

# Climate Change, Noncommunicable Diseases, and Development: The Relationships and Common Policy Opportunities

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## Keywords

health inequities, mitigation, adaptation, health cobenefits

## Abstract

The rapid growth in noncommunicable diseases (NCDs), including injury and poor mental health, in low- and middle-income countries and the widening social gradients in NCDs within most countries worldwide pose major challenges to health and social systems and to development more generally. As Earth's surface temperature rises, a consequence of human-induced climate change, incidences of severe heat waves, droughts, storms, and floods will increase and become more severe. These changes will bring heightened risks to human survival and will likely exacerbate the incidence of some NCDs, including cardiovascular disease, some cancers, respiratory health, mental disorders, injuries, and malnutrition. These two great and urgent contemporary human challenges—to improve global health, especially the control of NCDs, and to protect people from the effects of climate change—would benefit from alignment of their policy agendas, offering synergistic opportunities to improve population and planetary health. Well-designed climate change policy can reduce the incidence of major NCDs in local populations.

**NCDs:**  
noncommunicable  
diseases

**GHGs:** greenhouse  
gases

**CVD:** cardiovascular  
disease

## CLIMATE CHANGE AND HEALTH: THE STORY SO FAR

Attributes of our modern world, including over- and inequitable consumption, have contributed to the increase in noncommunicable diseases (NCDs) and their unfair social distribution (1). These same social attributes, along with continuing growth in the global population, have led to increased atmospheric concentrations of greenhouse gases (GHGs), particularly CO<sub>2</sub>, methane, and nitrous oxide, and to climate change (2). This combined concentration of GHGs means that Earth's average surface temperature will rise by at least 2°C by 2050, with a further total warming by 2100 to within the range of 1.8°C–4.0°C (3). As the temperature of the planet rises, there are, and will be, more frequent and severe floods, droughts, storms, and heat waves.

These changes to Earth's biophysical system will exacerbate and extend the rates and ranges of many diseases and overall poor health among all populations (4, 5). And without a lessening of background rates of diseases, the multiplier effects of climate change on health outcomes will greatly exacerbate existing health inequities between and within countries, which poses a major additional challenge to international development (6). One major, although conservative, estimation suggested that the extent of climate change that had already occurred by the year 2000 was directly responsible for the loss of at least 5.5 million disability adjusted life years (DALYs) in that year (7) and that the poorest countries and populations experienced the greatest proportion of the disease burden (8). That assessment related only to diarrhea, malaria, injuries from coastal and inland floods or landslides, and malnutrition.

To date, much of the climate change and health research effort has focused on infectious diseases, along with deaths and injuries from extreme weather events, the adverse health effects of heat extremes, and risks of undernutrition due to declines in food yields. In general, the range of possible impacts on NCDs has received little attention. However, climate

aside, the current and projected estimates of the ten leading causes of disease globally indicate a predominance of NCDs, with rapid growth in low- and middle-income countries (9) and higher prevalence, generally, among lower socioeconomic groups. NCDs will likely be affected by climate change in two ways. First, climate change itself may directly and indirectly increase the incidence of NCDs. Second, policy responses to climate change—both adaptation and mitigation—will likely have both positive and negative implications for NCDs.

In this article, we aim to bring together the climate change and NCD agendas. In the first section, we describe the relationship between climate change itself and risk of different NCDs. The second section explores how well-designed climate change policy in three key areas—urbanization, food systems, and energy generation systems—may affect NCDs, thereby identifying how action in these sectors could provide benefits for both population and planetary health. Although this article focuses only on the above mentioned policy areas, urgent action is also required in a number of other areas including population growth.

## CLIMATE CHANGE–RELATED PATHWAYS TO NONCOMMUNICABLE DISEASES

The most common NCDs (heart disease, stroke, cancer, type 2 diabetes, and respiratory diseases) accounted for 60% of the 58 million global annual deaths in 2004 (9). The current and projected growth in mortality from NCDs is mainly in low- and middle-income countries (Figure 1).

