 (0-1)	1420 (753-2569)	1178 (630-2073)	1232 (646-2188)
Caribbean	4254 (2683-6427)	2585 (1831-3419)	2129 (1391-2957)	375097 (239355-565178)	237249 (172581-308438)	196200 (132784-270472)
Europe, Central	824 (458-1330)	133 (55-240)	75 (31-151)	107011 (70887-150385)	34868 (23149-48255)	28002 (18521-40124)
Europe, Eastern	1100 (511-1854)	271 (131-459)	178 (79-321)	162467 (99217-235860)	62215 (41348-86132)	53414 (35442-74271)
Europe, Western	53 (38-67)	18 (14-23)	15 (11-20)	29755 (20858-41173)	22966 (15380-32473)	22238 (14985-32135)
Latin America, Andean	4968 (3521-6733)	1126 (783-1555)	828 (560-1219)	426896 (303958-578560)	97873 (68270-134570)	71890 (48897-105147)
Latin America, Central	14596 (10326-20589)	4125 (2589-5377)	2931 (1707-3924)	1318378 (944693-1838430)	368806 (236301-481668)	264434 (164114-351141)
Latin America, Southern	732 (471-1022)	165 (110-272)	125 (72-214)	65350 (43035-91687)	15457 (10429-24822)	11702 (6907-19480)
Latin America, Tropical	6371 (4040-10467)	1966 (1071-2934)	1071 (582-1765)	559975 (355971-929991)	173559 (96121-258381)	96381 (54047-160455)
North Africa / Middle East	65036 (48890-86966)	35303 (26135-46752)	26370 (18165-35403)	5872716 (4453007-7761419)	3333436 (2530748-4362130)	2584892 (1845426-3364206)
North America, High Income	21 (15-32)	20 (13-28)	17 (11-24)	17665 (11358-26438)	14104 (9342-20939)	14113 (8956-21071)
Oceania	2306 (1616-3134)	1570 (824-2621)	1458 (691-2569)	205622 (146160-276964)	138548 (73608-226805)	128912 (63087-223411)
Sub-Saharan Africa, Central	93102 (71622-118911)	97265 (73131-128285)	98331 (73375-130036)	8018404 (6208237-10228014)	8539526 (6481075-11195696)	8612222 (6503243-11354701)
Sub-Saharan Africa, East	245829 (198304-305761)	150581 (121641-183431)	116778 (92678-143502)	21352576 (17270788-26477582)	13488793 (11018476-16336193)	10605337 (8499560-12882145)
Sub-Saharan Africa, Southern	11906 (7891-17037)	6448 (4359-9366)	5942 (3672-9159)	1073376 (720808-1516041)	597845 (411842-848922)	548399 (349479-824776)

Table 3c Cont.

Sub-Saharan Africa, West	320177 (246489-405618)	270168 (205367-360109)	231071 (171812-311336)	27698490 (21349444-35019704)	23864956 (18265114-31792904)	20620748 (15674448-27653376)

Table 4a: 1980 top 10 highest attributable deaths due to malnutrition, by indicator

Underweight Ranking	Underweight Attributable Deaths (95% CIs)	Stunting Ranking	Stunting Attributable Deaths (95% CIs)	Wasting Ranking	Wasting Attributable Deaths (95% CIs)
India	1053866 (806054-1364457)	India	1111725 (851004-1434298)	India	773155 (556863-1059685)
China	218736 (158728-295971)	China	291490 (219873-380796)	Nigeria	154682 (107738-207421)
Nigeria	196571 (144189-256234)	Nigeria	244431 (186735-312317)	China	107233 (59711-167423)
Bangladesh	176179 (137463-227096)	Indonesia	194889 (147496-252527)	Bangladesh	104711 (73700-142522)
Indonesia	171030 (128801-222962)	Bangladesh	183059 (142227-235416)	Indonesia	100605 (68103-140363)
Ethiopia	118077 (84065-163478)	Ethiopia	137531 (98222-189131)	Ethiopia	66944 (45054-96046)
Pakistan	102144 (75622-133361)	Pakistan	117110 (86909-152871)	Pakistan	65474 (43420-90659)
Congo, the Democratic Republic of the	74118 (55654-95103)	Egypt	95718 (70825-124607)	Congo, the Democratic Republic of the	48178 (34349-64881)
Egypt	51854 (33921-74885)	Congo, the Democratic Republic of the	91263 (70451-115197)	Sudan	29012 (20247-38736)
Tanzania, United Republic of	45559 (35252-57711)	Brazil	82088 (63480-104709)	Myanmar	28910 (20533-38321)

Table 4b: 2011 top 10 highest attributable deaths due to malnutrition, by indicator

