ANNUAL REVIEWS

Annual Review of Public Health

Barriers and Enablers for Integrating Public Health Cobenefits in Urban Climate Policy

Maya Negev,[1] Leonardo Zea-Reyes,[2,3,4] Livio Caputo,[5] Gudrun Weinmayr,[6] Clive Potter,[2] and Audrey de Nazelle[2,7]

[1]School of Public Health, University of Haifa, Haifa, Israel

[2]Centre for Environmental Policy, Imperial College London, London, United Kingdom; email: anazelle@imperial.ac.uk

[3]Research Area, Cónclave Consultora, Guadalajara, Jalisco, Mexico

[4]University Centre for the Arts, Architecture, and Design; University of Guadalajara, Jalisco, Mexico

[5]Energy Futures Lab, Imperial College London, London, United Kingdom

[6]Institute of Epidemiology and Medical Biometry, Ulm University, Ulm, Germany

[7]MRC Centre for Environment and Health, Imperial College London

Annu. Rev. Public Health 2022. 43:255–70

First published as a Review in Advance on December 22, 2021

The *Annual Review of Public Health* is online at publhealth.annualreviews.org

https://doi.org/10.1146/annurev-publhealth-052020-010820

Keywords

cities, urban public health, climate change, transportation, local government, coproduction

Abstract

Urban climate policy offers a significant opportunity to promote improved public health. The evidence around climate and health cobenefits is growing but has yet to translate into widespread integrated policies. This article presents two systematic reviews: first, looking at quantified cobenefits of urban climate policies, where transportation, land use, and buildings emerge as the most studied sectors; and second, looking at review papers exploring the barriers and enablers for integrating these health cobenefits into urban policies. The latter reveals wide agreement concerning the need to improve the evidence base for cobenefits and consensus about the need for greater political will and leadership on this issue. Systems thinking may offer a way forward to help embrace complexity and integrate health cobenefits

into decision making. Knowledge coproduction to bring stakeholders together and advance policy-relevant research for urban health will also be required. Action is needed to bring these two important policy agendas together.

1. INTRODUCTION

There are multiple ways of tackling climate change (CC) mitigation and adaptation in cities, and experts widely agree that, given the urgency of the problem, all available tools need to be put into play (88). Some pathways, however, may generate benefits beyond CC or act synergistically to prevent or protect against some of the detrimental impacts of CC. Health is of particular relevance here because the safeguarding of human health motivates much of the CC agenda and policy reforms. Behavioral changes promoting health can also have significant associated climate benefits (90). Climate policy has the capacity to generate cobenefits owing to the added value of health promotion beyond protection from climate-related adverse outcomes and also because of the policy alliances it can create to promote ambitious and transformative actions. While the evidence on cobenefits of transport and land-use policies that tackle CC is growing, it does not, however, appear to be translating into action and widespread adoption (32). Governments still tend to adopt policies that address CC and other environmental problems in a piecemeal, incremental, and siloed manner (25). Despite a strong consensus among experts about the need for transformative and integrated policy making, examples of successful urban transformations are scarce (46). A better understanding of the barriers to an improved integration of health cobenefits into CC action in cities is needed.

Cities account for 70% of greenhouse gas (GHG) emissions (35) and are set to bear the brunt of the effects of CC. In particular, CC threats to public health are amplified in vulnerable populations in urban settings (65). Those who govern and manage cities, however, must contend with, and seek to balance, a multitude of priorities, some of which may be considered competing. While promoting economic benefits tends to be high on policy makers' agendas, other goals include better public health, sustainability, resilience, and equity. Policy goals or targets in different sectors are traditionally dealt with by separate government departments working in silos. This approach limits the potential for cobenefits and synergies while at the same time creating opportunities for manifestation of unintentional negative consequences. For example, the diesel fuels promoted to reduce GHG emissions have taken a toll on public health owing to their particularly toxic emissions (82), as has cobalt mining used to make electric vehicle batteries (34). In addition, these technological solutions may bring limited improvement for air pollution and GHG emissions but no further health benefits. In reverse, tactical land-use urban policies can promote a switch to public and active transport such as walking and cycling, which can greatly reduce GHGs and also ambient air pollution, while simultaneously decreasing physical inactivity (66, 85). Both air pollution and physical inactivity are leading risk factors for death worldwide (61). Win-win situations such as these could make ambitious CC policies seem more attractive, thus ensuring more buy-in and successful uptake.