This section of the article provides a brief overview of the climate change impacts on major NCDs and is summarized in Table 1.

### Climate Change Effects on Cardiovascular Health

Climate change may increase the risk of cardiovascular disease (CVD) through three main exposure pathways: directly via air pollution

**Table 1 The direct and indirect pathways from climate change to NCDs<sup>a</sup>**

Climate change impacts	Pathway from climate change to NCDs	NCD outcome	Direction of health risk
<i>Direct</i>			
More frequent and increased intensity of heat extremes	Heat stress	CVD Respiratory disease	Increased risk
Increased temperatures and less rainfall	Higher ground-level ozone and other air pollutants	CVD Respiratory disease (e.g., bronchitis, asthma)	Increased risk
	Increases in airborne pollens and spores	Respiratory disease (e.g., bronchitis, asthma)	Increased risk
Changes in stratospheric ozone and in precipitation and cloud coverage	Increased exposure to solar UVR	Autoimmune diseases (multiple sclerosis)	Reduced risk
Higher winter temperatures in temperate latitudes		CVD Respiratory disease	Reduced risk
Extreme weather event (fires, floods, storms)	Structural damage	Injuries	Increased risk
<i>Indirect</i>			
Drought, flooding	Impaired agriculture, reduced food yields, and nutrition insecurity	Poor general health	Increased risk
Extreme weather event (fires, flooding, storms)	Trauma	Mental health (posttraumatic stress disorder)	Increased risk
Extreme weather event (fires, flooding, storms)	Impaired livelihood, impoverishment	Mental health (anxiety/depression)	Increased risk

<sup>a</sup>Abbreviations: CVD, cardiovascular disease; NCDs, noncommunicable diseases; UVR, ultraviolet radiation.

and extreme temperatures and indirectly via changes to dietary options.

Exposure to air pollutants may increase as a result of climate change because of its effect on (a) weather and thereby pollution concentrations, (b) anthropogenic emissions, (c) natural sources of air pollutants, and (d) the distribution and types of airborne allergens. Several environmental air pollutants, which include carbon monoxide, oxides of nitrogen, sulfur dioxide, ozone, lead, and particulate matter, are associated with increased hospitalization and mortality due to CVD (10).

Most regions of the planet are expected to become warmer because of climate change. In the densely populated tropical and subtropical areas, the highest temperature increases are mainly in inland areas within the large continents with an expected increase of 1–3°C by 2020 and 3–5°C by 2080 (38). Heat-related mortality and morbidity arise from overloading

the cardiovascular and respiratory systems (12). The physiological reactions to increased heat exposure include increased core body temperature, increased heart rate, shift of blood flow from central organs to skin, increased sweating, and associated dehydration if sufficient replacement liquid is not consumed. Combined cardiovascular effects of exposure to heat and air pollutants during hot seasons have been reported in many cities (13). The August 2003 heat wave in Western Europe incurred an estimated excess mortality of more than 70,000 deaths, especially from cardiovascular and respiratory causes (14, 15). Global warming will also likely reduce winter CVD and respiratory deaths, but physiological adaptation to increasing temperatures will blunt much of this benefit and some but not all of the impacts of heat extremes.

Some NCD effects occur at several removes from the actual change in climate. The

ongoing warming in the Arctic region, and the attendant loss of sea-ice and permafrost, is disturbing traditional living, hunting, and eating patterns in the Inuit communities of northern Canada (16). This change has reduced physical mobility options and increased reliance on imported energy-dense processed foods, thus potentially amplifying obesity, CVD, and diabetes (17).

