2. Malnutrition and changing food systems

The multiple burdens of malnutrition – undernourishment and undernutrition, micronutrient deficiencies, and overweight and obesity – impose high and, in some cases, rising economic and social costs in countries at all income levels. Different types of malnutrition may coexist within the same country, household or individual, and their prevalence is changing rapidly along with changes in food systems. The often confusing terminology used to describe malnutrition is it itself a reflection of the complex, multidimensional, dynamic nature of the problem and the policy challenges associated with it.

Malnutrition concepts, trends and costs

Malnutrition is an abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of the macronutrients that provide dietary energy (carbohydrates, protein and fats) and the micronutrients (vitamins and minerals) that are essential for physical and cognitive growth and development (FAO, 2011c). Good nutrition both depends on and contributes to good health.

Undernourishment and undernutrition

Undernourishment refers to food *intake* that is insufficient to meet dietary energy requirements for an active and healthy life. Undernourishment, or hunger, is estimated by FAO as the prevalence and number of people whose food intake is insufficient to meet their requirements on a continuous basis; dietary energy supply is used as a proxy for food intake. Since 1990–92, the estimated number of undernourished people in developing countries has declined from 980 million to 852 million and the prevalence of undernourishment has declined from 23 percent to 15 percent (FAO, IFAD and WFP, 2012).

Undernutrition is the *outcome* of insufficient food intake and repeated infections (UNSCN, 2010). Undernutrition or underweight in adults is measured by the body mass index (BMI), with individuals with a BMI of 18.5 or less considered to be underweight.[8]

Measures of undernutrition are more widely available for children: underweight (being too thin for one's age), wasting (being too thin for one's height) and stunting (being too short for one's age). This report uses stunting in children under the age of five as the primary indicator of undernutrition because stunting captures the effects of long-term deprivation and disease and is a powerful predictor of the life-long burden of undernutrition (Victora *et al.*, 2008).

Stunting is caused by long-term inadequate dietary intake and continuing bouts of infection and disease, often beginning with maternal malnutrition, which leads to poor foetal growth, low birth weight and poor growth. Stunting causes permanent impairment to cognitive and physical development that can lower educational attainment and reduce adult income. Between 1990 and 2011, the prevalence of stunting in developing countries declined by an estimated 16.6 percentage points, from 44.6 percent to 28 percent. There are 160 million stunted children in developing countries today, compared with 248 million in 1990 (UNICEF, WHO and The World Bank, 2012). Country-level malnutrition data mask considerable socio-economic or regional differences within countries. Although data are limited, a stark division between rural and urban areas in the burden of undernutrition is apparent in many countries (Box 3).

[8] The BMI equals the body weight in kilograms divided by height in metres squared (kg/m^2) and is commonly measured in adults to assess underweight, overweight and obesity. The international references are as follows: underweight = BMI < 18.5; overweight = BMI ≥ 25; obese = BMI ≥ 30. Obesity is thus a subset of the overweight category.

BOX 3
The urban–rural malnutrition divide

Available cross-country evidence on child nutritional status consistently shows that, on average, children in urban areas are better nourished than children in rural areas (Smith, Ruel and Ndiaye, 2005; Van de Poel, O'Donnell and Van Doorslaer, 2007). The most recent data compiled by UNICEF (2013) shows that in 82 out of 95 developing countries for which data are available the prevalence of child underweight is higher in rural areas than in urban areas.

Evidence from India indicates that the rural–urban divide may also hold for adults. Guha-Khasnobis and James (2010) found a prevalence of adult underweight of around 23 percent in the slum areas of eight Indian cities, while the prevalence in rural areas in the same states was close to 40 percent. Headey, Chiu and Kadiyala (2011) argue that the combination of laborious farm employment and weaker access to education and health services jointly contribute to rural adult nutrition indicators being substantially worse than those of urban slum populations.

The socio-economic determinants of child nutritional status, such as maternal education and status within the family, are generally consistent between urban and rural areas, but the levels of these determinants often differ markedly between urban and rural areas. Urban mothers have approximately twice as much education and considerably higher decision-making power than their rural counterparts (Garrett and Ruel, 1999; Menon, Ruel and Morris, 2000).

Other evidence supporting the advantage of urban children over their rural counterparts is provided by country-level analyses. They show that urban children tend to have better access to health services, which in turn is reflected by higher immunization rates (Ruel *et al.*, 1998). Urban households are also more likely to have access to water and sanitation facilities, although they may come at high cost, especially for the poor (World Resources Institute, 1996). Finally, except for breastfeeding practices, which are more likely to be optimal among rural mothers, children's diets in urban areas are generally more diverse and more likely to include nutrient-rich foods such as meat, dairy products and fresh fruits and vegetables (Ruel, 2000; Arimond and Ruel, 2002). Examples from IFPRI's analysis of 11 demographic and health surveys show the consistently higher intake of milk and meat products by toddlers in urban areas compared with rural areas (Arimond and Ruel, 2004).

Thus, the lower prevalence of undernutrition among children in urban areas appears to be the result of the cumulative effect of a series of more favourable socio-economic conditions, which in turn lead to a healthier environment and better feeding and caring practices for children.

Micronutrient deficiencies

Micronutrient malnutrition is defined as being deficient in one or more vitamins and minerals of importance for human health. It is an *outcome* of inappropriate dietary composition and disease. It is technically a form of undernutrition (UNSCN, 2010), but is often referred to separately because it can coexist with adequate or excessive consumption of macronutrients and carries health consequences that are distinct from those associated with stunting.