This article provides an overview of the published quantitative evidence linking urban CC policies to public health and considers the barriers and enablers for better integrating health considerations into decision making on mitigating and adapting to CC in cities. We conclude with some reflections on ways forward for more effective collaborative approaches to health-promoting CC policy making in cities.

2. METHODOLOGY

Two systematic reviews were conducted (58, 63). The first, on quantified health cobenefits of urban planning policies that address CC, described the nature and extent of such synergistic effects to give some context to the ensuing discussion. The second, a review of reviews on barriers and enablers of integrating health into urban CC policies, examined understandings of whether and to what extent the health cobenefits agenda could promote more beneficial climate policy in urban settings. This literature was critically discussed to help identify research and implementation gaps and develop recommendations for effective governance and policy agendas. Details on both search strategies can be found in the **Supplemental Material**.

Supplemental Material >

3. HEALTH COBENEFITS OF URBAN CLIMATE POLICY

In the first systematic review conducted for this article, we identified 21 papers that attempt to quantify the health cobenefits of climate policies. Of these, nine were conducted in Europe (mostly Western Europe), five in North America, and seven in the rest of the world, including the Global North and Global South. The results are presented in **Supplemental Table 1**, and the criteria for our selection of papers from an initial set of 8,878 articles are set out in the **Supplemental Material**. Transport, land use, and buildings (residential and commercial, including energy efficiency and heating practices, for example) were the three most studied sectors; the authors agreed that these have the most potential for realizing multiple health cobenefits (see **Supplemental Figure 1**). Land-use management and sustainable transportation in particular are inherently interconnected, with wide agreement in the published literature that a redesign of modern cities involving a shift away from private vehicles would yield cobenefits in terms of improved air quality, increased physical activity, social cohesion, and access to green spaces (61).

Many studies have quantified the potential for climate mitigation and health cobenefits as part of a shift from private motorized transport to public and active transport (13, 39, 48, 52, 66, 75, 76, 80, 83–85, 91–93). For example, Stevenson et al. (83) simulated alternative land-use policies by building compact-city scenarios with increased land diversification and proximity to public transport in six large cities worldwide. This induced a modal shift away from private vehicles, reducing particulate matter emissions by up to 12%, although results varied depending on city characteristics (83). Increased physical activity levels from increased active travel decreased levels of diabetes, cardiovascular diseases, and respiratory diseases in the population, with quantified health benefits ranging from 420 to 826 disability-adjusted life years (DALYs) per 100,000 people, even after accounting for potential increases in road trauma. In an example of modeled mobility scenarios in three Austrian cities, a 55% drop in kilometers driven by cars relative to the 2010 baseline led to an annual drop in CO_2 of 530,000 t and health cobenefits resulting in an avoidance of 76 premature deaths per 100,000 inhabitants per year (70% of which stemmed from increased physical activity triggered by active travel) (91). Overall, these mode shift simulation studies have all quantified benefits from physical activity accompanying GHG emission reduction (13, 48, 66, 75, 84, 93); where additionally air pollution health cobenefits were quantified, these tended to be dwarfed by physical activity benefits (52, 76, 80, 83, 91, 92).

Other studies assessed the health cobenefits of urban greening and sustainable mobility. For instance, investments in cycling, pedestrian, and green infrastructure in three cities in New Zealand were estimated to decrease GHG emissions by 1,149 t of CO_2 and increase active travel by 30%. The latter in turn reduced health burden by 34.4 DALYs per year, owing to benefits in cardiac and respiratory diseases. The study concluded that once health savings and the value of carbon reductions are considered, investing in active travel amenities is economically worthwhile (13). Several other studies corroborate these findings (39, 52, 80, 84). In another study in Barcelona,

reclaiming public space for people, promoting urban greening, and endorsing sustainable mobility and active lifestyles were estimated to increase the average adult life expectancy by 200 days. The majority of preventable premature deaths was attributable to changes in NO_2 concentrations (291 deaths avoided), followed by noise (163 deaths), heat (117 deaths), green spaces (60 deaths), and finally active transport (36 deaths) (62). Overall, the most health-promoting climate policies were seen to be those that integrated a variety of approaches, whereas purely technological scenarios would yield far fewer benefits than modal shifts would. A study in London and Delhi, for instance, demonstrated that optimal outcomes require strategic land use, increased active travel, and a shift to low-carbon transport modes, which could lead to an annual reduction of 7,439 DALYs in London and 12,995 DALYs in Delhi, compared with the business-as-usual scenario. A sole focus on modal shifts to active travel in London and Delhi, however, led to, respectively, 45 and 7 times greater health benefits than the low-carbon emissions technology (92).