Underweight Ranking	Underweight Attributable Deaths (95% CIs)	Stunting Ranking	Stunting Attributable Deaths (95% CIs)	Wasting Ranking	Wasting Attributable Deaths (95% CIs)
India	225684 (169807-293569)	India	256795 (193061-328794)	India	167686 (114566-233683)
Nigeria	142687 (95450-211732)	Nigeria	191439 (132697-275584)	Nigeria	115993 (74058-171526)
Congo, the Democratic Republic of the	101346 (74062-138631)	Congo, the Democratic Republic of the	127579 (95096-168375)	Congo, the Democratic Republic of the	79687 (56380-107633)
Pakistan	53882 (40452-70892)	Pakistan	68450 (52067-87257)	Pakistan	36123 (22755-54624)
Ethiopia	38965 (29908-50460)	Ethiopia	48256 (37818-60786)	Ethiopia	24178 (16591-33350)
Niger	31009 (22765-41125)	Niger	36936 (27537-47079)	Niger	20206 (13754-28231)
Burkina Faso	26781 (18585-37677)	Tanzania, United Republic of	33393 (23700-44473)	Burkina Faso	20003 (13401-29821)
Afghanistan	25859 (17155-35904)	Afghanistan	32943 (23401-44295)	Sudan	18796 (12740-26991)
Sudan	22429 (15903-31449)	Burkina Faso	32138 (22923-43362)	Chad	16030 (10131-22837)
Chad	21024 (14997-28237)	Sudan	26312 (19178-36231)	Mali	14461 (8673-22208)

Table 5a: Top 10 countries with the largest absolute decrease in percent of deaths among children age 1-59 months due to each indicator of malnutrition from 1980 to 2011

Underweight Ranking	Underweight Absolute Decrease	Stunting Ranking	Stunting Absolute Decrease	Wasting Ranking	Wasting Absolute Decrease
China	.433 (.324-.537)	China	.383 (.294-.464)	Myanmar	.266 (.166-.371)
Malaysia	.323 (.252-.39)	Iran, Islamic Republic of	.276 (.153-.394)	Bosnia and Herzegovina	.224 (.145-.317)
Uzbekistan	.301 (.126-.469)	Brazil	.26 (.151-.36)	China	.205 (.102-.327)
Iran, Islamic Republic of	.3 (.136-.457)	Mauritius	.258 (.176-.347)	Uzbekistan	.197 (-.035-.425)
Mauritius	.284 (.205-.367)	Chile	.249 (.175-.338)	Benin	.171 (.035-.3)
Bosnia and Herzegovina	.272 (.184-.372)	Sri Lanka	.248 (.172-.319)	Malaysia	.148 (.03-.261)
Turkey	.27 (.133-.414)	Bosnia and Herzegovina	.236 (.127-.342)	Botswana	.142 (-.018-.29)
Indonesia	.267 (.185-.34)	Malaysia	.218 (.143-.294)	Mauritius	.141 (.021-.258)
Botswana	.243 (.141-.343)	Oman	.213 (.087-.334)	Tanzania, United Republic of	.133 (.029-.243)
Bhutan	.241 (.143-.321)	Jordan	.213 (.118-.317)	Iran, Islamic Republic of	.132 (-.046-.293)

Table 5b: Top 10 countries with the largest absolute decrease in percent of DALYs among children age 1-59 months due to each indicator of malnutrition from 1990 to 2010

Underweight Ranking	Underweight Absolute Decrease	Stunting Ranking	Stunting Absolute Decrease	Wasting Ranking	Wasting Absolute Decrease
Iran, Islamic Republic of	.273 (.107-.433)	China	.305 (.214-.39)	Uzbekistan	.167 (-.051-.396)
China	.27 (.178-.365)	Iran, Islamic Republic of	.273 (.141-.387)	Iran, Islamic Republic of	.163 (-.013-.325)
Uzbekistan	.238 (.07-.405)	Oman	.202 (.062-.316)	Benin	.145 (.015-.264)
Turkey	.198 (.093-.313)	Brazil	.182 (.089-.262)	South Africa	.143 (.003-.273)
Mexico	.192 (.115-.284)	Mauritania	.164 (.084-.245)	Botswana	.132 (-.03-.299)
Angola	.19 (.071-.306)	Turkey	.159 (.054-.256)	Mozambique	.126 (.04-.22)
Mauritania	.187 (.1-.271)	Kuwait	.157 (.063-.255)	China	.125 (.037-.224)
Oman	.186 (.021-.329)	Chile	.157 (.103-.219)	Mexico	.122 (.032-.223)
Indonesia	.176 (.101-.252)	Angola	.153 (.067-.249)	Lesotho	.108 (-.002-.22)
Bhutan	.175 (.096-.239)	Argentina	.146 (.056-.236)	Papua New Guinea	.107 (-.011-.201)