Several micronutrients have been identified as being important for human health, but most of these are not widely measured. Three of the most commonly measured micronutrient deficiencies and related disorders refer to vitamin A, anaemia (related to iron) and iodine (Figure 2 and Annex table). Other micronutrients, such as zinc, selenium and vitamin B_{12}, are also important for health, but comprehensive data do not exist to provide global estimates of deficiencies in these micronutrients. This report also tends to report micronutrient deficiencies among children, again because data across countries are more consistently available for children than for adults.

Deficiency in vitamin A impairs normal functioning of the visual system and maintenance of cell function for growth, red blood cell production, immunity and reproduction (WHO, 2009). Vitamin A deficiency is the leading cause of blindness in children. In 2007, 163 million children under five in developing countries were estimated to be vitamin A deficient, with a prevalence of about 31 percent, down from approximately 36 percent in 1990 (UNSCN, 2010).[9]

Iron is important for red blood cell production. A deficiency in iron intake leads to anaemia (other factors also contribute to anaemia, but iron deficiency is the main cause). Iron-deficiency anaemia negatively affects the cognitive development of children, pregnancy outcomes, maternal mortality and the work capacity of adults. Estimates indicate modest progress overall in reducing iron-deficiency anaemia among children under five and pregnant and non-pregnant women (UNSCN, 2010).

Iodine deficiency impairs the mental function of 18 million children born each year. Overall, iodine deficiency – as measured by both total goitre rate and low urinary iodine – is falling. Estimates indicate that goitre prevalence (indicative of an extended period of deprivation, assessed in adults and/or children) in developing countries fell from around 16 percent to 13 percent between 1995–2000 and 2001–07 (regional averages shown for only two time periods in Figure 2 due to data limitations). Low urinary iodine (indicative of a current iodine deficiency) fell from around 37 percent to 33 percent (UNSCN, 2010).[10]

Despite considerable variation at country level (see Annex table), a number of regional and subregional trends and patterns in stunting and micronutrient deficiencies are discernible, as shown in Figure 2 and the Annex table.[11] In general, sub-Saharan Africa and Southern Asia have high levels of stunting and micronutrient deficiencies, with relatively modest improvements over the last two decades. Prevalence rates for stunting and micronutrient deficiencies are relatively low in Latin America and the Caribbean. In terms of numbers, most of the severely affected population lives in Asia, but with wide subregional variation.

Overweight and obesity

Overweight and obesity, defined as abnormal or excessive fat accumulation that may impair health (WHO, 2013a), are most commonly measured using BMI (see footnote 8 and Box 4). A high body mass index is recognized as increasing the likelihood of incurring various non-communicable diseases and health problems, including cardiovascular disease, diabetes, various cancers and osteoarthritis (WHO, 2011a). The health risks associated with overweight and obesity increase with the degree of excess body fat.

The global prevalence of combined overweight and obesity has risen in all regions, with prevalence among adults increasing from 24 percent to 34 percent between 1980 and 2008. The prevalence of obesity has increased even faster, doubling from 6 percent to 12 percent. (Figure 3) (Stevens *et al*., 2012).

The prevalence of overweight and obesity is increasing in nearly all countries, even in low-income countries where it coexists with high rates of undernutrition and micronutrient deficiencies. Stevens *et al.* (2012) found that, in 2008, Central and South America, North Africa and the Middle East, Northern America and Southern Africa were the subregions with the highest prevalence of obesity (ranging from 27 percent to 31 percent).

Social and economic costs of malnutrition

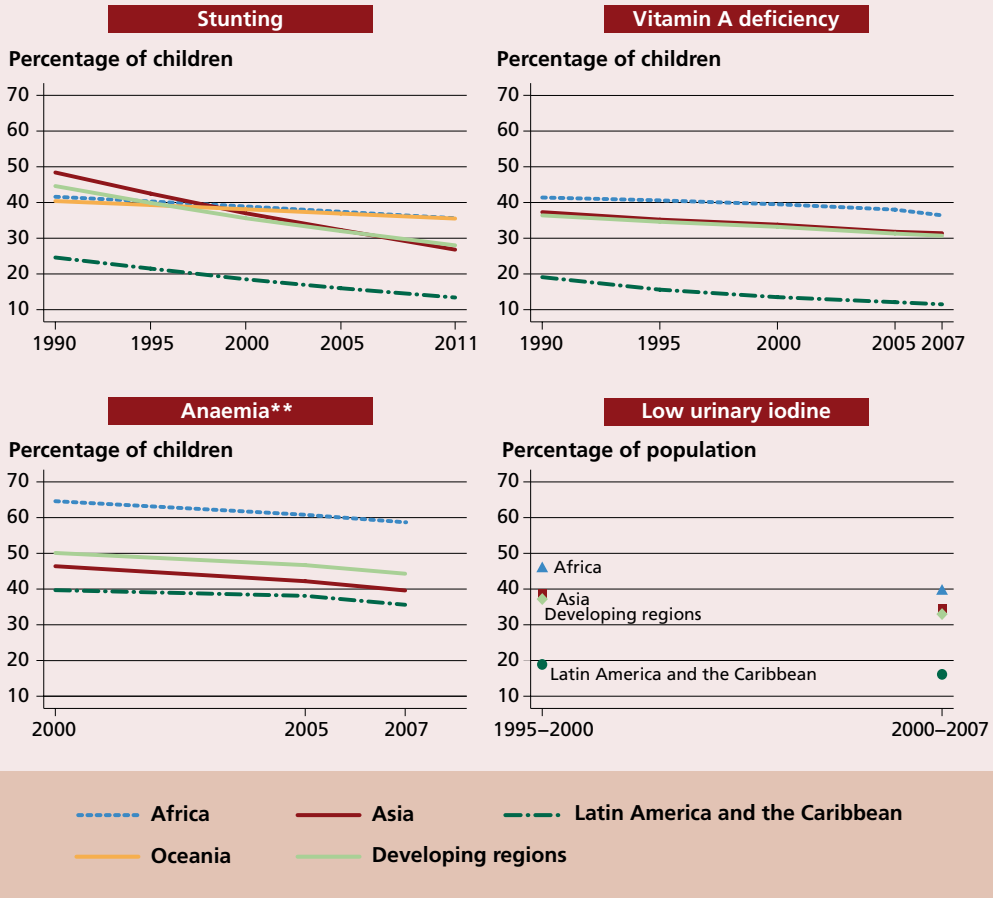
The social and economic costs of malnutrition can be quantified in different ways, although any methodology has limitations. Disability-adjusted life years (DALYs) measure the social burden of disease, or the health gap

