Indicators linking health and sustainability in the post-2015 development agenda

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See Online for appendix

The UN-led discussion about the post-2015 sustainable development agenda provides an opportunity to develop indicators and targets that show the importance of health as a precondition for and an outcome of policies to promote sustainable development. Health as a precondition for development has received considerable attention in terms of achievement of health-related Millennium Development Goals (MDGs), addressing growing challenges of non-communicable diseases, and ensuring universal health coverage. Much less attention has been devoted to health as an outcome of sustainable development and to indicators that show both changes in exposure to health-related risks and progress towards environmental sustainability. We present a rationale and methods for the selection of health-related indicators to measure progress of post-2015 development goals in non-health sectors. The proposed indicators show the ancillary benefits to health and health equity (co-benefits) of sustainable development policies, particularly those to reduce greenhouse gas emissions and increase resilience to environmental change. We use illustrative examples from four thematic areas: cities, food and agriculture, energy, and water and sanitation. Embedding of a range of health-related indicators in the post-2015 goals can help to raise awareness of the probable health gains from sustainable development policies, thus making them more attractive to decision makers and more likely to be implemented than before.

Introduction

The Millennium Development Goals (MDGs) are supposed to be achieved by 2015. An extensive consultation process sponsored by the UN is now considering how to build on the MDGs and develop a new set of Sustainable Development Goals (SDGs) for the post-2015 era. These goals should be relevant to countries at all levels of development. The UN Open Working Group (OWG), including 30 member states, is due to submit its report about the progress towards developing the SDGs to the UN General Assembly in September, 2014, which will be followed by a summit in 2015 with the heads of state. The appendix further describes these consultation processes.

Broad agreement in the international community exists about the need to sustain and build upon health gains made in the MDG era. New challenges to be addressed include the increasing trend of non-communicable diseases, promotion of health[1] and wellbeing at all stages of life[2], and universal health coverage.[1,3]

Recognition of health as an outcome and indicator of sustainable development is increasing. Sustainable development is widely accepted to be underpinned by environmental, social, and economic factors.[4] This Review focuses on environmental factors because social and economic determinants of health have been extensively discussed elsewhere,[5] and environmental determinants of health have been relatively neglected despite their importance. For example, reduction of key environmental risks, including exposure to air, water, and chemical pollution, can help to prevent up to a quarter of the total burden of disease, including a large proportion of childhood deaths.[6]

Indicators integrating health and environmental sustainability deserve more attention in view of increased awareness that many of the planet's ills and those of individuals have common sources and solutions. Unsustainable patterns of resource use and consumption are causing profound damage to the ecosystems upon which human existence depends. Some of the planetary environmental boundaries of resource provision and regeneration, within which humanity can safely flourish, have already been crossed.[7] As the world's population soars to reach about 10 billion people by the end of the 2100, the risk of causing further damage to the environment will be magnified. Even with the present mitigation commitments and pledges fully implemented, there could be roughly a 20% likelihood of exceeding a 4°C global average increase in temperature by 2100, which would cause unprecedented heat waves, severe drought, and major floods in many regions.[8]

The UN High Level Panel of Eminent Persons has called for a set of "transformative shifts" to achieve sustained poverty reduction, improved health, and reduced social inequalities, and to slow "the alarming pace of climate change and environmental degradation, which pose unprecedented threats to humanity".[9]

Extensive evidence to link environment, health, and development policies that can be used to develop health indicators of SDGs now exists. For example, the burden of disease attributable to a range of environmental risks has been assessed.[10–12] Additionally, health co-benefits (ie, ancillary benefits) from sustainable development strategies have been identified, particularly those that reduce emissions of greenhouse gases.[13–18]

Illustrative examples of health-related indicators are provided for cities, energy, water, and food. These were among the key themes of the 2012 Rio+20 UN Conference on Sustainable Development,[19] and are topics in ongoing SDG discussions.[20–23]

Methods

The four thematic areas (cities, energy, water, and food) were selected because of their relevance to ongoing sustainable development discussions, to mitigation of and adaptation to climate change, and because of their linkage to major burdens of disease. In each sector, we identified potential indicators based on clear epidemiological evidence of consistent associations; plausible mechanisms linking development action and its health effect; and availability of relevant monitoring data. Three other topic areas were listed as crucial issues at Rio+20—namely, disasters, jobs, and oceans—but we have not included them in this Review because work on disasters has been published separately, the links between oceans and health are poorly understood, and indicators for jobs are not directly related to environmental sustainability and health.

The analysis used in this Review drew on health-impact assessment and included screening potential policies for inclusion in the SDGs; scoping reviews to map evidence on health and development linkages for each of the four themes; electronic expert and stakeholder consultations to synthesise key health and development linkages using a template that captured causality or burden of disease and the policy context; and a face-to-face expert consultation, leading to proposed health indicators for the selected Rio+20 thematic areas, published as thematic briefs of meeting outcomes in 2012.[24] The appendix further describes the methods.

