Promoting health through climate change mitigation in Europe

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Several EU climate change mitigation policies have the potential to deliver health co-benefits. However, existing frameworks guiding research in this area lack important details that are needed to understand how evidence of health co-benefits can be used to support the ambition and acceptability of EU climate policy. In this Personal View, we propose an integrated framework for advancing the state-of-the-science on health co-benefits of climate change mitigation and realising the societal effect of evidence documenting co-benefits. We apply this framework to the EU context. Our framework spans multiple economic sectors—including land use, land-use change, and forestry and health systems—and provides details on the different types of mitigation actions, levers of change, and societal actors with the agency to implement specific mitigation actions. This framework aims to inform future research on the magnitude of health co-benefits of climate change mitigation, and provide strategies to communicate health co-benefits to support increases in mitigation ambition and societal acceptance of mitigation actions.

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Introduction

Mitigating climate change by reducing emissions and enhancing sinks of greenhouse gases (GHG) is essential for protecting human health and reducing the costs of adaptation.[1] Mitigation has been shown to deliver sizeable additional co-benefits—ie, the positive effects of policies aimed at reducing GHG emissions or increasing sinks on other objectives, such as improving public health, the environment, the economy, and equity.[2,3] In the past few years, several reviews have provided a comprehensive synthesis on the available evidence of health co-benefits of mitigation globally.[4,5] The health co-benefits of climate change mitigation are compelling because they: (1) can be substantial; (2) can potentially offset the costs of mitigation through avoided health damages; and (3) can enhance incentives for mitigation by delivering direct benefits in the short term to local communities (eg, reduced mortality of improved air quality from phasing out of coal-fired power plants)[6,7] or individuals (eg, improved individual health through shifting to plant-based diets or active travel).[3]

Existing conceptual frameworks linking mitigation actions and health vary in their purpose and scope. Bikomeye and colleagues[8] provide a conceptual framework intended to guide research, drawing from a non-systematic literature review that links mitigation and adaptation strategies with health outcomes. The framework considers broad types of interventions (eg, reduced fossil fuel use) spanning several sectors, but does not clearly articulate which interventions apply to which economic sectors, or the specific levers of change or agents that are relevant to the implementation of interventions. Although the framework does consider interventions as part of climate-smart health care, it does not elaborate on the specific interventions and pathways that are related to health co-benefits of mitigation in health care. The Pathfinder Commission provides a broad research framework for mapping evidence on climate change action and health that explicitly considers economic sectors, classes of mitigation actions (drawing from existing approaches to classify types of mitigation actions), implementation strategies (eg, economic instruments and regulatory approaches), and a broad set of health impact pathways that is more inclusive than environmental exposures and health behaviours, including social inequities and structural determinants of health.[4] Although a summary of the diverse range of mitigation actions is considered, the framework does not specifically distinguish between demand-side and supply-side mitigation actions or link specific societal actors with mitigation actions and their co-benefits. WHO has developed a broad framework linking science, policy, and practice for a comprehensive assessment of climate mitigation and adaptation investments, and their impacts on human health.[9] The framework targets broad audiences, including practitioners as well as researchers, to guide the selection of indicators, methods, and models that can be used to generate economic valuations of health co-benefits of mitigation actions. However, a framework with additional granularity regarding the types of mitigation actions, levers of change, and actors in a position to implement these actions is needed to complement these existing frameworks, evaluate the magnitude and nature of health co-benefits, and understand how evidence of co-benefits can be used to support the ambition and acceptability of climate policy among target audiences.

Most of the available evidence on climate change and health focuses on the health impacts of climate hazards, with far less evidence focused on mitigation and health, and the health co-benefits of mitigation specifically.[10] The current literature is often missing clarity on the distinction between averted health impacts of future climate change and the more immediate health co-benefits of mitigation actions, referring to both broadly as co-benefits.[11,12] Therefore, a framework is needed to

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For more on the **CATALYSE consortium** see https://catalysehorizon.eu

promote clarity on the distinct exposure pathways, timelines, and spatial scales underlying averted health effects of future climate change in terms of the health co-benefits of mitigation actions.

As members of the CATALYSE consortium, which aims to generate evidence of health co-benefits related to EU climate policy, we propose an integrated framework for advancing the state of the science on the health co-benefits of climate change mitigation and realising the societal effects of co-benefits evidence. This framework has broad applicability, but in this Personal View, we apply it specifically to the EU policy context.

Although Europe is a large historical and current contributor to global GHG emissions, it is also well placed to lead the way in health-centred climate change mitigation. The EU has several relevant mitigation-related policies and proposals (panel). Through European Climate Law, the EU has a legally binding target to be climate neutral by 2050, with intermediate targets of

***Panel:* Main EU climate change mitigation policies and plans that could deliver health co-benefits**

European Climate Law (adopted in 2021)

Legal objective of achieving climate neutrality (ie, net zero) by 2050. Covers all greenhouse gas (GHG) emissions and all economic sectors. Balance between emissions and removals to be achieved domestically within EU borders.