Alongside transport and land use, the third most researched sector for health cobenefits was the commercial buildings sector. From 2000 to 2016, estimates show that US buildings complying with the LEED (Leadership in Energy and Environmental Design) green building certification prevented the emission of 30.6 Mt of CO_2, and associated air quality improvements prevented 289 premature deaths, 171 hospital admissions, 11,000 asthma exacerbations, and 54,000 respiratory symptoms (51). In New York City, the phase-out of high-sulfur heating fuels was estimated to decrease $PM_{2.5}$ concentrations by 0.71 $\mu g/m^3$ per year and prevent 290 premature deaths, 180 hospital admissions for respiratory and cardiovascular diseases, and 550 cases of asthma every year. Moreover, such a policy was projected to decrease social inequality by concentrating health benefits in high-poverty neighborhoods as a result of higher baseline sulfur content in their heating fuels (42). Taking a different approach, a multinational European study investigated green roofs as an option to mitigate the urban heat island effect. The study found that 30% city-wide green roof coverage could decrease average summer temperatures by 1.5°C and heat wave mortality by 23–37% (54).

Many additional climate mitigation interventions have health cobenefits. The introduction of low-carbon waste infrastructure in Nairobi was shown to reduce CO_2 emissions by 111,669 tons per year, together with a reduction in air pollution amounting to US$3.63 million in annual savings through health benefits (70). Similarly, effective municipal waste management in Accra, Ghana, was projected to diminish the environmental footprint of the waste sector by ceasing open waste burning, accounting for a 53% drop in total CO_2 emitted relative to the 2030 business-as-usual scenario, accompanied by a significant decrease in $PM_{2.5}$ concentrations, preventing 120 premature deaths every year (40). A study in Suzhou City, China, modeled impacts of a combination of policy scenarios ranging from increased industrial building energy efficiency to fuel economy in the transport sector to find a 44% reduction in DALYs from air pollution reductions would accompany a 42% drop in GHG emissions (49).

Most cobenefits publications focus on highly developed countries, the United States and Europe in particular (24, 41). Cities in the Global South are particularly underrepresented (78), even though further rapid urbanization in the mega cities of the Global South is expected to have significant environmental and health impacts.

4. BARRIERS AND ENABLERS FOR THE INTEGRATION OF HEALTH AS A COBENEFIT OF URBAN CLIMATE POLICIES

Supplemental Material >

Three domains emerged from our systematic review of reviews on barriers to and enablers for integrating health cobenefits in urban climate policy (see **Supplemental Material**, Section 2): evidence-based policy, political will and leadership, and institutional arrangements. **Figure 1** presents the domains and subdomains in this section.

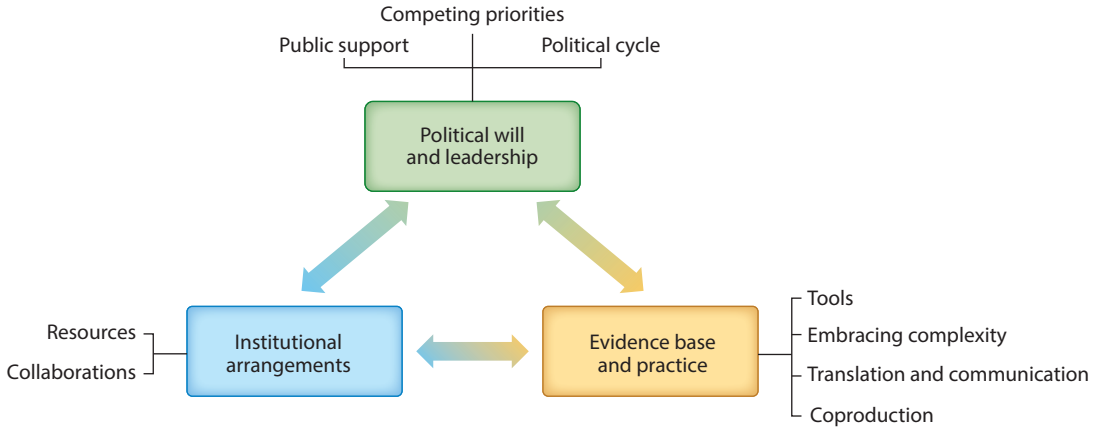

Figure 1

Barriers to and enablers for integrating health as a cobenefit in urban climate policy. Political will and leadership, evidence base and practice, and institutional arrangements were the three key domains identified in our systematic review of reviews. These domains and their subdomains represent important leverage points to overcome fundamental hurdles to health-promoting climate change policy making.