This paper summarises the outcomes of the analyses, presents proposed indicators, and outlines the evidence that supports their use. For some of the thematic areas covered in this Review, development targets have already been elaborated, although not yet formally accepted, by the OWG (eg, by the UN Sustainable Energy for All Initiative), and in these cases we have referred to these processes. For other thematic areas, the choice of specific development targets is being discussed, and in these cases we instead refer to general objectives outlined in existing SDG discussion papers, presuming that the overall aspiration to reduce health risks and pollution exposures to the feasible minimum, using cost-effective policies and interventions, should be integral to the final selection of targets and indicators. For each thematic area, we outline development trends and health effects, links with sustainability and climate change, lessons learnt from MDG-era monitoring, and health co-benefits or other health effects of post-2015 development policies. We propose drawing on existing statistics and data from the thematic area and health to make the best use of the existing information.

Cities Development trends and health effects

Unplanned urban growth, leading to continued expansion of slums and substandard housing; unsustainable transportation systems; and inadequate infrastructures for energy, drinking water, sewage, and solid-waste management were identified as key unsustainable urban development trends. They exacerbate the burden of non-communicable disease from risks related to outdoor air pollution,[12,14] physical inactivity, and injuries;[16] from exposures to excessive heat, cold, damp, or extreme weather; and water-borne and vector-borne communicable diseases.[17,25] The horizontal expansion of cities (urban sprawl) has been associated with more motor vehicle travel, physical inactivity, obesity, and injury risks, and more extreme urban heat events, also affecting health.[26–28] Although the global proportion of people who live in slums decreased from 39% to 33% of the urban population between 2000 and 2012, which resulted in the attainment of the MDG target, absolute numbers of people who live in slums grew.[29,30] About a quarter to a third of people who live in urban areas in developing countries rely upon inefficient coal and biomass stoves, causing disease burdens from indoor smoke including chronic obstructive pulmonary disease (COPD), childhood pneumonia, stroke, ischaemic heart disease, and lung cancer.[31]

Links with sustainability and climate change

Cities account for up to 70% of global greenhouse gas emissions because of their heavy use of energy for transportation, buildings, and industry.[32] Cities can also be particularly vulnerable to climate change effects— eg, the urban heat island effect and increased coastal flooding due to sea level rise.[33] However, cities in rich and poor countries offer opportunities to reduce greenhouse gas emissions and improve health through more compact, efficient design of housing, transport, and other infrastructures, capitalising on high urban population densities.

Lessons learnt from MDG-era monitoring

MDG Target 7.D called for achieving "by 2020 a significant improvement in the lives of at least 100 million slum dwellers", which requires baseline definitions for, and counting of, slum populations. The UN Habitat Global Urban Data Base now obtains data about people who live in slums in more than 60 countries. However, few countries report on all five parameters used to define a slum household.[34–36] Future sustainable development targets for cities will need to take into account that global population growth will be largely in urban areas.

For more on the **UN Habitat Global Urban Data Base** see http://www.unhabitat.org/stats/

Health co-benefits of post-2015 development policies

Our literature review identified a range of health co-benefits of sustainable development policies. First, a modal shift to efficient public transport and safe walking and cycling networks, combined with regulatory restrictions on high-emission vehicles, reduces risks to health from air pollution, traffic injuries, and physical inactivity. This shift also reduces inequities in access to employment, education, and services.[17,37–39] Second, sustainable, climate change-resilient water, sewage, and waste management can improve access to safe drinking water sources with benefits for health.[40] Third, urban planning and green spaces can improve resilience to heat

waves; [33] provide opportunities for physical activity; reduce air and water pollutants; and reduce housing vulnerability to flooding, mudslides, and windstorms.[17,41] Finally, energy-efficient, climate-adapted housing (including access to clean energy and lighting; good use of ventilation, with screening of doors, eaves, and windows; and adequate space) can reduce the burden of indoor air pollution risks, dampness, and mould; airborne infectious disease transmission; heat and cold exposure; and vector-borne diseases.[13,17] Many of the indicators used for cities (panel 1) can also be applied in smaller settlements.

Energy

Development trends and health effects

Inability to access clean energy sources results in high levels of domestic and ambient fine particulate air pollution exposures. It also contributes to other health risks, such as burns, injuries, intoxications, and violence (particularly to women while collecting fuel).[6] Household air pollution was estimated to be the leading risk factor in 4·3 million deaths in 2012, mostly among the poorest people who are reliant upon coal or biomass for cooking.[12]

Outdoor air pollution, predominantly from fossil fuel combustion, was estimated to be the leading risk factor in 3·7 million deaths in 2012, with almost half a million of these deaths being attributed to outdoor air pollution created by inefficient combustion of solid fuels for cooking in homes.[12] There is robust evidence of the quantitative association between air pollution and health, for the rapid changes in mortality following peaks of air pollution, and for the long-term disease and mortality effects of air pollution, including on childhood pneumonia, COPD, cardiovascular disease, and lung cancer.[12,44,48,49]

Energy, sustainability, and climate change

Electricity, particularly from coal combustion, is a large and increasing contributor to greenhouse gas emissions and to fine particulate air pollution. Policies to reduce coal combustion can reduce mortality due to fine particulate air pollution.[50] A very large proportion of the primary energy used to generate electricity in conventional thermal power plants is lost in the form of heat.[51] The combustion of fossil fuels is the major driving force for climate change;[51] diesel fuel combustion, kerosene lamps, and primitive solid fuel stoves are also substantial sources of short-lived climate pollutants, particularly black carbon, a major component of particulate emissions.[13,52–55]

Lessons learnt from MDG-era monitoring

No target was set in the MDGs related to sustainable energy. However, in 2011, the UN Secretary General's Sustainable Energy for All initiative proposed three targets for the year 2030: universal access to modern energy technologies, doubling the rate of energy efficiency improvements, and doubling the share of renewable energy in the overall energy supply[56] (panel 2).