Key features:

- 2030 target of at least 55% reduction of net GHG emissions compared with 1990
- Recognition of need to enhance EU's carbon sink through land use, land-use change, and forestry (LULUCF) regulation
- Commitment to net-zero emissions by 2050 and negative emissions after 2050

European Green Deal (proposed in 2019)

Policy initiatives to set EU on path to climate neutrality by 2050.

Key initiatives:*

- EU strategy on adaptation to climate change
- EU biodiversity strategy for 2030
- Farm-to-fork strategy
- European industrial strategy
- Just Transition Mechanism
- Clean energy for all Europeans
- EU forest strategy for 2030

Fit for 55 (proposed in 2021 and adopted in 2023)

Set of legislative proposals and amendments to existing legislation to cut EU's net GHG emissions to reach climate neutrality.

Key features:

- EU Emissions Trading System and extension to buildings and road transport
- Social Climate Fund
- Effort-sharing regulation on member states' emissions targets
- Emissions and removals from LULUCF
- Alternative fuels infrastructure
- Carbon Border Adjustment Mechanism
- Reducing methane emissions in energy sector
- CO_2 emission standards for cars and vans
- >40% renewable energy by 2030
- Reduce final energy consumption at EU level by 11·7% in 2030
- Energy performance of buildings (provisional agreement in December, 2023)
    - All new buildings should be zero emission by 2030
    - Existing buildings should be transformed to zero emission by 2050

RePowerEU Plan (2022)

Response to energy market disruptions from Russian invasion of Ukraine. Aims to rapidly reduce dependence on Russian fossil fuels by 2027.

Key features:

- Increases renewable energy target of Fit for 55 package from 40% to 45%
- Boosts industrial decarbonisation
- Investments in energy infrastructure and interconnections
- Regulatory measures to increase energy efficiency
- Regulatory framework for hydrogen

Climate Target Plan 2040 (2024)

Communication to start process to establish 2040 climate target putting the EU firmly on a path towards climate neutrality by 2050.

Key features:

- Proposed 90% net GHG emissions reduction compared with 1990

Energy Performance of Buildings Directive (revised in 2023)

Legislation to decarbonise buildings: the single largest energy consumer in EU.

Key features:

- Emission reductions of at least 60% in building sector by 2030 versus 2015 and climate neutrality by 2050
- At least double annual energy renovation rate of buildings by 2030
- Supporting vulnerable consumers to fight energy poverty

Energy Efficiency Directive (revised in 2023)

Key driver to reduce EU's overall energy consumption.

Key features:

- Doubling rate of energy efficiency improvements by 2030
- A fully decarbonised district heating and cooling supply by 2050

*European Green Deal includes Fit for 55 package and European Climate Law.

reducing net GHG emissions by at least 55% by 2030 compared with 1990 levels.[13] The European Climate Law aims to ensure that all EU policies, economic sectors, and actors contribute to this goal. Several policies and measures have been proposed, including the Green Deal and the Fit for 55 legislation package. The Fit for 55 package operationalises the ambition to reach climate law targets of a 55% reduction in GHG emissions in 2030 and climate neutrality goals in 2050. To protect vulnerable individuals, companies, and member states from the unintended negative consequences of climate change policies, the Just Transition Mechanism will provide €55 billion in financing between 2021 and 2027 to alleviate the socioeconomic effects of the transition to net zero.[14] Although progress is currently not moving fast enough to reach the agreed targets, the midterm review of the 8th Environment Action Programme concluded that meeting the 2030 targets of the Green Deal are still within reach if member states implement their commitments to policies and laws.[15] Guiding principles in EU climate policies have been cost-effectiveness in mitigation and economic fairness among member states.[16] Health co-benefits are seldom fully accounted for in climate policy impact assessments,[17,18] with consideration of health co-benefits limited to prevented air pollution.[19] Even with this restricted scope, the societal benefits of mitigation clearly outweigh the costs of inaction.[20]

Gaps addressed by the framework

One of the primary motivations for climate change mitigation policy is to avert the adverse health effects of climate hazards, including heat, drought, floods, storms, and disease-vector spread. Our framework distinguishes these from the health co-benefits or harms of mitigation, which we refer to as positive or negative effects on health resulting from climate change mitigation policy operating through pathways other than climate hazards. We hereafter refer to these as co-benefits for simplicity, but highlight the possibility of mitigation actions affecting exposures in ways that are detrimental to health (eg, increased air pollution concentrations from climate policy promoting diesel-powered over petrol-powered vehicles or the shift to renewable solid biomass for residential heating).[21,22] The majority of health co-benefits studies to date have focused on pathways through air pollution, low-carbon diets, and active travel.[4,5] Although climate change is already affecting health in Europe due to cumulative, historical GHG emissions,[23] actions to reduce CO_2 emissions today will determine the magnitude of climate change hazards and their associated health effects largely after 2050, when the magnitude of climate hazards (eg, temperature) will diverge under global mitigation scenarios (eg, representative concentration pathways; figure 1A).[24] In contrast, health co-benefits start to occur almost immediately with the implementation of mitigation actions.