4.1. Evidence Base and Practice

A solid evidence base is widely regarded as critical in making the case for transformational change. Experts agree that further research is needed to demonstrate and quantify the potential benefits of different courses of action and to help practitioners and stakeholders gain a better understanding of impacts on different health outcomes. Comparisons between different geographical and socioeconomic contexts are especially needed (9, 14, 23, 27, 30, 36, 53, 60). Decision makers need access to research to identify synergies in policy and to reach judgments about trade-offs among health, environmental gains, and other outcomes. They may feel at times that broader priorities of economic growth and, in the Global South, development need to be balanced against health and environmental benefits (9, 17, 23, 28–30, 69). By highlighting how CC-related policies can help reach other policy goals (e.g., energy security, economic development, political stability, resilience, equity), including potentially higher-priority goals, research on cobenefits will also open up opportunities for ambitious CC policies (55). Research on cobenefits is also thought to have contributed to a shift toward positive framing of the CC policy agenda (55); positive framing of personal health gains has been shown to be preferable over loss framing for societal engagement (45).

Although research is seen as important, the uptake of research outputs by policy makers is ultimately key to determining impact. Authors argue that while there has been progress on extending the research and evidence base for integrating health in CC policy making, more progress on policies and actions themselves is still needed (28). Some of the limitations of current research and how these might be overcome to enable better integration of health in urban CC policies are discussed next.

4.1.1. Tools. The first enabler identified in our review of reviews is the development and usage of tools available to practitioners. There has been a substantial increase over the past decade in the development and availability of assessments and tools that can quantify impact on health from strategies across sectors, including health impact assessments (HIAs) as well as climate risk assessments, nested models, integrated environmental health impact assessments, and others (23). Data collection efforts in cities, in particular those that aimed to monitor exposure, vulnerability,

and disease and to characterize and assess CC-related services and practices (e.g., transport, waste, water, land use) and their resulting economic benefits, have also improved (28). These elements are widely hailed as important to make health cobenefits more salient and to help integrate health in urban policies (5, 9, 23). In developing countries, however, such assessments or even the data are often simply unavailable (30, 79). Studies are carried out mostly by nongovernmental organizations and are therefore largely unpublished and unshared (16). Yet, the evidence base must reflect the specific needs and challenges in those countries to be useful there.

Critically, however, the effectiveness of such tools in influencing practice and policy is not typically demonstrated (28, 43). Even when the evidence base on cobenefits is mentioned in policy documents, they are in fact rarely integrated into policy designs and implementation (55). Conversely, some evidence indicates that scientific knowledge has not sufficiently translated into public knowledge (28).

Some of the shortcomings of monitoring and assessment tools may have hampered their effective use in policy making. The literature has highlighted, in particular, issues with unequal spatial coverage (Global South in particular); insufficient attention to vulnerable populations; lack of dynamic indicators; insufficient set of risks and benefits assessed; and lack of clarity in definitions and goals of tools. To improve the use and effectiveness of assessment tools, authors have recommended that researchers should strive to harmonize assessment methods, standardize data collection methods, and assess impacts of inaction and economic impacts of health cobenefits. Perhaps more fundamentally, current researchers are urged to work toward the establishment of causation and to improve understanding of decision-making processes and of public acceptability of solutions (27–30, 55).

4.1.2. Embracing complexity. The second enabler is embracing complexity. Commentators have repeatedly argued that ensuring impact will require researchers to embrace the complexity of urban systems far more effectively throughout the research process. Traditional research approaches have at times failed to recognize cities as complex systems and have therefore failed to fully incorporate the dynamics of politics and social behavior in their research. Grasping complexity requires combining different disciplines, theories, and approaches, from experimental epidemiology to qualitative studies and agent-based modeling through to behavioral and socioeconomic research, in a consistent and interdisciplinary manner (8). Understandings of socioecological processes and how these work to constrain and enable the way urban systems are governed are still largely lacking in the published literature. Academic literature on CC strategy and health that attempts to account for the complexity of urban systems remains largely conceptual. For example, to help guide future research, Bikomeye et al. (9) developed a holistic conceptual framework of health benefits of climate policy. Berry et al. (8) developed conceptual dynamic models with a causal process diagram focusing on mental health. The social-ecological model of health, which conceptualizes health as a product of the interplay among individual, social, environmental, and physical factors, is commonly referred to as an important theoretical framework for research (27, 73). More recently, planetary health concepts with a focus on interactions between ecosystem and human health have increased in popularity (27). Applications of these models in the evaluations of the effectiveness of real-world interventions is a critical gap in current research (27, 28).