### Climate Change Effects on Respiratory Health

Changing climate conditions and increasing temperatures will compromise outdoor air quality by increasing the production of tropospheric ozone (18). Ozone exposure will contribute to increased respiratory tract irritation, chronic pulmonary disease hospitalizations (19), and lung disease mortality (13, 20). The fine-particle air pollution arising from the fuel cycles for fossil fuels not only cause climate change but also increase the risk of acute respiratory infections (21). Extraordinary spring pollen counts have been recorded in North America in recent years, and the early arrival of spring is extending the spring allergy and asthma seasons, with implications for increased risk of respiratory and allergic diseases (22–24). Growing evidence indicates that warmer and drier climates will result in an increased area burned by bushfires (25), resulting in greater air pollution. More intense bush fires may therefore increase the risk of respiratory illness (and also cardiovascular events), particularly among susceptible groups such as asthmatics, children, and the elderly (26).

### Climate Change and Cancers

Global climate change will alter the trajectory of recovery of stratospheric ozone and, with changes in precipitation and cloud coverage, alter ambient ultraviolet radiation (UVR) and its spectral composition. Additional changes in ambient temperature, precipitation, and cloud coverage will alter sun exposure behavior.

Climate change thus has the potential to change the risk of UV-related health outcomes, including cancers (27).

Climate change may bring new pests, diseases, and weeds into the agricultural system (28). Some pests will be able to invade new areas and become increasingly problematic for the maintenance of biodiversity, the functioning of ecosystems, and the profitability of crop production. Depending on how this effect is managed, increasing use of herbicides and pesticides could lead to greater contamination of some foods and greater human exposure and raise the risk of cancers (29). As climate warms and weather patterns become more erratic, liver cancer, through aflatoxin contamination (30), may become an increasing problem. These fungal metabolites contaminate cereals and pulses; dry, hot conditions can increase the risk of contamination during crop growth, whereas the harvesting and storage of mature crops are at risk of contamination during wet conditions (31).

### Climate Change and Mental Health

Increasing frequency and intensity of extreme temperatures and weather events, and increased competition for scarce natural resources, on top of existing social inequities, are likely to affect interpersonal and intergroup behavior and may result in increased stress and anxiety. Even in the absence of direct impacts, the perception and fear of climate change may threaten mental health (32, 33).

Populations exposed to extreme weather events such as hurricanes, tornados, floods, fires, drought, and tsunamis may experience immediate mental health consequences. Coker et al. (34) report that 63% of Hurricane Katrina evacuees experienced either moderate or severe symptoms of post-traumatic stress disorder. However, most psychosocial effects of climate change are likely to be gradual and cumulative. Climate change–vulnerable communities are beginning to experience disruptions to the social and economic determinants

of mental health (33). Droughts are predicted to become more frequent and severe in many subtropical regions of the world. In addition to causing hunger, droughts cause displacement (35), farming jobs are lost, and anxiety, depression, and suicide rates, especially in farmers, often rise (36). The long-term drying in areas such as southern Australia, parts of southern Africa, southern Canada, and the Mediterranean region may significantly increase the incidence of poor mental health outcomes (37).

### Climate Change and Injuries

Extreme weather events—such as the cyclones that have struck coastal populations of Bangladesh, Myanmar, and Vietnam in recent times—injure and kill. Likewise, the hurricanes that frequently impinge on the Caribbean cause injury, death, and distress (38). Sea level may rise by one meter or more by the end of this century (39), which has significant implications for the one-third of the world's population who live within 60 miles of a shoreline and 13 of the world's 20 largest cities located on a coast. Coastal inundation, more extensive episodes of flooding, increased frequency of increasingly severe storm surges (especially at times of high tide), and damage to coastal infrastructure (roads, housing, and sanitation systems) all pose direct risk of injury. Temperature extremes affect physiological functioning and accident-proneness. Outdoors workers and those working in poorly ventilated hot conditions may be at increased risk of injury (40).

### Climate Change, Other NCDs, and NCD Resilience

The projected changes in stratospheric ozone and in precipitation and cloud coverage will alter solar UVR. Research indicates that increased exposure to solar UVR can reduce the risks of various autoimmune diseases, including, in particular, multiple sclerosis (41).