Health co-benefits post-2015 development policies

Power-generation technologies with improved efficiency and greater reliance upon renewable energy can reduce air pollution emissions per unit of electricity output, including emissions of fine particulates (the pollutant most closely linked to premature mortality). Access to modern, low-emission energy technologies in the household can substantially reduce the incidence of key household air pollution-related diseases such as pneumonia, stroke, ischaemic heart disease, COPD, and cancer. Low-emission technologies (at point of use) include liqufied petroleum gas, biogas, and electricity. Advanced combustion biomass cookstoves are another promising technology under development.[13,43,60] Photovoltaic solar systems can provide an alternative to kerosene and diesel for household lighting and some power requirements, reducing the risk of burns, poisoning, and household air pollution. Combustion of kerosene and diesel fuel produces carbon dioxide and black carbon emissions, contributing to both health risks and climate change.[53–55] Passive solar hot water heaters can improve access to hot water for personal hygiene and domestic use.[17]

Cities that prioritise energy-efficient land use, buildings, and transport systems designed around transit and active transport systems can substantially reduce their energy requirements and thus air pollution emissions.[16,17,50,51] Energy-efficiency measures should be coupled with energy-saving strategies, otherwise demand often rises and can outweigh the expected efficiency benefits.[61] Air pollution exposure is thus a health-related indicator of results from these combined strategies. Methane is a short-lived climate pollutant[62] and a tropospheric ozone precursor; such ozone pollution is estimated to lead to around 150 000 deaths a year[63] from respiratory conditions (and reduce crop productivity). Capture of methane from sewage, livestock manure, and landfills, and combustion as a fuel, can substantially reduce such health-harmful greenhouse gas emissions and create comparatively clean energy sources.[62,64,65]

The third Sustainable Energy for All target—increased use of renewable energy sources such as photovoltaic and solar concentrating power, wind, wave, and hydropower—can reduce demand for fossil fuel energy and thus reduce fine particulate air pollution,[51,56] and potentially extend access to energy to people who are outside the electricity grid, provided that the renewable sources are affordable.

Health facilities often have extremes of very high, inefficient energy consumption in large facilities, and an absence of adequate energy access in resource-constrained settings.[18,66] Health sector access to efficient, modern or renewable energy sources can improve the delivery of health services, reduce black carbon from the use of diesel generators, and benefit environmental health and sustainability.[54,62] An indicator for sustainable electricity access in the health sector is thus also proposed (panel 2).

Panel 1: **Healthy sustainable cities**

Target 1

Reduce the percentage (by x%) of people living in urban slums and substandard housing, defined as the lack of (1) durable housing structure,* (2) sufficient living area, (3) access to safe, affordable water, (4) access to improved sanitation, and (5) security of tenure.[36,37]

Potential indicators

(1) Percentage of people living in urban slums, as per the MDG-era definition. (2) Percentage of urban households living in durable structures (as per the MDG-era definition of housing: sited away from hazardous locations;† a permanent structure offering protection from climatic extremes of rain, heat, cold, and humidity; and built in compliance with local building codes).[34] (3)Percentage of urban households with access to 'modern' energy sources for heating, cooking, and lighting,[42] as defined by WHO indoor air quality guidelines for household fuel combustion (new indicator).[43] The definition of durable housing captures some housing and health risks (eg, injuries, extreme heat, and cold exposures).[17] However, current definitions make no reference to risks from inefficient domestic biomass and coal combustion or poor ventilation, despite the large burden of related disease, including pneumonia and non-communicable diseases from smoke in the home. Nor are strategies to prevent ingress of disease-carrying pests and vectors addressed. Although ventilation and screening indicators would require new data collection systems, assessment of urban access to modern energy sources for cooking, heating, and lighting is feasible with available data sources.

Data sources

For indicators (1) and (2): UN Habitat's Monitoring Urban Inequities Programme and Global Urban Indicators Database. For (3): WHO household energy database, disaggregated for people living in urban areas. Efforts to supplement survey data with spatial mapping of slum indicators, with earth and satellite observations have also been made.[34,35]

Target 2

Reduce exposure to urban air pollution and related deaths and disease by x%.

Potential indicators

(1) Percentage of the urban population exposed to small or fine urban particulates (PM_{10} or $PM_{2·5}$ [particles with a diameter of ≤10 or ≤2·5 micrometres]) in concentrations exceeding WHO Air Quality Guidelines.[44] (2) Estimated burden of disease from urban ambient air pollution.