Clark et al. (15) argue that research that fails to embrace complexity is of limited use to policy makers who need to juggle complex real-world problems and priorities in their everyday lives. As delivery, impacts, and effectiveness of policies are, to a certain extent, context dependent, policy makers may be justified to consider as irrelevant an evidence base generated elsewhere (15). To be of use, research must include understandings of real-world conditions and of the complex environment in which decision makers operate. Research that will help embrace complexity, integrate

underlying systemic drivers of CC, and simulate possible impacts of interventions will help frame and explain solutions so as to increase their public acceptance (8, 55).

The integration of social complexity and how people interact with their social, political, cultural, and physical environments is often seen as a particular challenge. Achieving shifts in behaviors and worldviews requires an understanding of underlying cultures, social and physical conditions, and practices that shape how cities and individuals operate (17). Research in public health and CC must develop improved testing of theories of behavior change and social practice, consider the relative roles of individual and collective action, and assess unintended consequences and the balance of costs and benefits (8). Given this need, some authors have called for the use of systems thinking to approach research and policy development in the CC context (7, 8, 21, 43). Research led with a systems thinking approach connects decision making with politics and prevailing ideologies, focuses on whole populations rather than just individuals, investigates indirect and distal influences or root causes of health and behavior rather than solely proximate factors, and integrates dynamics of health and behavior across contexts (8).

4.1.3. Translation and communication. A third enabler is knowledge translation, another area that is largely overlooked in research development but is key to transformative action (17, 77). To ensure uptake of the evidence base on CC solutions and health and to increase awareness, some researchers suggest pairing research outputs with targeted communications and concrete actions (28). Crane et al. (17) note in particular the importance of helping leaders understand scientific evidence (including policy implications, the scientific process, and uncertainty), given their essential role in transformational solutions.

To effectively communicate research findings, however, the type of evidence base most convincing to policy makers must also be recognized. For example, while health practitioners may favor a randomized controlled trial as a solid evidence base, politicians tend to prefer a good story (33, 74), which in all fairness may grasp the complexity of the real-world more accurately than a controlled trial. Historical precedence, storytelling, and ideology may matter more than low *p*-values in the context of planning decisions (33, 74) and thus must be considered and integrated in the array of research outputs to make them relevant for policy making.

The long-winded development of a solid evidence base also hampers evidence uptake because it is a poor match with the short-term political cycles (56, 74). Researchers may thus consider the production of case studies and stories to communicate to policy makers during research production (32, 77).

4.1.4. Coproduction. A fourth and fundamental enabler is the coproduction of research. Enacting complex research programs such as those described above, which fully embrace complexity, include effective translation, and lead to action, may require a sea change in how research is developed. Many now consider that a joint community–policy–research effort in a coproduction framework is needed (8, 15, 17, 27, 32, 43, 77). Scientific evidence coproduced with end users can address goals, priorities, and beliefs that shape city systems. Incorporating these perspectives through the involvement of a range of stakeholders in cocreated knowledge and solutions can help fundamentally change the vision of cities and their functioning and build consensus around their solutions. Coproduction is thought to boost creativity, provide healthy criticism and scrutiny of research assumptions and findings, and create solutions that are more directly applicable and impactful to local communities (27).

Increased engagement of researchers with policy makers and communities is essential to maximize impact on decision making (72). Guidance and training for non–health policy makers on health cobenefits may generate fruitful interactions. To strengthen the institutional capacity to

do so, Huang et al. (36) suggest that a lead agency should coordinate multiple organizations, the public health research community among them, to develop targeted communications products for politicians. Researchers also need to understand how policy makers use and deploy evidence in their decision making if they are to produce policy-relevant research.