[9] The UNSCN (2010) estimates of the prevalence of vitamin A, iodine and anaemia deficiencies at the world, developing region and regional levels presented in Figure 2 are slightly different from those presented in the Annex table. The latter are calculated using weighted averages of the country prevalences reported in the Micronutrient Initiative (2009) report.

[10] Both sets of estimates are based on multivariate models applied to all countries for those time periods. The estimates are not very different from those obtained by simply averaging over the available surveys (UNSCN, 2010).

[11] Regional groupings follow the M49 UN classification. For more details, see Statistical annex.

FIGURE 2
Prevalence of stunting, anaemia and micronutrient deficiencies among children,* by developing region



Notes: *Data for stunting, vitamin A deficiency and anaemia data refer to children under five years of age; data for low urinary iodine refer to the entire population.
**Anaemia is caused by several conditions, including iron deficiency.
Sources: Authors' compilation using data on stunting from UNICEF, WHO and The World Bank, 2012 (see also the Annex table of this report), and data on vitamin A deficiency, anaemia and low urinary iodine from UNSCN, 2010.

between current health status and an ideal situation where everyone lives into old age, free of disease and disability (WHO, 2008a). One DALY represents the loss of the equivalent of one full year of "healthy" life.

DALYs are used in a number of ways in making health policy decisions, including identifying national disease control priorities and allocating time for health practitioners and resources across health interventions and R&D (World Bank, 2006b). Because the DALY framework takes into account the interrelationships between nutrition, health and well-being (Stein *et al.*, 2005), it can also be used in economic analyses and assessments of the cost-effectiveness of health and nutrition interventions to assess the relative progress of health policies across countries (Robberstadt, 2005; Suárez, 2011).

The most recent work on the global burden of disease shows that child and maternal malnutrition still imposes by far the largest nutrition-related health burden globally, with more than 166 million DALYs lost per year in 2010 compared with 94 million DALYs lost due to adult overweight and obesity (Table 1). Worldwide, DALYs attributed to high BMI (overweight and obesity) and related risk factors, such as diabetes and high blood pressure, have increased dramatically, while those attributed to child and maternal malnutrition have decreased. However, in most of sub-Saharan Africa, child underweight remains

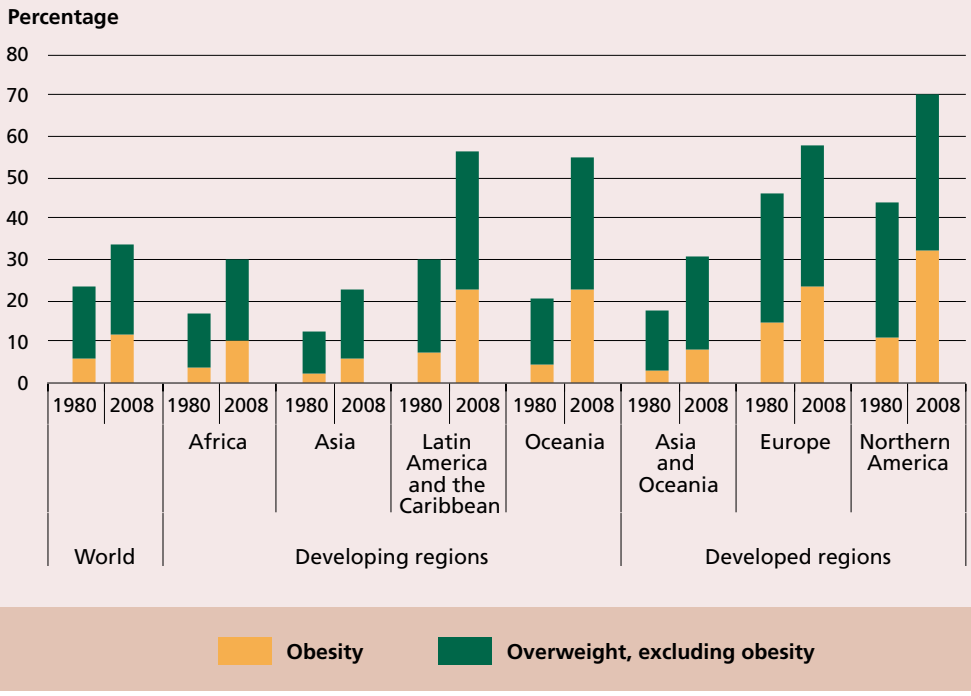
BOX 4
Limitations of using the body mass index in measuring excessive body fat

Body mass index (BMI) is a convenient and widely available measure of underweight, overweight and obesity. It is a proxy measure of excessive body fat. BMI does not distinguish between weight from fatty tissue and that from muscle tissue; nor does it indicate how an individual's body mass is distributed. People who carry a disproportionate amount of weight around their abdomen are at a higher risk of various health problems; waist circumference can therefore be a useful measure to gain additional insight, but it is measured less often and less easily than BMI (National Obesity Observatory, 2009).