Data sources

(1) Average air pollution concentrations of PM_{10} or $PM_{2·5}$ are available for more than 1600 cities in the WHO Global Observatory's Ambient Air Pollution database.[45] (2) Estimates of burden of disease from ambient air pollution in cities are generated by WHO air quality data (from monitoring of stations, satellite remote sensing, and air pollution chemical transport models) and scientific evidence from population exposure–response relationships.[10,44] Improved data for sources of pollution will also be important to inform policy priorities (panel 2).

Target 3

Efficient, healthy, and safe urban transport by the increased use of public transport and active travel modes together with policies to increase road safety.

Potential indicators

(1) Percentage of trips or passenger kilometres travelled by public transport, cycling, and walking. (2) Number of traffic injury deaths, including among vulnerable road users—eg, pedestrian and cyclist deaths per 1000 km of non-motorised travel.

Data sources

(1) International and urban transport datasets collect data for trips or passenger kilometres by mode of travel[46] (cycle and pedestrian modes need improved coverage). (2) Global traffic injury data are collected in international datasets and by WHO in 182 countries for four-wheelers, two or three-wheelers, cyclists, and pedestrian road-user deaths. However, the data are not disaggregated for public or private transport modes, nor do they include rail transport;[47] therefore, comprehensive reporting on this indicator would be dependent on expanding current data collection to cover all passenger travel modes—eg, rail, bus, private and commercial vehicles, cycling and walking, and urban or rural locations. Although desirable, this indicator might be more suited for implementation at some point in the future as data availability improves.

* While all five indicators comprise the formal definition of slums, information about secure tenure is not available for most of the countries, so for the purposes of MDG monitoring, only the first four indicators are used to estimate the percentage of the urban population living in slums. Although target 1 is derived from the MDGs and mainly focused on low-income and middle-income countries, the other two targets are relevant to cities in countries of all levels of development. Although urban sprawl is an important factor affecting health, we do not think it would make a suitable indicator because of its complexity of measurement and the need to validate the measure across a range of cities worldwide. †Hazardous locations are further defined by UNHABITAT to include geologically hazardous landslide, earthquake, or flood zones; waste dumps; highly polluted industrial zones; and other high-risk zones (eg, energy transmission lines, airports, etc).

Water and sanitation

Development trends and health effects

More than 6·5 million children younger than 5 years are estimated to die annually, and diarrhoea accounts for 9% of these deaths.[67] A large proportion of this mortality is attributable to unsafe drinking water, inadequate sanitation, or insufficient hygiene. By 2012, more than 2·3 billion people had gained access to improved drinking water sources and 1·9 billion people to improved sanitation compared with the 1990 baseline year. Despite this progress, 748 million people remain without improved water sources, billions of people do not have safe drinking water, and 2·5 billion are without basic sanitation, including roughly 1 billion people

For more on **water and sanitation** see http://www.wssinfo.org/

Panel 2: Sustainable Energy for All

Sustainable Energy for All, target* 1
Ensure universal access to modern energy services.

Indicators
(1) Percentage of households using modern fuels or technologies, as defined by WHO guidelines, for all cooking, heating, and lighting activities.[43,57,58] (2) Mortality and morbidity attributed to household air pollution. (3) Percentage of health facilities with access to clean and reliable electricity, defined as no outages of more than 2 h in the past week for required lighting and procedures.

Data sources
(1) WHO's household energy database (≥150 countries). This database is being expanded to include heating and lighting.[42] (2) Modelled estimates of personal household air pollution exposure from the WHO Global Household Air Pollution Measurement database and WHO indoor air quality guidelines for household fuel combustion, which summarises evidence from exposure-response studies.[41] (3) WHO Service Availability and Readiness Assessment (SARA) of health facilities collects data for the percentage of facilities with reliable electricity access; this database is being upgraded to track improved facility access to energy-efficient and renewable energy sources.[59]

Sustainable Energy for All, targets 2 and 3
Double the global rate of improvement in energy efficiency and double the share of renewable energy in the global energy mix.

Indicator
Global mortality and morbidity attributed to outdoor ambient air pollution at levels above WHO guidelines (annual mean PM 2·5 or 10 μg/m³).

Data sources
(1) Population exposure to ambient air pollution concentrations exceeding WHO Air Quality Guidelines based on ground level urban air pollution monitoring of data collected by WHO[45] and complemented by other methods such as remote sensing using satellite data and air pollution (chemical) transport models, to cover areas with little data. (2) Mortality and morbidity estimates based on population exposure to air pollution from monitoring of data in association with evidence on exposure-response, as summarised in WHO Air Quality Guidelines.

Collection of better data for sources of fine particulate air pollution (motor vehicles, electricity generation, buildings, industry, waste, and agricultural incineration) would also be important to allow identification of priority actions. However, the measurement of air pollution, as such, provides an important indication of the overall progress of policies in the relevant sectors.

*Note: Sustainable Energy for All uses the term objectives, but we have used the term targets for consistency.

openly defecating. Huge disparities in access exist between different regions of the world, between socioeconomic groups, and between cities and rural settings where 82% of people who do not have access to improved water sources, and 70% of those without sanitation are living.[60] The 2010 UN General Assembly resolution[68] defined safe drinking water access and sanitation as a human right.