Food systems are (and, increasingly, will be) affected by climate change (42). The drought-

prone and long-term drying conditions in subtropical regions, higher temperatures, rising sea levels, increasing frequency of flooding, and acidification of oceans are now beginning to contribute to impaired yield, quality, and affordability of food in many countries (42, 43). Just considering cereal production, Fischer and colleagues (44) predicted, by 2080, climate change-related production losses in 40 developing countries (mainly in Sub-Saharan Africa), which have a combined population of 2 billion. The implications are significant for the number of people living in hunger-prone and chronic food insecure situations, with consequences for increased susceptibility and reduced resilience to NCDs and infectious diseases.

### THE NCD IMPACT OF STRATEGIES TO ADDRESS CLIMATE CHANGE

This section of the article addresses the effects on NCD risks of climate change mitigation and adaptation responses. The underlying determinants of NCDs and of climate change overlap substantially. Policy responses that aim to address common determinants may reduce NCD levels, could help avoid further climate change, and may assist in the management of existing climate change.

GHG emissions have grown largely as a result of industrialized societies' demand for ever-increasing volumes of production and consumption, along with increasing numbers of consumers globally as a result of population growth. The associated GHG emissions arise largely from the energy, transportation, land use and forestry, agriculture, and building sectors (45). Each of these sectors is intimately linked with public health. For example, the makeup of the built environment and transport systems and the nature of global food systems shape the recognized behavioral risk factors associated with NCDs (46, 47). Climate change mitigation and adaptation policies therefore have the potential to impact on NCDs and are explored now in detail (summary in **Table 2**).

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**Climate change mitigation:** measures or actions to reduce global warming and most often involves reductions in the concentration of greenhouse gases

**Climate change adaptation:** enhancing resilience or reducing people's vulnerabilities to observed or expected changes in climate

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**Table 2 The noncommunicable disease (NCD) effects of climate change mitigation and adaptation strategies**

Sector	Strategy	Climate change implications	Pathway from climate change to NCDs	NCD risk
Energy	Reduce household use of solid (biomass) fuels	Mitigation: reduce GHG emissions	Reduced indoor air pollution	Reduced CVD Reduced respiratory diseases Reduced COPD
	Generate cleaner electricity	Mitigation: reduce GHG emissions	Reduced outdoor pollution	Reduced respiratory diseases
	Improve household energy efficiency: provide efficient heating and cooling appliances, improve home insulation	Mitigation and adaptation		Reduced CVD Reduced respiratory diseases Reduced extreme temperature mortality
Urban planning	Improve walking and cycling infrastructure	Mitigation: reduce GHG emissions	Increased active transport, physical activity	Reduced CVD Reduced obesity Reduced respiratory diseases
	Develop and support community hubs	Mitigation: reduce GHG emissions	Increased connectivity; reduced use of fossil fuel-dependent cars; more active travel	Reduced obesity Reduced CVD Reduced heat stress Reduced respiratory diseases Improved mental health
	Reduce use of fossil fuel-dependent cars, supply hybrid or electric cars for fleet vehicles	Mitigation: reduce GHG emissions	Reduced urban air pollution; reduced road traffic volume	Reduced lung cancer Reduced respiratory diseases
	Improve urban design, including street trees, pedestrian crossings, more footpaths, reduced distance to public transport, more urban green space	Mitigation and adaptation	More social connectivity; more shade; greater walkability and active travel	Reduced obesity Reduced CVD Reduced heat stress Reduced respiratory diseases Improved mental health
Food and agriculture	Reduce production and consumption of animal source products	Mitigation: reduce GHG emissions	Less saturated fat intake	Reduced CVD Reduced colorectal cancer Reduced general health
	Support rural development: new food production techniques, rural livelihoods	Adaptation: improve resilience to climate change	Improved and expanded supply of nutritional food sources	Decreased undernutrition and improved resilience to NCDs
	Food system diversification: invest in urban agriculture	Adaptation	Increased food security	Increased resilience to NCDs

<sup>a</sup>Abbreviations: COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; GHG, greenhouse gas; NCDs, noncommunicable diseases.