BMI classifications were established based on risks of type 2 diabetes and cardiovascular disease, but populations and individuals vary in terms of how BMI relates to both body fat composition and the prevalence of disease (WHO, 2000).

The limitations of the international BMI classifications are particularly evident among Asian populations. For example, in 2002 an expert group, convened by the World Health Organization (WHO), found that the Asian populations considered have a higher percentage of body fat as well as higher incidence of diabetes and cardiovascular disease at lower BMIs than do Caucasians (controlling for age and sex). However, the experts also found differences in the appropriate BMI cut-off points among the Asian populations themselves. The expert group decided to maintain the existing international standard classifications, but also recommended the development of an additional classification system for Asian populations that uses lower cut-offs and encouraged the use of country-specific cut-offs and the waist circumference measure (Nishida, 2004).

FIGURE 3
Prevalence of overweight and obesity among adults, by region



Sources: Authors' calculations using data presented in Finucane *et al.,* 2011 and Stevens *et al.,* 2012.

TABLE 1

Disability-adjusted life years in 1990 and 2010, by malnutrition-related risk factor, population group and region

REGION	CHILD AND MATERNAL MALNUTRITION		UNDERWEIGHT				OVERWEIGHT AND OBESITY			
	Total DALYs *(Thousands)*		Total DALYs *(Thousands)*		DALYS per 1 000 population *(Number)*		Total DALYs *(Thousands)*		DALYs per 1 000 population *(Number)*	
	1990	2010	1990	2010	1990	2010	1990	2010	1990	2010
World	**339 951**	**166 147**	**197 774**	**77 346**	**313**	**121**	**51 613**	**93 840**	**20**	**25**
Developed regions	**2 243**	**1 731**	**160**	**51**	**2**	**1**	**29 956**	**37 959**	**41**	**44**
Developing regions	**337 708**	**164 416**	**197 614**	**77 294**	**356**	**135**	**21 657**	**55 882**	**12**	**19**
Africa	**121 492**	**78 017**	**76 983**	**43 990**	**694**	**278**	**3 571**	**9 605**	**15**	**24**
Eastern Africa	42 123	21 485	27 702	11 148	779	205	353	1 231	5	11
Middle Africa	18 445	17 870	12 402	11 152	890	488	157	572	6	13
Northern Africa	10 839	4 740	4 860	1 612	216	68	2 030	4 773	36	47
Southern Africa	2 680	1 814	930	382	155	63	620	1 442	36	51
Western Africa	47 405	32 108	31 089	19 696	947	383	412	1 588	6	14
Asia	**197 888**	**80 070**	**115 049**	**32 210**	**297**	**90**	**12 955**	**34 551**	**9**	**16**
Central Asia	3 182	1 264	967	169	133	27	953	1 709	43	57
Eastern Asia	21 498	4 645	6 715	347	53	4	5 427	13 331	9	14
Southern Asia	138 946	60 582	89 609	27 325	514	150	2 953	9 281	6	11
South-Eastern Asia	27 971	9 736	15 490	3 318	270	61	1 045	5 032	5	16
Western Asia	6 291	3 843	2 269	1 051	104	41	2 577	5 198	42	45
Latin America and the Caribbean	**17 821**	**6 043**	**5 292**	**979**	**94**	**18**	**5 062**	**11 449**	**26**	**36**
Caribbean	2 559	1 073	849	252	204	67	401	854	25	38
Central America	5 437	1 491	2 124	366	133	22	1 228	3 309	28	42
South America	9 826	3 479	2 319	361	64	11	3 433	7 286	25	34
Oceania	**507**	**286**	**290**	**115**	**302**	**87**	**69**	**276**	**30**	**67**

Notes: DALY (disability-adjusted life year) estimates for child and maternal malnutrition include factors such as child underweight, iron deficiency, vitamin A deficiency, zinc deficiency and suboptimal breastfeeding. They also include maternal haemorrhage and maternal sepsis and iron-deficiency anaemia among women. Estimates for overweight and obesity refer to adults aged 25 and older.
Source: Compiled by the Institute for Health Metrics and Evaluation using data presented in Lim *et al.*, 2012 from the Global Burden of Disease Study 2010.

the leading risk factor underlying the disease burden (Lim *et al.*, 2012).

Population-adjusted DALYs show substantial decreases in the burden of underweight, one of the components of child and maternal malnutrition (Table 1).[12] Nevertheless, they also show that the burden of underweight remains particularly high in sub-Saharan Africa and in Southern Asia. Population-adjusted DALYs further show that in most developing regions underweight imposes a much larger cost than overweight and obesity (for their respective reference populations). Conversely, in Latin America and the Caribbean as well as in some Asian subregions, overweight and obesity impose a larger burden than underweight. In several developing regions, notably Oceania, the burden of overweight and obesity per 1 000 population is higher than in developed regions.