Links with sustainability and climate change

Fresh water resources are threatened by unsustainable development, and climate change, which could undermine MDG-era achievements in improving access to clean drinking water.[69,70] Climate change is predicted to increase the frequency of heavy precipitation events and to lead to increased droughts in some areas.[8]

Lessons learnt from MDG-era monitoring

Target C of MDG 7 "Ensure Environmental Sustainability" called for halving the proportion of the global population without sustainable access to safe drinking water and basic sanitation by 2015 (1990 baseline). The WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation[60] reported that the global target for access to improved drinking water sources was met in 2010, although the target for improved sanitation is not expected to be met by 2015. The measures used in the MDG era to monitor improvements in population access to safe drinking water did not track the environmental sustainability of water resources and masked large inequalities in access. Present monitoring exercises, however, have shown that tracking climate resilience of existing safe water sources and tracking enabling policies and investment trends in countries is feasible.[71] Monitoring of the MDG indicators stimulated substantially improved data collection and reinforced awareness of continued needs.[72,73]

A six-country study by JMP has shown that improved drinking water sources might still contain substantial bacterial and chemical contamination.[74] The selection of post-2015 indicators needs to better monitor such risks (panel 3). Finally, WHO, on behalf of UN Water, has begun to track finance, governance, and human resources for water, with the 2010 launch of the biannual Global Analysis and Assessment of Sanitation and Drinking water (GLAAS).[76–78]

Post-2015 development policies and health linkages

There is wide understanding that lack of access to safe water, sanitation, and hygiene affect many health outcomes.[75,79] These include diarrhoeal, vector-borne, and neglected tropical diseases; malnutrition; and non-communicable disease risks related to chemical contaminants. Poor people are the most affected by water-related diseases and climate change.[69]

Health underpins the debate on water, sanitation, and hygiene, as reflected in UN-Water's advice to countries for

Panel 3: Sustainable access to safe drinking water, sanitation, and hygiene

Target 1
Achieve universal access to basic drinking water, sanitation, and hygiene for households, schools, and health care facilities.

Indicators
(1) Percentage of population using basic drinking-water.
(2) Percentage of population using basic sanitation.*
(3) Percentage of population with hand-washing facilities at home. (4,5) Percentage of health care facilities and schools with basic drinking-water, basic sanitation, and hygiene.*[75]

Data sources
Indicators (1), (2), and (3), would draw on the existing household survey database of the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP). Indicators (4) and (5) will need additional administrative data and surveys of health facilities and schools.

Target 2
Halve the percentage of the population without access at home to safely managed drinking water and sanitation services.† Safe management includes assessment and response to risks posed by climate change.

Indicator
(1) Percentage of population using a safely-managed drinking water service at home.† (2) Percentage of population with basic sanitation whose excreta is safely managed.‡

Data sources
For indicator (1), direct water quality testing (*Escherichia coli* measurement) and risk management data collection are being piloted by JMP.[60] For indicator (2) WHO, UN-Habitat, and UNEP are developing methods for monitoring excreta and wastewater management through containment, collection, and disposal, or reuse. Monitoring of safely managed services will require new data from service providers and regulators, earth observations, or other novel sources. New approaches for assessment of climate resilience of water supplies in relation to health care as piloted in Vision 2030 [2009][69] and in the Atlas on Health and Climate [2012] could support monitoring.[70]

Target 3
Foster an enabling policy environment for water, sanitation, and hygiene.

Indicator
Number of countries with an enabling environment to reach targets 1 and 2, as defined by a standardised measure of (1) adequate financial investment, (2) human resource allocations, and (3) policies in place.

Data sources
UN Water GLAAS biennial report surveying 90 countries so far and donors (2010, 2012, 2014).[76–78]

*Basic drinking-water refers to water from an improved source (as per the existing MDG indicator) with a total collection time of 30 minutes or less from a roundtrip, including queuing. Basic sanitation facilities effectively separate excreta from human contact and ensure that excreta do not re-enter the immediate household environment. †Safely managed drinking-water services reliably deliver water that is sufficient to meet domestic needs and do not represent a substantial risk to health. The service should include risk management and be subject to compliance monitoring. ‡Safely managed sanitation services include basic household sanitation along with effective faecal sludge and wastewater management.

a dedicated post-2015 global goal "Securing Sustainable Water for All". Proposed targets include universal access to safe drinking water, sanitation, and hygiene; sustainable use and development of water resources; equitable, participatory, and accountable water governance; and improved wastewater treatment, reuse, and water quality. Finally, a target for reducing mortality from water-related disasters has been proposed.[75]

Future monitoring should integrate existing data from household surveys that are the basis for current water, sanitation, and hygiene (WASH) tracking by JMP; data on enabling policies and investments, as captured in GLAAS; and improved data about water quality and sustainability aspects. New methods need to be developed for tracking wastewater and water resource management as this is crucial to the sustainability of water access and prevention of water-related health effects (panel 3).[75]

Healthy and sustainable food and agricultural systems

Development trends and health effects

Present patterns of unsustainable food production and distribution are associated with hunger and undernutrition and overweight and obesity. Around 868 million people have inadequate energy intake. Additionally, approximately 2 billion people have one or more micronutrient deficiencies,[80] and 165 million children younger than 5 years are stunted, with negative implications for their development.[81]