### Climate Change Strategies Relating to the Energy Sector and NCD Implications

The burning of fossil fuels is the main contributor to global GHG emissions (2). Human use of energy via electricity, transport, industrial production, and fuel is based predominantly on

fossil-fuel production and use. Urgent changes in power generation and energy use in all sectors are necessary, especially in high-income countries where a halving of emissions is needed by 2030 (48). Two key mitigation policy areas associated with the energy sector are also likely to provide benefits to NCDs: energy generation and domestic energy use.

**Energy generation.** One of the main pathways linking electricity generation to climate change and human health is through the fine-particle air pollution arising from the fuel cycles for fossil fuels. These emissions not only cause climate change but also increase the risks of CVD, lung cancer, and acute respiratory infections (21, 49, 50). Public health benefits in terms of reductions in local air pollutants will be gained if fossil fuel–based sources for power generation (coal, oil, and gas) are reduced. Modeling the health effects of cutting emissions from the electricity generation sector by 50% in high-income countries and less in low-income countries, by 2030, through decarbonizing energy production would provide health gains in India and China of ~1,500 and 500 life-years per million people, respectively. In the European Union, the benefits would be more modest, at ~100 life-years per million people in 2030 (51).

**Domestic energy.** Improvements in the type of fuel used and of energy efficiency in domestic homes and buildings are vital for equitable public health outcomes (51). The burning of traditional solid fuels is a major contributor to climate change through deforestation as result of biomass fuel demand, which results in the loss of carbon sinks (38). Cooking technologies such as some types of biomass stoves also make a significant contribution to regional climate change via air pollution, specifically black carbon, which acts as a local warming agent and contributes to glacial melting (52). Biomass fuels are probably the greatest source of human pollution exposure (53); the poorest half of the world's households rely on such fuels (54). Indoor smoke from inefficient burning of biomass fuels contributes not only to climate change but to lung cancer, lower respiratory infections and pulmonary disease, low birth-weight, cataracts, and possibly asthma and heart disease, a total of some two million deaths per year (21, 55, 56). Modeling the effects of a hypothetical climate change mitigation strategy—the introduction of 150 million low-emissions household cook-stoves in India over a 10-

year period—would, by 2020, avert ~240,000 premature deaths from acute lower respiratory infections among children aged younger than 5 years and more than 1.8 million premature adult deaths from ischemic heart disease and chronic obstructive pulmonary disease (54).

Badly constructed buildings are difficult to heat and cool, thereby requiring the inefficient use of fossil fuels. In high-income countries such as the United Kingdom, energy use in residential buildings accounts for ~140 megatons of carbon dioxide emissions or ~26% of total emissions. Substantial reductions in these emissions are achievable through energy efficiency improvements (54). A community trial in New Zealand found that insulating low-income households resulted in improved self-reported wheezing, fewer days off school and work, and fewer visits to general practitioners, as well as a trend for fewer hospital admissions for respiratory conditions (57). Retrofitting existing homes would likely improve heart and respiratory illness, lift poor people out of fuel poverty, and help reduce carbon emissions. It would also help households adapt to more intense and frequent temperature extremes. However, the construction of energy-efficient buildings should not create tight buildings that do not allow sufficient circulation of fresh air, which can contribute to indoor air quality problems.

### **Climate Change Mitigation and Adaption Strategies through Urban Planning and NCD Cobenefits**

The world is predominantly urban and becoming increasingly so. Most of the future urban growth will take place in cities in low- and middle-income countries (58). A key challenge, and opportunity, is to ensure that current and future urban development is done in such a way that prevents NCDs, reduces poverty, and builds societies that live within environmental limits (59, 60). Potential climate change mitigation and adaption policy options and the NCD cobenefits are described below.