Beyond the social costs of malnutrition reflected in DALYs, malnutrition also imposes economic costs on society. As noted in Chapter 1, the economic costs of undernutrition, which arise through its negative effects on human capital formation (physical and cognitive development), productivity, poverty reduction and economic growth, may reach as high as 2–3 percent of global GDP (World Bank, 2006a). These costs can be much higher in individual countries than the global average implies. For example, one study estimated

[12] Population refers to the particular population group, i.e. children under five for underweight and adults for overweight and obesity.

the total cost of underweight for five Central American countries and the Dominican Republic at US$6.7 billion, ranging from 1.7 percent to 11.4 percent of GDP (Martínez and Fernández, 2008). Around 90 percent of the cost was accounted for by productivity losses due to higher mortality and lower educational attainment.

The economic costs of undernutrition are cumulative through an inter-generational life cycle of deprivation. An estimated 15.5 percent of babies are born each year with low birth weight (UNSCN, 2010). Low birth weight, childhood undernutrition, exposure to poor sanitary conditions and inadequate health care are reflected in poor physical growth and mental development, resulting in lower adult productivity.[13] In addition, the "developmental origins of adult disease" hypothesis (also known as the Barker hypothesis) posits that low birth weight has lasting negative health effects, such as being at greater risk of overweight, diabetes and coronary heart disease in adulthood (de Boo and Harding, 2006). More insidiously, stunted girls grow up to be stunted mothers, and maternal stunting is one of the strongest predictors for giving birth to a low-birth-weight infant. Maternal and child malnutrition thus perpetuate the cycle of poverty.

Micronutrient deficiencies, as distinct from undernutrition, also impose significant costs on society. The median total economic loss due to physical and cognitive impairment resulting from anaemia was estimated at 4 percent of GDP for ten developing countries, ranging from 2 percent in Honduras to 8 percent in Bangladesh (Horton and Ross, 2003). This study also suggested that while the productivity losses associated with anaemia are higher for individuals who must perform heavy manual work (17 percent), they are also serious for those doing light manual work (5 percent) and cognitive tasks (4 percent). Further evidence shows that treating anaemia can increase productivity even for people whose work is not physically demanding (Schaetzel and Sankar, 2002).

Vitamin and mineral deficiencies have been estimated to represent an annual loss of between 0.2 and 0.4 percent of GDP in China; this represents a loss of US$2.5–5.0 billion (World Bank, 2006a). Ma *et al.* (2007) found that actions to solve iron and zinc deficiencies in China would cost less than 0.3 percent of GDP, but failure to take action could result in a loss of 2–3 percent of GDP. For India, Stein and Qaim (2007) estimated that the combined economic cost of iron-deficiency anaemia, zinc deficiency, vitamin A deficiency and iodine deficiency amounts to around 2.5 percent of GDP.

Overweight and obesity also impose economic costs on society directly through increased health care spending and indirectly through reduced economic productivity. Most of the losses occur in high-income countries. A recent study by Bloom *et al.* (2011) estimates a cumulative output loss due to non-communicable diseases, for which overweight and obesity are key risk factors, of US$47 trillion over the next two decades; assuming a 5 percent rate of inflation, this would amount to around US$1.4 trillion, or 2 percent of global GDP in 2010.

A meta-analysis of 32 studies from 1990 to 2009 compared estimates of the direct costs of health care spending related to overweight and obesity in several high-income countries as well as in Brazil and China. Estimates of the direct costs for adults ranged from 0.7 percent to 9.1 percent of the individual countries' total health care expenditures. The cost of health care for overweight and obese people is around 30 percent higher than for other people (Withrow and Alter, 2010). In the United States of America, around 10 percent of total health care spending is obesity-related (Finkelstein *et al.*, 2009).

Total costs (direct and indirect costs) are, of course, higher. Total costs arising from overweight and obesity in the United Kingdom were estimated at £20 billion in 2007 (Government Office for Science, 2012). The indirect costs of overweight and obesity among adults in China were estimated at around US$43.5 billion (3.6 percent of GNP) in 2000, compared with direct costs of around US$5.9 billion (0.5 percent of GNP) (Popkin *et al.*, 2006).

Multiple burdens of malnutrition

The burdens of malnutrition can overlap, as shown in Figure 4. It is common to describe a double or even triple burden of malnutrition (FAO, IFAD and WFP, 2012), yet

[13] Alderman and Behrman (2004) calculate that the economic benefits from preventing one child from being born with a low birth-weight are about US$580 (the present discounted value).

the three types of malnutrition considered here (designated as A = child stunting, B = child micronutrient deficiencies and C = adult obesity) occur in different combinations around the world. The figure also shows the very few countries in the world that have no significant malnutrition problems in these categories.

The first group (AB) includes countries where rates of child stunting and micronutrient deficiencies are classified by the World Health Organization (WHO) as moderate or severe. All countries where stunting is a public health concern also have prevalence rates for micronutrient deficiencies classified by WHO as moderate or severe. The second group (B) includes countries where stunting rates have declined but micronutrient deficiencies remain widespread. These countries illustrate that simply addressing the factors influencing stunting, including increasing the energy content of diets, is not sufficient to provide the necessary range of micronutrients.