Appendix

Data Sources and Adjustments

Details on Data Sources

Data for this analysis consist of both prevalence estimates from an analysis of survey microdata and from tabulated data sources where microdata were unavailable. The database includes both nationally-representative and sub-national estimates. Survey datasets analyzed include Reproductive and Health Surveys (RHS),[19] Multiple Indicator Cluster Surveys (MICS),[20] Demographic and Health Surveys (DHS),[21] Living Standards Measurement Surveys (LSMS),[22] Anthropometric and Nutritional Indicators Survey 1&2 (ANIS1&2) from Iran,[23] China Health and Nutrition Survey (CHNS),[24] the Mexican Family Life Survey (MxFLS),[25] and the Zambia Living Conditions Monitoring Survey (LCMS).[26] Tabulated data were from databases from UNICEF,[27] the United Nations (UN) Statistics Division,[28] and the WHO Global Database on Child Growth and Malnutrition.[29,30]

Growth Standard Adjustment

Tabulated data sources report the fraction of the population less than 2 standard deviations below the median (-2SD) of the growth standard curve. Many of the tabulated data sources are based on the 1978 NCHS/WHO Growth Standards. Because malnutrition prevalence calculated using the 1978 NCHS/WHO Growth Standards is not equivalent to malnutrition prevalence calculated using the 2006 WHO Child Growth Standards, we developed a methodology to crosswalk malnutrition prevalence estimates based on the old standards to estimates based on the new

standards. Similar to the methodology of Yang et al,[31] we used microdata from 216 DHS, MICS, and RHS to calculate malnutrition prevalence for each survey using both the old and new growth standards. We regressed each survey's logit-transformed malnutrition prevalence as calculated using the old standards against the corresponding logit-transformed malnutrition prevalence as calculated using the new standards. We applied the coefficient and constant from this regression to the tabulated old-standard data to make it comparable to the new-standard data.

Age Group Adjustment

Much of the tabulated data that were available on malnutrition prevalence estimates are reported for varying age ranges (for example, studies that measured malnutrition in only those aged 3 to 36 months). As malnutrition prevalence varies by age, we adjusted data reported for different age groups so that they would be comparable to estimates for the 0 to 59 month age group. Using 85 DHS surveys that contained anthropometric measurements for children in the full 0-59 age group, we calculated malnutrition prevalence for each of the different age groups of children reported in the tabulated data. We then used factor analysis to inform our grouping of malnutrition prevalence estimates of different aged children into three larger groups. These groupings were then used as dummy variables in a robust linear regression model (see *Robust Linear Regression* section for details) to adjust their values, with the age group category containing the 0-59 prevalence estimates serving as the absorbed category. In order to adjust the data in the unabsorbed age group categories to the level of the 0-59 group, we added the coefficient on each dummy variable to the corresponding data points. These age-group-adjusted data were used for the remainder of the analysis.

Methods Used in Generation of Prevalence Time Series

In order to generate the complete time series of prevalence of each of the malnutrition indicators, we employed a three-step process that mirrors previous methods.[32-34] The same process was applied to underweight, wasting, and stunting; to avoid repetition we only describe the procedure for underweight.

Robust Linear Regression

The first step is a robust linear regression of logit-transformed underweight prevalence. We used the following predictor variables: 1) mean years of education of women of reproductive age;[35] 2) log-transformed lagged-distributed income (a smoothed measure of gross domestic product);[36] and 3) total caloric availability (kilocalories per capita) from the Food Balance Sheets of the Food and Agriculture Organization.[37] The model is as follows:

$$\text{Underweight -2SD Prevalence}_{i,t} \sim \beta_0 + \beta_1 \text{Edu}_{i,t} + \beta_2 \text{lnLDI}_{i,t} + \beta_3 \text{Caloric}_{i,t} + \varepsilon$$

Spatial-Temporal Regression

Given that not all the variation in malnutrition prevalence is explained by the covariates above, we employed a second step, which is a spatial-temporal regression. Using the residuals from the result of the predictions of the robust linear regression, we performed a locally-weighted regression that allows residuals nearby in space (based on GBD regions) and time to have more weight than those farther away. In order to prevent subnational data from unduly influencing the national trends, we down-weighted the total contribution in a country of any non-nationally-representative data points to 10% while the contribution of nationally-representative data

comprised the remaining 90%. The predicted residuals are added on to the predictions from the robust linear regression.

Gaussian Process Regression

The final step of the generation of the time series is a Gaussian Process Regression (GPR). It uses the results from the spatial-temporal regression as the mean function and draws from a multinomial distribution, based on the uncertainty in the data and in the prior, to generate 1000 draws of a posterior distribution from which we calculate the final mean and confidence interval estimates.