Poor nutrition causes nearly half of child deaths (3·1 million children each year) and one in four newborn babies (>800 000 every year) die because they are born too small or too soon as a result of poor maternal nutrition.[73,82]

The proportion of people who are overweight and obese[73] is rapidly rising. In 2008, an estimated 1·46 billion adults worldwide were overweight. Of these people, 205 million men and 277 million women were obese.[83,84] People who are overweight or obese have an increased risk of coronary heart disease, stroke, some cancers, and type II diabetes. Overconsumption of saturated fat (largely from animal products) increases the risk of cardiovascular disease.[15,85] Overconsumption of red meat and processed meat is associated with an increased risk of colorectal cancer, diabetes, and mortality.[86–90] Substitution of saturated fat with unsaturated dietary fat[91] and increased consumption of fruits, vegetables, whole

grains, dietary fibre, nuts, and seeds[12] has been linked to reduced coronary heart disease risks.[92] WHO recommends that no more than 10% of total energy intake be obtained from saturated fats.[85]

In 2005, roughly a third of the world's cereal harvest was fed to livestock,[93] which had direct and indirect effects on food price volatility and food security.[94] At the same time, livestock are an essential source of income, food security, and essential proteins and micronutrients for many of the world's small landholders, pastoralists, and people living in rural areas with a low income. Health-relevant indicators for sustainable foods, therefore, need to be sensitive to this complex web of causality.

Links with sustainability and climate change

Animal products and processed foods are among those foods with the highest effect on climate and environment (including water, air pollution, and deforestation).[95] In particular, ruminant meat production typically generates substantially more greenhouse gas emissions per protein unit produced than do alternative plant or poultry-based protein sources, as a result of heavy use of energy, water, and grain inputs (as well as livestock generation of methane emissions).[96] Climate change poses major challenges to agricultural productivity in the face of rising demands.[8]

Lessons learnt from MDG-era reporting

Target C of MDG 1 "Eradicate extreme poverty and hunger" aimed to halve the proportion of people having hunger between 1990 and 2015.[97] The indicators used for measurement were global prevalence of childhood underweight (aged <5 years)[73] and the proportion of the population below a minimum level of dietary energy consumption. The proportion of underweight children is estimated to have decreased from 25% in 1990, to 16% in 2011, but this decline is insufficient to meet the MDG target. Underweight prevalence in 2011 was highest in Southern Asia (31%) and sub-Saharan Africa (21%).[73,81] Globally, stunting in children younger than 5 years decreased from 40% to 26%, but there were major regional differences.[81,98] A large burden of disease from undernutrition clearly persists, and climate change could increase stunting of children in the future.[95] Obesity and dietary balance were not part of the MDG goals; they are, however, an increasing concern.

Post-2015 policies and health linkages

Sustainable food and agriculture policies aim to improve the efficiency of agricultural production systems, while at the same time preserving biodiversity and the diverse ecosystem services upon which the world's food supply depends (eg, soil nutrients, climate regulation, etc).

The UN Secretary-General's Zero Hunger Challenge sets targets for an integrated approach to sustainable foods.[99] A set of nutrition goals were also adopted by the World Health Assembly in May, 2012[100] (panel 4).

There is wide agreement on replacing the indicator for child underweight with that of childhood stunting (ie, low height for age) for a post-2015 SDG nutrition target. Stunting is preferred because of the international agreement on its definition,[107] wide availability of high-quality data, and its close association with poor cognitive and educational performance, low adult wages, lost productivity, and, when accompanied by excessive weight gain later in childhood, increased risk of nutrition-related chronic diseases.[81,82,108] Stunting also requires multisectoral actions on food and nutrition security, agriculture, education, water, sanitation and hygiene interventions, poverty reduction, and the status of women.[109] Intervention in the critical period between conception and the second birthday can have the most effect on child growth and development.[107]

In parallel, the WHO Global Monitoring Framework and targets for the Prevention and Control of Non-communicable Diseases[110] (panel 4) sets global targets for halting the rise in diabetes, overweight, and obesity by 2025. The framework also calls for measurement and monitoring of saturated fat intake and of the proportion of the population eating less than the recommended five servings of fruits and vegetables per day.[110]

Maintenance of a healthy body-mass index (BMI) is also associated with low overall caloric consumption, which, in turn, might translate into low food-related greenhouse gas emissions and reduce energy requirements for motorised transport, compared with populations with a high mean BMI.[111] Substitution of high saturated-fat, high-calorie meats, and processed foods with more unprocessed foods, fibre-rich foods, and fresh fruits and vegetables was also a key recommendation of the WHO Global Strategy on Diet and Physical Activity.[112]

Indicators of dietary diversity show an aspect of sustainable food production with substantial health linkages.[15,113] Attributable morbidity and mortality have been estimated for a range of related dietary risk factors, including overconsumption of red meat, processed meats, and high-calorie sugary drinks; insufficient consumption of fruits, vegetables, whole grains and fibres, milk products, and polyunsaturated and omega 3 fatty acids; and insufficient intake of other micronutrient-rich foods such as nuts and seeds. Millions of deaths annually are attributed to such dietary risk factors, although there may be overlap with burden of disease or deaths attributable to more than one dietary risk.[12]

As low-income countries shift from subsistence farming to industrialised food production,[112] the gradual loss of biodiverse local food varieties of legumes, fruits, nuts, seeds, and berries, and increased reliance upon simplified diets of imported food varieties or mass-produced staples can lead to diets that are energy rich, but contain few vital micronutrients. Conversely, more biodiverse agricultural production systems can help to foster micronutrient-rich food varieties, improved food security, and improved nutritional status in undernourished rural populations,[114,115]

Panel 4: Goal–improved nutrition from sustainable food production

Target 1

Less than 5% of children younger than 5 years with stunting.