The next three groups include countries where the prevalence of adult obesity exceeds the global median. The third (ABC) includes countries where stunting, micronutrient deficiencies and obesity occur simultaneously. The fourth (BC) includes countries where the prevalence of stunting has declined but micronutrient deficiencies remain and obesity is a significant problem. Countries in the fifth group (C) have reduced stunting and micronutrient deficiencies but have serious obesity problems. Only 14 countries in this sample, all of them high-income countries, have no malnutrition problems of public health significance according to the malnutrition types and thresholds defined here.[14]

Food system transformation and malnutrition

The variations in malnutrition shown in Figure 4 reflect the changes in diets and lifestyles, known as the nutrition transition, that occur with economic growth and transformation of the food system. This process, also commonly referred to as agricultural transformation or the food system revolution, is typically characterized by rising labour productivity in agriculture, declining shares of population in agriculture and increasing rates of urbanization. As the food system transforms, centralized food-processing facilities develop along with large-scale wholesale and logistics companies, supermarkets emerge in the retail sector and fast-food restaurants become widespread. The transformation thus affects the whole system, changing the ways food is produced, harvested, stored, traded, processed, distributed, sold and consumed (Reardon and Timmer, 2012).

Figure 5 presents a stylized depiction of this transformation. In subsistence farming, the food system is basically "closed" – producers essentially consume what they produce. With economic development, subsistence farming gives way to commercial agriculture in which producers and consumers are increasingly separated in space and time and their interactions are mediated via markets. In the later stages of the food system transformation, very little overlap exists between producers and consumers and the system "opens up", reaching beyond the local economy to tie together producers and consumers, who may even live in different countries. The introduction of new actors may lead to consolidation of certain stages (for example, when wholesalers affiliated with supermarket chains buy directly from the producers and bypass the previous multiplicity of rural traders), but with additional processing the actual number of actors in the system may increase.

The relationships in Figure 6 are striking. All countries with agricultural GDP per worker below US$1 000 have severe problems of stunting *and* micronutrient deficiencies (category AB as described above). A large share of the population in these countries is rural and earns a living from agriculture. In Burundi, for example, 90 percent of the economically active population are in agriculture, and for all countries in this category this share is 62 percent.

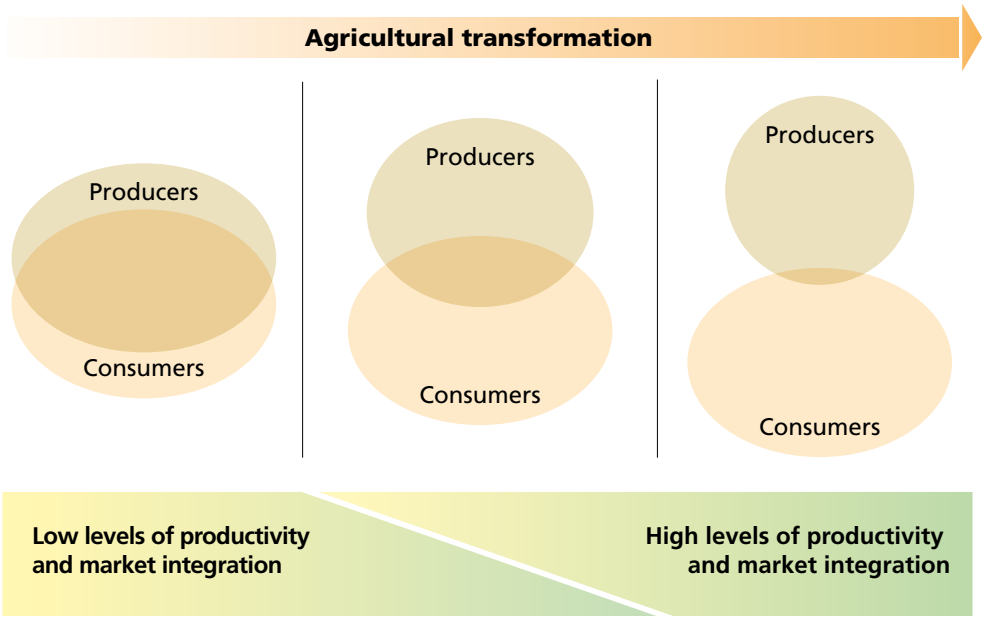
As labour productivity rises to US$1 000–4 499 per worker, stunting declines sharply but all countries continue to suffer from micronutrient deficiencies, either alone

[14] Most of these countries may have nutrition-related public health concerns, but at rates below the thresholds defined here.