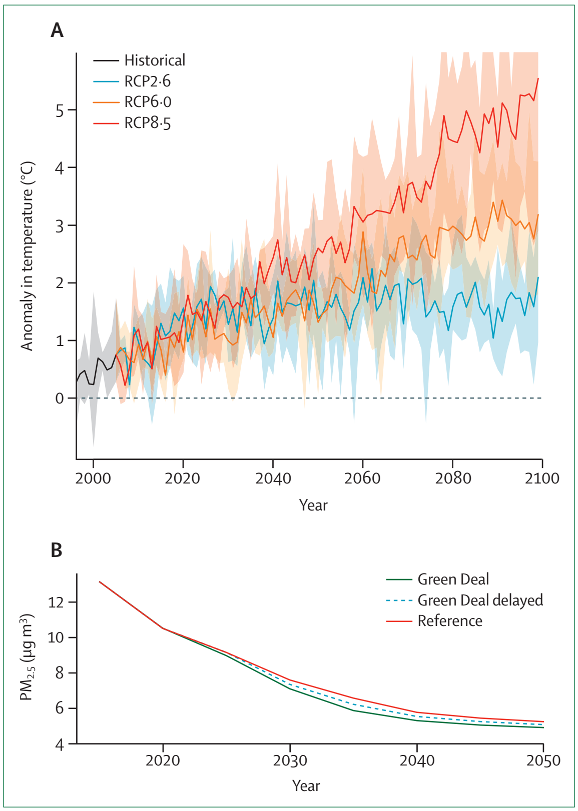

Figure 1: **Projected changes in temperature and air pollution in Europe**
(A) Annual mean temperature in Europe relative to reference period (1976–2005) by RCP scenario. Data described in detail elsewhere.[24] (B) Projected change in population weighted $PM_{2·5}$ under scenarios representing no added climate policy (reference), the Green Deal, and the Green Deal with a 5-year delay in implementation. This projection is based on scenarios developed as part of the CATALYSE project. A full description of this scenarios and emissions modelling work will be published in a publicly available report in due course. (unpublished data). $PM_{2·5}$=fine particulate air pollution. RCP=representative concentration pathway.

A **full description of this scenarios and emissions modelling work** will be published in a publicly available report at https://pure.iiasa.ac.at/

The timing of health benefits is one motivation for highlighting the distinctions between averted health effects of future levels of climate hazards and the more immediate health co-benefits due to other pathways. Projected trends can differ considerably between climate hazards (eg, global air temperature) and important health co-benefits exposure pathways (eg, fine particulate air pollution [$PM_{2·5}$]). Even without more ambitious climate policy beyond what the EU committed to before the Green Deal, $PM_{2·5}$ concentrations in Europe are projected to continue a downward trend due to technology changes and air pollution regulation (figure 1B). These trends imply that delayed mitigation action, compared with early action, not only increases the health impacts of climate hazards in the second half of the century, but also delivers smaller air pollution-related health co-benefits within the next two decades that could be attributed specifically to climate policy and offset mitigation costs.

Particularly when experienced in early life, reductions in harmful exposures (eg, air pollution) or increases in beneficial exposures (eg, green spaces) can deliver co-benefits that accrue over the life course. The potential for large, cumulative health benefits over the life course make children a particularly important subpopulation to consider in health co-benefits of mitigation research. However, children remain an under-represented group in the co-benefits literature, in which the majority of evidence has been based on mortality outcomes and largely focused on adults.[11,25] In the case of air pollution, evidence indicates that air pollution exposure starting as early as the in-utero period can influence health outcomes throughout later life.[26,27] In addition to the ample evidence linking air pollution exposure during adulthood with health in adulthood,[28] reductions in air pollution experienced during childhood have been associated with lung function growth during childhood and adolescence, setting the trajectory for adult health.[29]

The health co-benefits literature has mostly focused on mitigation actions in sectors of the economy with large GHG emissions, namely electricity and heat production, transport, buildings, and food systems.[4,5,11] Including other sectors with clear relevance to both health and climate change mitigation in a comprehensive framework encourages the publication of more detailed studies in less-researched sectors. In particular, emerging but still fragmented evidence supports including land use, land-use change, and forestry (LULUCF) and health systems into a health co-benefits of mitigation framework.

Mitigation actions in LULUCF have been poorly integrated into the health co-benefits literature to date.[30] Climate-smart forest management strategies are important for achieving mitigation goals.[31] A large body of evidence links forests and human health,[32] but very little work has quantified the potential health co-benefits of land-based carbon sinks.[30] Nature-based solutions—ie, actions that simultaneously benefit the environment, climate, and people—have important mitigation potential through indirect pathways, involving behavioural change and resource saving, in addition to the direct pathways of carbon sequestration and storage.[33] For example, microclimate regulation through green infrastructure and urban streetscape greening can promote walking and cycling, reducing vehicle kilometres travelled in cities, and reducing heating-related and cooling-related energy demand.[33] Estimates indicate that nature-based solutions could reduce total carbon emissions by around 17% in European cities via indirect pathways and an additional 6% through carbon sequestration and storage,[33] with potential for considerable health co-benefits.[34] These co-benefits are in addition to those related to adaptation (eg, reduced heat-related morbidity and mortality due to reduced urban heat islands).