### Urban design and the built environment.

Urban design that supports greater street connectivity and balanced land use mix with more residential than nonresidential density mitigates climate change through the incentives that people and organizations are given to pursue low carbon emission activities. Such designs have implications for NCDs. Compact, walkable urban environments are a key mechanism to promote physical activity and reduce body mass indices, car travel, and air pollution (61). The positioning of vital community resources such as schools, parks, and health centers near residential and commercial areas (60) is important for health and climate change mitigation. Workplace proximity is a major influence on the commuting decision to walk (63).

In addition to compact community hubs, climate change mitigation and NCD prevention can be achieved through urban design that incorporates green spaces within communities, focused along transportation routes and floodplains (64). Enhancing urban green spaces will help mitigate climate change through CO<sub>2</sub> biosequestration, and proximity to, and time spent in, the natural environment (green space) also has a strong positive impact on general health, stress, blood pressure, and mental health (33). The presence of green space also has indirect benefits for NCDs by encouraging physical activity and social connectedness, improving air quality, and reducing urban heat island (UHI) effects (65). Green space may also help reduce health inequities; English-based research found that those populations exposed to the greenest environments had the lowest levels of socioeconomic inequalities in health (66).

Urban environments amplify climate change-related health risks owing to the UHI effect. The UHI effect results from higher average temperatures due to the lack of shade and vegetation, as well as to dark road and building surfaces in urban settings (67). The actual built environment (offices, residential, and others) produces GHGs through fossil fuel-based energy consumption via heating and cooling and through other electrical equipment. The conglomeration of nonresi-

dential buildings often results in a lack of green space as well as an accentuation of the UHI effect (67). Health impacts of the UHI effect are socially graded: Lower socioeconomic and minority ethnic groups are more likely to live in warmer neighborhoods and lack the sufficient resources to cope appropriately (68). Mitigation and adaptation strategies could include the introduction of a mandatory green rating system for all residential and nonresidential buildings as part of the building code. Support could be given to create urban gardens and green roofs, thereby helping to biosequester CO<sub>2</sub> emissions and providing a space for sustainable social activities.

**Transport systems.** Transport systems reliant predominantly on fossil fuel are a major contributor to climate change and a common determinant of the health effects arising from urban air pollution, traffic injury, and physical inactivity (69–72). The greatest health burden from fossil fuel-based transport is in the mega-cities of developing countries (72). Many of the health risks are also strongly linked to socioeconomic status. Road traffic injuries have one of the steepest socioeconomic gradients, and many of the environmental impacts tend to fall disproportionately on poorer populations (73).

Local neighborhoods that are easily accessed and navigated by active transport such as walking and cycling (see previous section), combined with high-quality public transport for longer journeys (powered by renewable energy), are vital for climate change mitigation and will lead to increased levels of physical exertion, thereby reducing obesity and CVD, traffic injuries, and levels of respiratory illness (72). The greatest human health and climate change mitigation premium would, however, come from a shift to zero-emissions vehicles plus active travel: Woodcock and colleagues (74) estimated that reducing CO<sub>2</sub> emissions through an increase in urban active travel (i.e., walking or cycling) and use of lower-emissions motor vehicles could achieve a 10%–19% reduction in London and a 11%–25% reduction



in Delhi in the number of years of life lost from ischemic heart disease. Transport policy that has active transport as its central focus, plus the provision of hybrid or electric cars for fleet vehicles (in all public sector institutions), would help achieve both climate change and NCD goals.

### **Climate Change Strategies in the Food and Agriculture Sector and NCD Cobenefits**

Agricultural production, food trade, and food manufacturing and retail determine the types of food available for purchase and consumption and its nutritional quality, physical location, and price. Each of these factors contributes to food security, dietary intake, and diet-related NCDs (75). Various climate change mitigation and adaptation strategies within the food and agriculture sector have implications for NCDs and are described below.