FIGURE 4
The multiple burdens of malnutrition

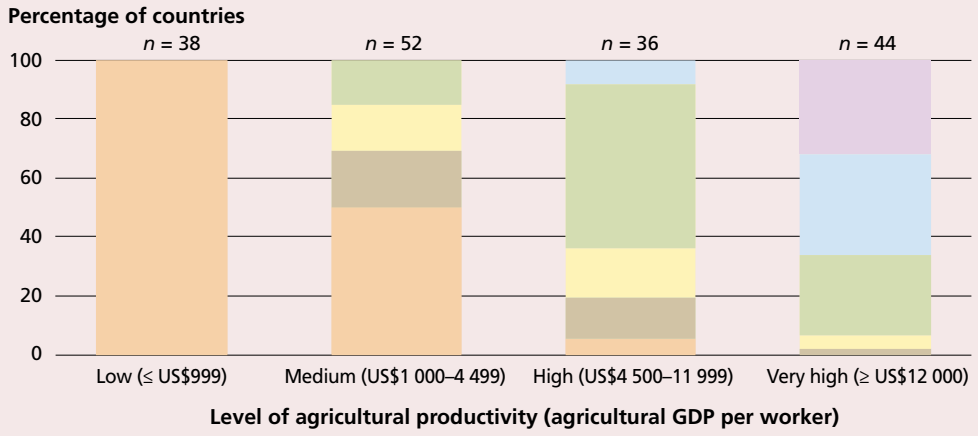
Notes: Data for stunting among children are from UNICEF, WHO and The World Bank (2012). A country is designated as having a public health threat related to stunting if at least 20 percent of its children are stunted (WHO, 2013b); data on stunting are not available for some high-income countries and these countries are assumed to have a prevalence of stunting that is far lower than 20 percent. Data on anaemia and vitamin A deficiency among children are from Micronutrient Initiative (2009). Countries face micronutrient deficiency-related public health threats if 10 percent or more of their children are deficient in vitamin A (WHO, 2009) or if at least 20 percent of children suffer from anaemia (WHO, 2008b). Countries with a per capita GDP of at least US$15 000 are assumed to be free of vitamin A deficiency (Micronutrient Initiative, 2009). Data on obesity among adults are from WHO (2013c). Countries where 20 percent or more of the adult population are obese (equivalent to the global median prevalence for that indicator) are considered to be facing a public health threat related to obesity.
* Data for Sudan was collected prior to 2011 and refer therefore to Sudan and South Sudan.
Source: Croppenstedt *et al.*, 2013. See also Annex table.

FIGURE 5
The food system transformation



Source: FAO.

FIGURE 6
Share of countries in each malnutrition category, by level of agricultural productivity



Notes: n is the number of countries characterized by each level of agricultural productivity. Agricultural productivity is derived by dividing agricultural GDP (in 2010 measured in current US dollars) by the population economically active in agriculture. Malnutrition categories are those illustrated in Figure 4.
Sources: Authors' calculations using agricultural GDP data from the United Nations (2012) and data on agricultural workers from FAO, 2013. Sources used to determine malnutrition categories are those used for Figure 4.

(category B) or in combination with stunting (AB), obesity (BC) or both (ABC). Already, at this medium level of agricultural labour productivity, obesity is a public health problem in more than one-third of all countries, always in combination with micronutrient deficiencies. Agriculture is still an important part of the economy in these countries, although the average share of the labour force in agriculture is lower, at 45 percent.

As labour productivity in agriculture rises above US$4 500, few countries continue to suffer from stunting, though most that do also add obesity to their woes (ABC). The majority of these relatively well-off countries suffer from micronutrient deficiencies and obesity (BC). Once agricultural labour productivity reaches very high levels per-worker, above US$12 000, a majority of countries manage to eliminate micronutrient deficiencies and a significant number manage to solve all three malnutrition problems. These countries typically have a very small share of the population in agriculture, are highly urbanized and have food systems that are globally integrated.

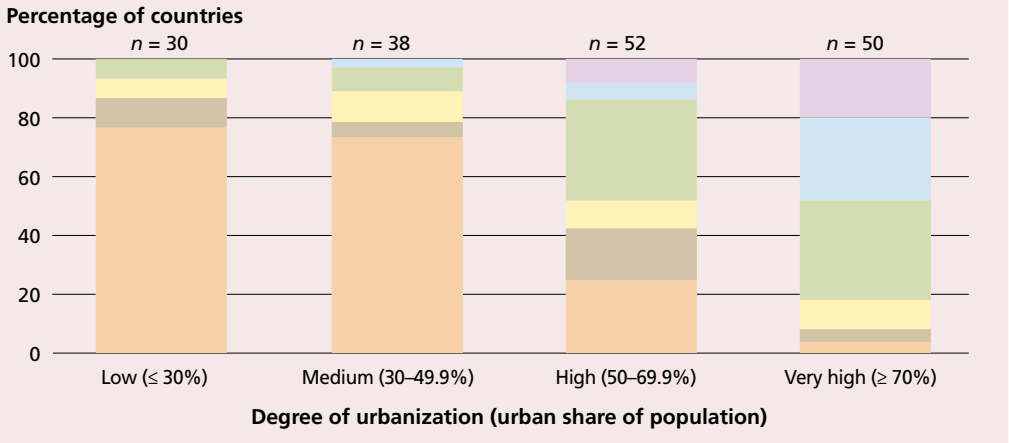
Figure 7 depicts this transition as it accompanies greater urbanization. The transformation of the malnutrition situation is remarkable and strikingly similar to that shown by growth in agricultural labour productivity: stunting falls and obesity rises almost in tandem. At the same time, micronutrient deficiencies fall very slowly as the rates of urbanization rise, and they remain remarkably prevalent even in higher-income, highly urbanized countries.

These changes in the food system, in agriculture and in levels of urbanization pose significant challenges. The nature of the malnutrition problem will itself transition, but problems of undernutrition, associated with deprivation, will continue to pose a major nutritional challenge, especially in low-income countries.

Dietary diversity in changing food systems

One of the key means of addressing micronutrient deficiencies – which seem to persist even with agricultural transformation, increased urbanization and higher incomes

FIGURE 7
Share of countries in each malnutrition category, by degree of urbanization



Notes: *n* is the number of countries characterized by each degree of urbanization. The degree of urbanization is the share of the urban population in the total population. Malnutrition categories are those illustrated in Figure 4.
Sources: Authors' calculations, using data for total and urban population from FAO, 2013. Sources used to determine malnutrition categories are those used for Figure 4.