Health care in the EU accounts for approximately 5% of EU GHG emissions.[35] Decarbonising health care is a topic that is rapidly gaining momentum,[36] and a growing literature quantifies the attributable health burdens due to the environmental effects of health-care delivery.[37,38] However, to date, health care has not been well integrated into frameworks and multisector studies of health co-benefits of mitigation. Climate change mitigation in health care often operates through other sectors, such as through green buildings, energy efficiency measures, and by promoting active travel and healthy low-carbon diets among staff and patients (table 1). However, there are also pathways by which the health-care system can directly contribute to climate change mitigation that can deliver health co-benefits. One example is by reducing demand for resource-intensive health care by focusing on disease prevention and reducing unnecessary procedures and medications, thereby reducing GHG emissions and resource use, and potential side-effects from unnecessary treatment.[39–41] However, because GHG emission reductions and health benefits cannot currently be effectively quantified, the magnitude of co-benefits that can be achieved in this pathway by optimising the balance between prevention and treatment is uncertain.[42] Sustainable procurement could also deliver health co-benefits given that upstream or downstream activities in the health-care supply chain (excluding those arising from assets directly owned by the health-care system) comprise approximately 70% of health-care emissions.[35] Shifting to sustainable procurement might simultaneously reduce air pollution emissions from industrial processes and goods transport. Additional complex feedbacks link health care with other sectors, as mitigation actions in other sectors can reduce preventable health-care utilisation and its associated climate and health impacts.[41]

An integrated health co-benefits framework

To address the gaps mentioned previously, we propose a comprehensive framework for evaluating the health co-benefits of climate change mitigation (table 1). Our framework spans multiple economic sectors, including LULUCF and health systems, and could be extended to apply to other sectors (eg, industry). Details on how different mitigation actions operate are provided, including societal actors with the agency to take specific actions and how they could shape exposure pathways linked to health.

Our framework explicitly maps change pathways by which mitigation actions can occur, including the type, lever, and agent of change (table 1). For the type of change, we draw on the avoid-shift-improve approach to describe the hierarchy of sustainability actions, which is particularly relevant to modifying behaviours or demand-side activity.[43] This approach has been widely used to describe pathways to improve the sustainability of transport, but is equally useful for describing mitigation actions in other sectors. In this approach, avoid implies a reduction in resource-intensive consumption or activities; shift implies a switch from a less to more sustainable means of consumption; and improve refers to actions that increase the resource