Indicator

Prevalence of stunting in children younger than 5 years (ie, percentage of children who fell below −2 SD from the length-for-age or height-for-age WHO Child Growth Standards median), data for whom are most readily available, or younger than 2 years, which is the group most sensitive to the interventions.

Data sources

Empirical data from national surveys available covering 150+ countries (WHO Global Database on Child Growth and Malnutrition.)[101] For the younger than 2 years indicator, existing data would have to be reanalysed both for the baseline situation and assessment of trends.

Target 2

Halt the increase in the percentage of people who are overweight or obese.

Indicator

Prevalence of adults (≥18 years), young children (≤5 years), older children, and adolescents (5–18 years) who are overweight (or obese). The WHO Global Monitoring Framework for the Prevention and Control of Non-communicable Diseases, approved by the World Health Assembly in 2013, set a target of halting the rise in diabetes and obesity by 2025.[102]

Data sources

Overweight and obesity in adults has a well-established definition† with high quality data frequently available via national surveys, and model-based country estimates that allow derivation of global and regional estimates for monitoring purposes. For overweight preschool age children, data are aggregated in the WHO Global Database on Child Growth and Malnutrition;[101] and for adults, in the WHO Global Data Base on Body-Mass Index. Additionally, people who are obese or overweight have an imbalance between energy intake and output, so physical activity is also relevant (panel 1).

Target 3

Healthy and sustainable diet as assessed by the following indicators.

Indicators

(1) Percentage of calories from saturated and unsaturated fat; (2) consumption of red meat (kg/per capita per day); (3) percentage of adult population (≥ 18 years) who eat less than five servings of fruit and vegetables, on average, per day; and (4) household dietary diversity (HDDS) score. HDDS is a measure of the balance of foods consumed in the past 24 h from 12 common food groups, including cereals, fish or seafood, roots and tubers, pulses, legumes, nuts, vegetables, milk products, fruits, oil or fats, meat, poultry, offal, sugar or honey, and eggs.[103] The percentage of saturated and unsaturated fat in the diet is also one of the indicators in the WHO Global Monitoring Framework for the Prevention and Control of non-communicable diseases. Future work should also consider sustainability and dietary effects of refined carbohydrates, another food group that substantially increases the risk of non-communicable diseases. Although the greenhouse gas emissions associated with the production of raw inputs for carbohydrates are relatively low compared with red meat, they are frequently consumed as processed foods (eg, cookies, potato chips, and pizza), hence requiring energy for production, packaging, and transport. Additionally, there is concern about their adverse effects on the risk of some non-communicable diseases. More work is needed on the greenhouse gas emissions and nutritional consequences of different diets. The environmental footprint of red meat varies substantially depending on how animals are fed (eg, whether they consume grain or graze on land unsuitable for arable crops). Devising and implementing low-emission, culturally acceptable, healthy, and affordable diets is an important focus of research and policy.

Data sources

HDDS scores can be derived from national and sub-national surveys of food consumption.[80] The composition of the food groups will of course vary across different settings. Data for fat intake and consumption of red (ruminant) meat can also be derived from national food security and food consumption surveys[104] collected by the Food and Agriculture Organization (FAO) and elaboration of the FAO Food Balance Sheets.[105] Data for average number of fruit and vegetable servings per day are available from WHO STEPS surveys, although good data for children and adolescents are not available and thus the emphasis here is on ages 18 years and above.[106] Global availability of data, however, is less consistent than for anthropometric indicators and needs improved emphasis on tracking and monitoring systems. Regular dietary surveys would be needed to track changes over time, which would be a substantial challenge for some resource-poor countries, and might limit the acceptability of the indicators under target 3 in the near future.