– is through consumption of a high-quality, diverse diet. The relationship between dietary diversity and changes in food systems is complex. Dietary diversity is determined by relative prices, incomes and the tastes and preferences of individuals and households, all of which are affected by changes in food systems. Evidence at the global level strongly suggests that rising household incomes lead to greater variety in the diet. At higher incomes, an increasing share of the household's diet comes from animal products, vegetable oils and fruits and vegetables, that is, non-staples. Meat and dairy consumption increases strongly with income growth; fruit and vegetable consumption increases also but more slowly, and consumption of cereals and pulses declines (Regmi *et al.*, 2001).

Household surveys from Bangladesh, Egypt, Ghana, India, Kenya, Malawi, Mexico, Mozambique and the Philippines also find that dietary diversity is strongly associated with household consumption expenditure (Hoddinott and Yohannes, 2002). Evidence from Bangladesh shows that income growth leads to strong growth in expenditures on meat, fish, fruits and eggs but little change in expenditure on rice, a staple (Thorne-Lyman *et al.*, 2010).

Absolute and relative price changes also significantly affect household dietary diversity. If prices rise, consumers tend to maintain their level of staple food consumption by switching to cheaper, less-diverse and nutritionally inferior diets. In Indonesia, when staple food prices rose sharply following the Asian financial crisis, poor households protected staple food consumption and reduced non-staples, which reduced dietary diversity and adversely affected nutritional status (Block *et al*., 2004). In Bangladesh, it is estimated that a 50 percent increase in the price of both staple foods (such as rice) and non-staple foods (such as meat, milk, fruits and vegetables) would lead consumers to reduce staple food intake by only 15 percent but reduce non-staple foods disproportionately more (Bouis, Eozenou and Rahman, 2011).

Households may react similarly to price variations that accompany seasonality; for example, a Save the Children pilot programme in the United Republic of Tanzania found that dietary diversity diminished during the lean season before harvest (Nugent, 2011). In such situations, social protection instruments are needed to avoid a deterioration in nutritional outcomes as well as to help households maintain assets, both human and physical, so as to prevent a short-term shock from turning into a long-term disaster.

Conclusions and key messages

The nature of the malnutrition burden facing the world is increasingly complex. Significant progress has been made in reducing food insecurity, undernourishment and undernutrition; however, prevalence rates remain high in some regions, most notably in sub-Saharan Africa and in Southern Asia. At the same time, micronutrient deficiencies remain stubbornly high and rates of overweight and obesity are rising rapidly in many regions, even in countries where undernutrition persists.

The social and economic costs of undernutrition, micronutrient deficiencies, and overweight and obesity are high. While costs associated with overweight and obesity are rising rapidly, those associated with undernutrition and micronutrient deficiencies remain much higher both in absolute terms of DALYs and relative to the affected populations. The economic cost of undernutrition may reach as high as 2–3 percent of GDP in developing countries. Moreover, undernutrition is one of the main pathways through which poverty is transmitted from one generation to the next.

Evidence shows that rates of undernutrition, as measured by child stunting, tend to fall with per capita income growth and the transformation of the food system, but progress does not come quickly and it is not automatic. Micronutrient deficiencies are even more persistent than stunting, and obesity can emerge even at fairly early stages of economic development and food system transformation.

Dietary diversity, given adequate levels of energy consumption, is a key determinant of nutritional outcomes but it is sensitive to changes in income levels and prices of staple and non-staple foods. In the face of a shock to food prices or incomes, households tend to maintain a minimum level of staple food

consumption even if it means sacrificing more nutritious foods that are necessary to provide the vitamins and minerals needed for good health.

Food system transformation and the nutrition transition go hand in hand. To address the nutritional challenges in a given context it is first necessary to understand the nature of the food system and identify key entry points throughout the system. The next three chapters of this report look at the various stages of the food system to identify the major pathways through which food system interventions can improve nutritional outcomes.

Key messages

- Malnutrition in all its forms imposes unacceptably high costs on society in human and economic terms. Globally, the social burdens associated with undernutrition and micronutrient deficiencies are still much larger than those associated with overweight and obesity. Rural people in low- and middle-income countries bear by far the highest burden of malnutrition. Addressing undernutrition and micronutrient deficiencies must remain the highest priority of the global nutrition community, even as efforts are made to prevent or reverse the emergence of obesity.
- All forms of malnutrition share a common cause: inappropriate diets that provide inadequate, unbalanced or excessive macronutrients and micronutrients. The only sustainable means of addressing malnutrition is through the consumption of a high-quality, diverse diet that provides adequate but not excessive energy. Food systems determine the availability, affordability, diversity and quality of the food supply and thus play a major role in shaping healthy diets.
- Income growth, whether from agriculture or other sources, is closely associated with reductions in undernutrition, but income growth alone is not enough. It must be accompanied by specific actions aimed at improving dietary adequacy and quality if rapid progress is to be made in eradicating undernutrition and micronutrient deficiencies.
- Dietary diversity is a key determinant of nutritional outcomes, but the consumption of nutrient-dense foods is very sensitive to income and price shocks, especially for low-income consumers. Protecting the nutritional quality of diets – not just the adequacy of staple food consumption – should be a priority for policy-makers.
- The malnutrition burden in a country changes rapidly with the transformation of the food system. Policy-makers must therefore understand the specific nature of the malnutrition problem to design interventions throughout the food system. Up-to-date data and analysis are necessary to support decision-making.