	ASI type	ASI type in health systems*	Relevant plans and policies	Lever for change	Agents of change	Exposure pathways
Transport						
Reduce vehicle km travelled	Avoid: reduce private motor vehicle travel demand	Avoid: reduce travel demand for staff and patients	15-min city, compact urban design; teleworking and services, and sustainable urban mobility plans	Governance, and science and technology	Governments (eg, European Commission, national, and local) and private sector (eg, cycle delivery)	Air and noise pollution, and road traffic injury
Reduce vehicle km travelled	Shift: mode shift from private motor vehicles to public and active modes (eg, passengers)	Shift: promote public and active modes for staff and patients	EU Clean Vehicles Directive and Intelligent Transport Systems Directive	Governance, science and technology, and individual and collective action	Private sector (eg, freight) and individuals (eg, passengers)	Air pollution, noise, road traffic injury, and physical activity
Decrease CO_2 emissions per km	Shift: switch to low CO_2 technology; improve: improve vehicle efficiency	Improve: reduce transport emissions in health facility-managed vehicles and throughout supply chain	EU Renewable Energy Directive; Sustainable & Smart Mobility Strategy and Action Plan; and EU emission standards for cars, vans, lorries, and buses	Governance, and economy and finance	European Commission, national governments, and private sector	Air and noise pollution
Buildings						
Reduce energy use (eg, electricity, heating and cooling)	Avoid: thermostat settings, passive cooling, and behaviour change in appliance use; shift: improve energy efficiency of buildings and appliances	Avoid and shift: reduce energy use in health facilities and buildings used in supply chain	Energy Performance of Buildings Directive, EPC updates, New EU Bauhaus, European Green Deal, and EU taxonomy	Governance and individual actions	European Commission, national governments, private sector, and individuals	Outdoor and indoor air pollution and thermal comfort
Decrease CO_2 emissions per unit energy	Shift: change energy sources or devices	Shift: purchase clean, renewable energy	Energy Performance of Buildings Directive, New EU Bauhaus, EPC updates, European Green Deal, and EU taxonomy	Governance, science and technology, and individual actions	European Commission, national governments, private sector, and individuals	Indoor air pollution and thermal comfort
Food						
Decrease carbon intensity of diets	Shift: increase healthy foods (eg, fruits, vegetables, legumes, nuts, and whole grains) and reduce unhealthy foods (red and processed meat) in diets	Shift: shifting to low-carbon, healthy menus in health facilities	European Green Deal	Governance, economy and finance (eg, price incentives), and individual and collective action	European Commission, national governments, private sector, and individuals (eg, dietary habits)	Diet composition and reduced air pollution
Converge to healthy caloric intake	Avoid and shift: shift to less calorie-dense whole foods over ultra-processed foods; improve: changes in food environment to increase availability of whole foods and decrease availability of ultra-processed foods	Improve: decrease availability of ultra-processed foods in health facilities	European Green Deal	Governance, economy and finance (eg, price incentives), and individual and collective action	European Commission, national governments, and private sector (eg, portion size, and low sugar and fat foods)	Caloric intake
Energy						
Reduce CO_2e of energy sources	Shift: shift to clean, renewable energy	Shift: purchase clean, renewable energy serving health and supply chain facilities	Renewable Energy Directive, and Energy Performance of Buildings Directive	Governance and sectoral programmes	European Commission, and national and regional governments	Outdoor and indoor air pollution
LULUCF						
Maximise CO_2 storage and sequestration	Avoid: reduce forest loss; shift: shift to wood-based products; improve: forest restoration and afforestation	NA	LULUCF Regulation, European Habitats Directive, EU Energy Strategies, Common Agricultural Policy, European Forest Strategy, and European Green Deal	Governance and individual actions (eg, forest owners)	European Commission, national governments, and private sector	Recreation, food, and heat and air pollution reduction
Health systems						
Reduce health-care demand	Avoid: focus on prevention, reducing unnecessary procedures and treatments	NA	NA	Governance, and individual and collective action (eg, hospitals)	European Commission, national governments, and private sector	Increased physical activity; shift to healthy, plant-based diets; and reduce air pollution
Reduce CO_2e per unit of care delivered	Improve: reduce emissions through sustainable procurement	NA	EU Public Procurement Framework, European Green Deal, and Circular Economy Action Plan	Governance, and individual and collective action (eg, hospitals)	European Commission, national governments, and private sector	Reduced air pollution

ASI=avoid-shift-improve approach. EPC=Energy Performance Certificates. CO_2e=CO_2 equivalent. NA=not applicable. LULUCF=land use, land-use change, and forestry. *Health-care sector mitigation actions largely occur through other sectors.

Table 1: **Framework mapping mitigation actions, societal actors, and health co-benefits exposure pathways in Europe**