**Climate change mitigation through changes in animal source food production and consumption.** GHGs are produced at all stages in the food system. However, the agricultural production stage represents the single biggest contributor to the overall food sector emissions; according to calculations by the Intergovernmental Panel on Climate Change, agriculture plus associated deforestation and land use changes account for ~29% of global emissions (76, 77). Production of foods from animal sources is the major contributor to emissions from the agricultural sector.

An unhealthy transition from plant-based diets to diets of highly refined foods and of meat and dairy products is occurring in all but the poorest countries (78), particularly among the urban middle classes (79). Although animal source products are important sources of essential nutrients, they are also significant contributors to CVD and colorectal cancer (30, 80, 81). The increasing demand for agriculturally intensive animal foods such as meat and dairy, especially in emerging economies, has serious

ramifications for both climate change and human health (82).

Given that the bulk of emissions from the food and agriculture sector is due to livestock production, a key climate change mitigation strategy would sensibly focus on this area. A recent international research program on the health cobenefits from actions to reduce GHG emissions in a number of different sectors (83) identified that, combined with technological improvements in farming practices, a 30% reduction in production and adult consumption levels of animal source foods would be needed to meet select national emissions targets. That 30% reduction in consumption of animal-source foods would reduce the years of life lost from ischemic heart disease by an estimated 15% in the United Kingdom and 16% in Sao Paulo, Brazil (84). These dietary changes would prevent not only ischemic heart disease but also some cancers and possibly reduce obesity.

**Climate change adaptation: food system diversification.** Climate change is affecting the food system, contributing to impaired quantity, quality, and affordability of food in many countries (42). Countries in the tropics and subtropics, where both warming and reduced rainfall are likely to occur, are at greatest risk of climate-related impacts on food yields (85, 86). Cereal grain yields in South Asia may decline by 10%–20% by later this century (38). Climate change pressures on yield, water, and fuel costs are already resulting in increasing food prices, which may exacerbate the NCD burden and health inequities: Some people will be able to purchase a healthy diet; some will only be able to purchase the cheapest sources of calories—energy-dense highly processed products that increase the risk of obesity and diabetes, and many millions will be unable to afford even that (87). Rural livelihoods are also vulnerable to climate change with subsequent impact on social and health conditions, thereby jeopardizing achievement of the United Nations Millennium Development Goals (42).

Adaptive responses to climate change by domestic food systems are therefore important components of climate change policy responses and development, helping to ensure that nutritious food is available regularly and at affordable prices, thereby reducing undernutrition and increasing resilience to NCDs. New food production techniques and improved food storage facilities are needed to enhance adaptive capacity, especially in regions where food yields will be most affected. Costly initiatives such as the development of new crop varieties may provide major benefits for food production; however, developing countries need support to finance such adaptation measures (88, 89).

Urban agricultural policies may help ensure the local provision of nutritious foods in climate-stressed conditions while also creating a local food supply that is environmentally sustainable (90). Although urban agriculture is unlikely to provide food yields that can compete with industrialized food production systems, and local production of food may not necessarily be less carbon intensive than industrial

practices, there are, however, lessons from developing countries with extensive experience in urban agriculture for food security purposes to provide examples of practical ways forward.

## CONCLUSION

Climate preservation and the improvement of health for people everywhere are inextricably linked. Coherent and sensitively designed cross-sectoral policies and programs in agriculture, energy use, and urban planning may produce major potential cobenefits for people and planet. However, if done badly, climate change policy in these areas may increase the prevalence of NCDs globally and widen health inequities. Addressing the environmental and social determinants of NCDs will improve global health, but advances will also be made in poverty eradication and social equity such that people, communities, and nations will be able to resist current climate change and avert further damage to the global environment and climate.