* The UN Secretary-General's Zero Hunger Challenge, launched at the Rio+20 Conference, called for an integrated approach to sustainable foods and food security citing five key targets, including 100% access to adequate food all year round and zero stunted children younger than 2 years.[99] The World Health Assembly (2012) agreed to a target of 40% reduction in the number of stunted children by the year 2025, corresponding to a 16% prevalence rate in 2025. By 2030, at an accelerated reduction rate, 13% prevalence could be reached.[107] A realistic target could be 10%. An aspirational target, but still meaningful, could be to bring stunting below 5% prevalence. Early intervention to prevent stunting is also important; existing data could be reanalysed to monitor stunting in children younger than 2 years. Stunting is also affected by other determinants such as availability of clean water.[107] †Age standardised prevalence of overweight and obesity in people aged 18+ years is defined as BMI more than or equal to 25 kg/m^3 for overweight and BMI more than or equal to 30 kg/m^2 for obesity. Prevalence of overweight and obesity in adolescents (defined according to the WHO growth reference for school-aged children and adolescents) is, for overweight, 1 SD above the mean BMI for age and sex; and for obese, 2 SDs above the mean body-mass index for age and sex. For children younger than 5 years, the cutoffs are 2 SD for overweight and 3 SD for obesity of WHO growth standards.

and support local environmental biodiversity.[116] The production of indigenous varieties of fresh fruits, vegetables, and other plant-based products, grown in season, might generate fewer greenhouse gas emissions per food unit than imported food products, and particularly animal-based products and processed foods.[117,118] However, local production of exotic or out-of-season varieties of fruits and vegetables might be healthy nutritionally but still require considerable chemical, water, or energy inputs, which offset the energy savings from transport.[117] With such limitations in mind, panel 4 suggests some health indicators.

Limitations of the analysis

Although this Review emphasises the co-benefits emerging from sustainable development policies, the possibility of co-harms arising from certain policies should be addressed. For example, improving the energy-efficiency of housing through improved insulation can reduce ventilation and thus increase indoor air pollution.[13] Our examples were focused on climate change mitigation strategies and more work is needed on the health implications of other threats to sustainability, including biodiversity loss and ocean acidification.

Limitations of this analysis include the potential incompleteness of evidence about linkages, the dependence on expert opinion, and broad scoping scientific-literature reviews. We tried to address these limitations by pre-defining criteria to identify links between development policies and health. We placed emphasis on indicators for which data are already available, or that could be developed with reasonable additional effort. This approach has restricted the scope of indicators covered here but also makes indicators proposed a realistic proposition.

The need for improved data is common to all the areas discussed here. Collection of new indicators capturing intersections of sustainability and health demands innovative methods and analysis.[119] These indicators will need to be meaningful and valuable to persuade decision makers to make the necessary investments in data collection and reporting. We do not propose specific targets because these will be subject to extensive negotiations by governments.

Another limitation of this paper is the focus on the physical environment and environmental-health determinants. Social and economic development are also recognised as pillars of sustainable development. The health co-benefits of socioeconomic policies—eg, to create jobs or facilitate trade—are not discussed in detail here.

At the same time, many of the environmental-health indicators suggested—from access to clean water to slum housing improvements and nutrition quality—also relate to social, economic, and equity issues, and indicators could be disaggregated to monitor social gaps and inequities.

Taking into account health and other co-benefits of sustainable policies can help to offset their costs[61] and bring additional benefits to society. More research is needed to document the overall effects on the macro-economic and sector policies in different settings.

Conclusions

Data for some of the indicators suggested here are available from a large number of countries; in the case of other indicators, data are partial, or at an early stage of development. Universal data availability, however, should not be perceived as an absolute prerequisite for indicator selection, because the data coverage for many MDG indicators improved over time.[72,73] Data for some proposed indicators (eg, those that require dietary surveys) could be optional at the outset with the possibility of their complete introduction in the future.

Some proposed indicators can be used to monitor progress in more than one development area—eg, air pollution is an important indicator both for sustainable cities and sustainable energy systems, which increases potential efficiencies of data collection and monitoring.

The potential indicators covered in this Review are examples that connect development policies, determinants of health, and health outcomes. Indicators showing such linkages can support better governance, improve accountability, and facilitate communication with communities, civil society, and the private sector. They constitute a key guide for the health sector to support implementation of Health in All Policies, and a contribution to the OWG deliberations.

Similar to the MDGs, new post-2015 SDGs are likely to affect global development policies for many years to come. Integration of the benefits to health and wellbeing into decisions to improve sustainability can encourage change towards more sustainable patterns of resource use and consumption and improve public health. These changes are essential to avoid widespread and profound damage to ecosystems, upon which human existence, as we know it, ultimately depends.

Contributors

CD conceived this article and wrote the first draft, with contributions from AH, JB, EF and MN. CD, AH, and EF contributed to data analysis and findings, with subsequent contributions from JB and HAR about energy, GA about cities, RH about water, and MDO and FB about food. CD organised the WHO expert consultation contributing to the analysis, which was co-organised by JB. CD, AH, JB, MN, and FB contributed to the consultation. CD, AH, and EF identified gaps and issues and coordinated inputs from co-authors. All authors contributed to the literature review and data interpretation, reviewed successive drafts, and approved the final version of the article.

Declaration of interests

AH is a member of the Thematic Group on Health for All of the Sustainable Development Solutions Network (SDSN; http://unsdsn.org) and has contributed to their discussions on indicators relevant to health. The SDSN was launched by the UN Secretary-General in August, 2012, and mobilises scientific and technical expertise in support of sustainable development. This Review is the work product of employees of WHO (CD, EF, MN, FB, RH, MD, HA-R), as well of as one employee (JB) of the National Institutes of Health (NIH), USA. However, the statements, opinions, or conclusions contained therein do not necessarily represent the statements, opinions, or conclusions of the NIH, its component

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