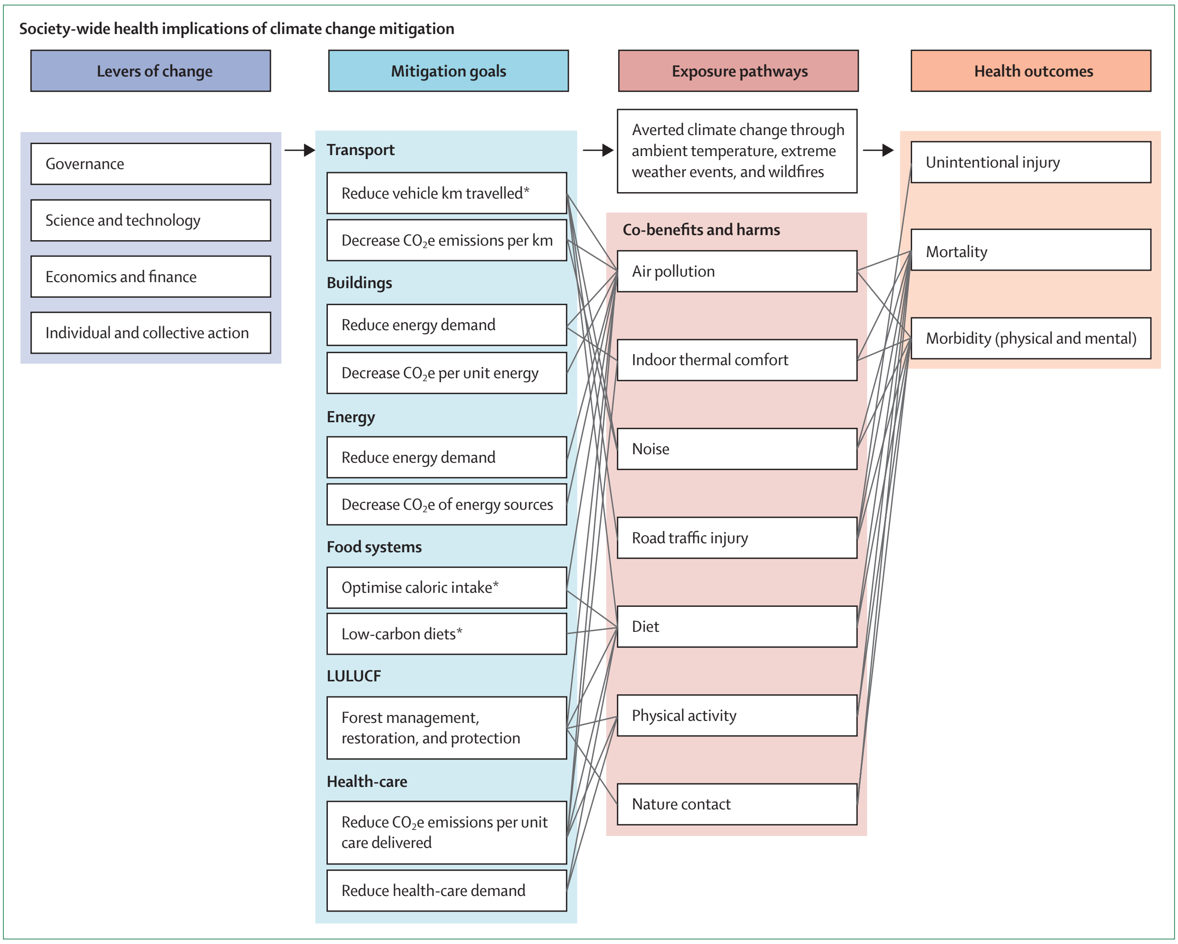

Figure 2: **Conceptual model linking levers of change, specific mitigation goals, exposure pathways, and population health outcomes within broader, society-wide goals**

*Mitigation goals are largely achieved through demand-side actions. CO_2e=carbon dioxide equivalent. LULUCF=land use, land-use change, and forestry.

efficiency of existing goods and services.[43] The types of mitigation actions in table 1 were selected to illustrate actions spanning the avoid-shift-improve approaches.

Several different levers of change are needed to reach net-zero emissions and deliver the society-wide goal of maintaining a stable global atmosphere consistent with human habitability. Adapting the levers of transformation for sustainable development identified in the Global Sustainable Development Report,[44] we linked levers of change (eg, governance, science and technology, finance, and individual and collective action) with examples of specific mitigation goals and environmental exposure pathways other than climate hazards and health behaviours that can generate co-benefits (figure 2). Multiple levers are typically relevant for each mitigation action (table 1). We identified agents of change to show which actors are in a position to implement specific mitigation actions.

Guiding future research

Our framework helps guide future research on (1) the magnitude and nature of health co-benefits of climate change mitigation; and (2) the communication and framing of health co-benefits to support increased ambition and societal acceptance of mitigation actions.

Promoting development of methods and tools

By specifying the type, lever, and agent of change needed to realise mitigation actions, our framework highlights where methods and tools frequently used in quantifying the health co-benefits of climate change mitigation should be expanded to cover the diverse change pathways that are potentially relevant for health.

Most existing evidence on the health co-benefits of mitigation has been derived from scenario modelling studies rather than the evaluation of implemented mitigation actions.[4] Modelling studies are frequently based on policy scenarios developed with integrated assessment models (IAMs), which link features of society and the economy with the atmosphere in a unified modelling framework. Although these models are powerful tools to support informed policy making, policy scenarios in IAMs tend to focus on specific types of mitigation actions, including financial instruments (eg, carbon pricing, fuel tax, and the emission trading scheme) and improve-type, supply-side actions in the so-called technosphere. These mitigation actions are typically efficiency gains through improved technology, such as performance standards or a phase-out of a specific technology. Avoid-type, demand-side actions and behaviour changes are often not as well represented in these models or their scenarios to reach policy targets.[5,45]

With notable exceptions, such as the WHO Health Economic Assessment Tool[46] for modelling health effects and carbon emissions related to walking and cycling scenarios, there is a general need to expand scenario modelling tools such as IAMs to better incorporate demand-side mechanisms to decrease GHG emissions and improve public health.[47] Key behaviour changes include shifting travel modes from private motor vehicles to active and public transport, dietary shifts, and behaviours to reduce energy consumption in buildings (eg, lowering thermostats). Without improved tools, the evidence and recommendations they deliver will continue to under-represent key mechanisms of action for achieving health co-benefits.