## SUMMARY POINTS

1. Climate change will exacerbate levels of cardiovascular and respiratory diseases, poor mental health, injuries, and malnutrition.
2. Climate change-related health impacts will increase pressure on health and social systems in low- and middle-income countries experiencing rapid growth in their burden of NCD.
3. Well-designed climate change mitigation strategies could provide a win-win opportunity: They would lower GHG emissions and concurrently reduce NCD risk in local populations, thus helping countries improve health, support development, and achieve national emission targets.
4. Reductions in urban air pollution and indoor air pollution have great potential cardiovascular and respiratory health benefits in low-income countries.
5. A shift toward active transport would result in widespread cardiovascular health gains and reduced risk of cancer, poor mental health, and other chronic conditions in all countries.
6. Reductions in both CVD and some cancers would arise from a reduction in the production and consumption of animal-source products among high-consuming populations.
7. Climate change adaptation strategies, if done well, can help manage existing climate change by creating living conditions that reduce the risk of NCDs and support development.

## FUTURE ISSUES

1. What is the relative contribution of climate change to global NCD rates?
2. How does climate change interact with existing NCD risks, and what will be the impact on development and global health?
3. How much of the global, regional, and national NCD incidence levels could be prevented through climate change mitigation action?
4. How much health benefit arises from different climate change adaptation strategies?

## DISCLOSURE STATEMENT

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the World Health Organization.

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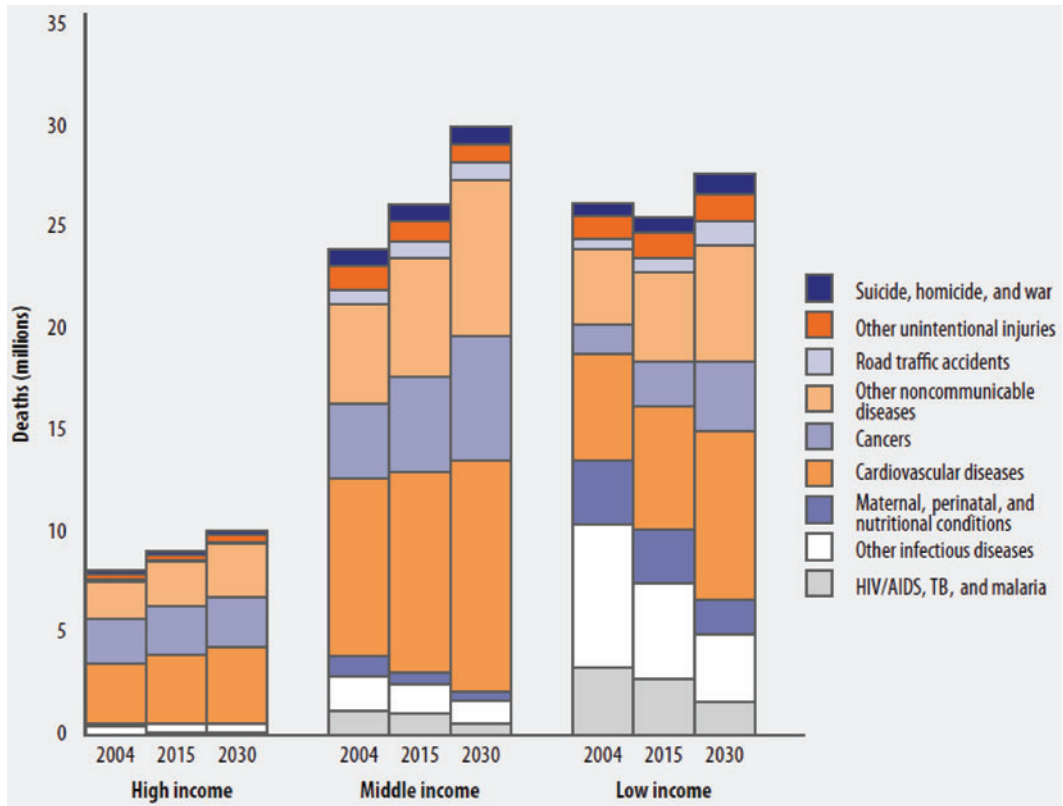
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**Figure 1**

Projected deaths by cause for high-, middle-, and low-income countries (9)





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