Comprehensive assessment of the health co-benefits of EU climate policy requires considering the implications at different spatial scales, spanning from global to urban scales. As a large current and historical contributor to GHG emissions,[48] EU climate mitigation policies have important implications at the global scale. GHG emissions from the EU accounted for 17% of global cumulative emissions (1950–2020).[49] The EU share of global CO_2 equivalent emissions was nearly 7% in 2022, a decrease from 14·8% in 1990, which is partly due to emission reductions within the EU, but more importantly, the rising share of emissions from China.[50] Reaching net zero by 2050 will clearly have large impacts on the health of populations within the EU (eg, due to reductions in air pollution). An estimated 308 000 (95% CI 187 000–432 000) excess deaths would be avoided annually in EU-27 countries due to improved air quality by phasing out fossil fuels.[51] However, emission reductions within the EU will also result in spillover air pollution-related health benefits in neighbouring countries, but the magnitude of these spillover effects remains poorly quantified.[52]

The specific strategies implemented by the EU to achieve GHG mitigation are also crucial for global-scale outcomes in the food sector. Policies such as stronger emissions standards or taxing emissions stimulate desired technological change within the EU, which might spill over to other regions, resulting in a decrease in GHG emissions. However, these policies can decrease competitiveness of European food production, giving rise to a major argument against unilateral action in the EU. Loss of competitiveness could lead to a net increase in food imports into the EU, thereby increasing emissions in other world regions via leakage. This mechanism is well established in quantitative analyses of carbon pricing in the food sector.[53,54] Moderate participation of non-EU regions in mitigation efforts has been shown to be effective in avoiding the largest part of this emission leakage. Emissions trade policy instruments, such as compensatory border adjustment mechanisms, might address leakage but also risk causing new trade conflicts. More promising options to avoid leakage would be to subsidise promising technological measures[55] or supplement supply-side measures with demand-side measures aiming to promote sustainable diets. Avoiding a large increase in net food imports into the EU might also help to reduce food miles, although these are considered less relevant than the production-related emissions of food systems.[56] Comprehensive analysis of the health co-benefits of the path to net zero in the food sector requires improved methods and tools that integrate the complex relationships between supply-side (eg, carbon and food prices, and technology) and demand-side (eg, shifts in dietary patterns) factors and the interconnectedness of global food markets.

Most IAMs used in modelling decarbonisation scenarios operate at the national level, with time steps of several years due to computational challenges of higher spatial and temporal resolution.[45] This feature prevents analysis of mitigation actions at the urban scale, which is of particular interest given the key role of cities in reaching net zero and realising health co-benefits.[45] Supplementing IAMs with other analytical approaches brings considerable advantages and flexibility, including spatially explicit processes and behaviours relevant to health co-benefits—for example, urban and transport planning measures, including densification and reducing road space allocation to reduce travel demand and promote active travel for short trips. Although these measures have been investigated for single cities,[4] analyses on a European-wide or multicity scale have not yet been conducted. Similarly, greenbelts restrict urban sprawl, leading to more compact land use, which is associated with a decrease in emissions from transport and buildings and might also contribute to carbon sinks.[33] Greenbelts also play an important role in providing opportunities for recreation and physical activity with associated health benefits. There is important scope for innovation from IAMs in the methods and tools used to integrate economy-wide activities at the national level, with models that can capture spatial processes underlying many of the key pathways for health co-benefits of mitigation within cities.

Leveraging evidence of co-benefits to promote engagement and acceptance

There are signs that climate mitigation policies are frequently facing public and political backlash—even when these policies have positive health impacts.[57] Examples include efforts by policy makers in European cities to restrict high-emission vehicles and promote active travel.[58–60] A framework that promotes more detailed

	Type of benefit or cost	Indicator
Urban residents		
Benefit	Reduced premature mortality and morbidity due to lower concentrations of air and noise pollution, reduced road traffic injury risk, and increased physical activity	Attributable deaths and QALYs
Cost	Longer journey times	Journey time
Urban commuters		
Benefit	Reduced premature mortality and morbidity due to increased physical activity	Attributable deaths and QALYs
Cost	Longer journey times	Journey time
Children		
Benefit	Improved health over life course (eg, birth weight, and cognitive and lung function) due to lower concentrations of air and noise pollution, reduced road traffic injury risk, and increased physical activity	QALYs over life course
Cost	None	NA
Public sector		
Benefit	Reduced health-service costs due to improved population health	Euros
Cost	Active and public travel infrastructure investment	Euros

QALYs=quality-adjusted life-years. NA=not applicable.

Table 2: **Example of distributional consideration of costs and benefits of mitigation actions: reduced vehicle-km travelled resulting from mode shift from private motor vehicles to public and active transport**

elaboration of which societal actors have the agency to act on which levers of change, and who benefits or pays, is valuable in highlighting incentives for action, and identifying and redressing potential injustices in advance.

Research is urgently needed to investigate how to achieve accelerated and wide-scale changes in individual behaviours and social systems, which are frequently assumed in most modelled mitigation scenarios.[61,62] In order for health co-benefits of mitigation evidence to promote rapid, substantial individual and societal change, individuals and decision makers must first engage with this evidence. However, several knowledge gaps remain regarding how local and national authorities, institutions, and individuals engage with the concept of health co-benefits of mitigation and whether they use it in decision making. A 2019 study indicated that, despite evidence of their magnitude, health co-benefits have played a limited role in the development of climate change mitigation policies in the EU, which were dominated by concerns with economic costs and energy security.[63]

Although most European citizens know that climate change is happening, people generally do not engage with actions that would reduce climate change.[61] This lack of engagement is, at least partly, because climate communication faces considerable challenges in overcoming individual-level barriers[64] to mitigation actions.[65] A focus on the health co-benefits of climate action could help overcome these barriers because: (1) it emphasises the positive effects of climate action (ie, gain frame); (2) many health co-benefits can be experienced in the short term; and (3) benefits can pertain to the person taking the action.[64] Evidence suggests that positive frames focused on opportunities can increase support for climate policies among those unconcerned by the effects of climate change.[66,67] Framing that focuses on the direct health benefits to an individual has been shown to increase willingness to adopt low-carbon diets.[68] Communicating the health co-benefits of tackling air pollution has been found to increase support for climate mitigation policies.[69] However, the persuasiveness of different types of framing has been shown to vary with individual characteristics, including age, personality, and values, suggesting that a portfolio of messages is needed for tailored strategies to engage diverse audiences.[70,71] Hence, there is a need to better understand when and how communicating the health co-benefits of climate action can shift attitudes and drive behavioural change.[64,72]

Health co-benefits research can assist in building public support for ambitious mitigation actions by explicitly considering the distribution of health co-benefits and broader social and environmental costs that affect stake holders. Social cost-benefit analysis sums the positive and

Search strategy and selection criteria

We searched PubMed for studies published from Jan 1, 2010, to Sept 1, 2024, presenting frameworks related to the health co-benefits of climate change mitigation. We grouped the search terms into three categories: co-benefit terms (“co-benefit*”, “co benefit*”, “cobenefit*”, “co-impact*”, “ancillary benefit*”, “ancillary impact*”, “health co-benefit*”, “health co benefit*”, and “health cobenefit*”), climate change mitigation terms (“climate change mitigation polic*”, “climate mitigation”, “climate mitigation polic*”, “climate polic*”, “mitigation”, “mitigation action”, “GHG mitigation”, and “green house gas mitigation”), and framework terms (“framework*” and “integrated framework*”). Search terms were entered one by one in the search fields of PubMed. Terms within each group were combined with the Boolean operator OR. Finally, the four groups of terms were combined with the operator AND. The search was not restricted geographically.

Our search returned 69 results. Most articles identified by our search were not relevant to this Personal View as they were either not about human health co-benefits of climate change mitigation; or they were focused on health co-benefits of mitigation but focused on specific contexts (eg, schools and individual country) or economic sectors (eg, food systems, energy, and health systems), or did not provide a framework. We identified three previously relevant conceptual frameworks, including those presented by Bikomeye and colleagues, the Pathfinder Commission, and the WHO framework, focused on the quantification and economic valuation of health outcomes related to mitigation.

negative welfare implications of mitigation actions on society, considering the benefit of avoided climate change and the net cost (or benefit) of the mitigation action incurred by different stake-holder groups. Social cost-benefit analysis primarily focuses on society-wide targets, providing little guidance on how mitigation actions affect specific stake-holder groups. As a result, potential opportunities to tailor communication strategies to engage stake holders who are resistant to mitigation actions are missed. Our framework lends itself to applications beyond the society-wide perspective to more fully elaborate the costs and benefits experienced by stake-holder groups. More comprehensive accounting of specific costs and benefits borne by different, societal stake holders is crucial for identifying and rectifying risks of mitigation that exacerbate health and other inequalities. Table 2 provides an example of how reducing vehicle kilometres travelled by promoting active travel in urban areas could help to evaluate the distributional effects of a mitigation action, and identify specific quantitative indicators that could be used to calculate net social benefits and costs.

Conclusion

Existing frameworks guiding research on the health co-benefits of climate change mitigation are largely based on broad classifications of mitigation actions. As a result, these frameworks are missing important details that are necessary for understanding how evidence of health co-benefits can be used to support the ambition and acceptability of climate policy. Our proposed framework provides more granular detail on the type, lever, and agent of change underpinning mitigation actions, which can advance our understanding in this area. Elaborating these details is important for: (1) improving engagement with a diverse range of societal actors looking for a clear indication of their potential role in delivering and benefiting from health co-benefits; (2) guiding the development of new methods and tools to quantify the health co-benefits of climate change mitigation and their distributional impacts; and (3) developing more targeted communications and framing strategies to align with the incentives and concerns of a diverse range of societal actors to foster societal support for mitigation actions.

Contributors

CT and SS contributed to the conceptualisation of the article. CT, ZK, LH-I, MSp, JL, IH, MN, FdD, and ND contributed to funding acquisition. FF, IT, VP, GK, and ZK conducted the analysis that generated figure 1B, verified the data, and had access to the raw data. CT, SS, FF, LH-I, PW, AP, JL, S-CH, MvdB, IS, MSa, FdD, and ND wrote the first draft of the manuscript. IT, GK, ZK, MSp, IH, MN, and DV-C contributed to the writing and editing of the manuscript. All authors contributed to reviewing and editing the manuscript and approved the final version of the manuscript for publication.

Declaration of interests

We declare no competing interests.

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