4.2. Political Will and Leadership

Scholarly consensus purports that a lack of political will and commitment is one of the most fundamental barriers to action. Across the climate agenda broadly, authors recognize the profound extent to which adaptation and mitigation outcomes are shaped by struggles for power and influence. There is a growing recognition of the need for policy makers to overcome the resistance of vested interests and lobby groups to produce more transformative policies (2, 28, 30, 36). In this sense, the cobenefits concept has been criticized for promoting a largely symptomatic approach to tackling CC while ignoring the key drivers and root causes of CC and related policies (55). Fox et al. (28), for instance, comment on the extent to which power imbalances among sectors lead to some policy domains attracting more resources and influence than others. Many papers identify the continuing power and influence of the car industry lobby as an important barrier to progress. As Khreis et al. (43) put it, there is a growing perception that the profit-maximizing objectives of this sector often dominate at the expense of public health. Policy makers need to ensure that the societal benefits of a shift toward more active transport and more climate-compatible planning solutions are not compromised by the interests of those who produce the means of transport. Khreis, Fox, and others point to the success of the car lobby in resisting interventions such as car-free zones, congestion charging, and increases in fuel duty (28, 43).

The public health research community has, at times, been criticized for the limited attention it has given to policy processes and the political imperatives that ultimately determine which projects are implemented and which languish in obscurity. In contrast with health practitioners, planners tend to work much more closely with policy makers and know how to respond to their needs and those of the public and other stakeholders in a timely and understandable fashion and within short-term election cycles. We found a number of editorials and articles that argue for the incorporation of a more sophisticated political understanding of health and for addressing institutional constraints to the adoption of more integrated solutions (37, 44, 50, 67). If integrated approaches to climate and health are to be adopted, then long-sighted and innovative political leadership on the one hand and greater social mobilization on the other hand will be needed (36).

Raising the political profile of a linked climate and health agenda process begins with awareness raising and greater engagement with the public and stakeholders in the policy process (43). The broader urban policy studies literature often points to the challenges of bringing a complex community of stakeholders into discussions around transport and land-use planning in particular (see, for instance, 18). Stakeholder engagement involving the community and other local actors in climate action can foster political will and leadership and create jointly developed policies that address local needs (5, 43, 55). In addition, many tools can be used to better engage stakeholders in public policy. HIA, mentioned above, is one of the increasingly popular tools for enabling intersectoral collaboration and public engagement in local climate policy (23, 28). Using quantifiable and reproducible indicators for measuring progress and pursuing common aims, while also highlighting the pitfalls from a systems perspective, is also increasingly recommended (19). Another emerging means through which to engage the public is social media and popular culture (47), which in turn influence political will.

Deployment of instrumental tools such as HIA is unlikely to be sufficient, however; an agenda for change must translate into legislative actions and policy programs if it is to have an impact.

Commentators such as Bulkeley (10) and Bulkeley & Betsill (11) have long observed the extent of resistance to state-led action in decarbonizing cities in the Global North, for instance, and have argued for a new urban politics of CC. A fully integrated approach to policy making can occur only when new actors, networks of influence, and types of funding come together; such conjunctions are still quite rare. In developing countries, weak governance and political instability are often additional major challenges for the design and implementation of urban climate policy (16) and may accentuate inequities (68), probably most acutely in rapidly growing heterogeneous cities.

4.3. Institutional Arrangements

Effective policy implementation is key to realizing cobenefits, and key to this step is intersectoral collaboration and shared problem solving (81). However, such collaboration is one of the main challenges in public policy in many countries; siloed approaches are still often dominant (1, 12). Specifically, a lack of intersectoral collaboration is frequently mentioned as one of the main barriers for integrating health into climate policy (29, 87, 89). Such integration requires multidimensional collaboration: vertical, across levels of national, regional, and local government; horizontal, across sectors including health, transportation, planning, welfare, and energy; and across organizations, with private and nongovernmental organizations (4). Several papers draw attention to the extent to which barriers to progress are embedded in and perpetuated through current institutional structures. Policy that impacts health is designed largely outside the health sector, and mainstreaming health considerations requires integration with other sectors (20). For example, climate policy is typically situated in environment or land-use planning departments. On their own, these departments tend to be less well-resourced and influential compared with their counterparts in energy and transportation (28). Moreover, within the public health sector, there is a lack of awareness of and commitment to the urgency of climate policy in itself and an urgent need for greater intersectoral collaborations (29).

Along with the tendency of sectors to work in silos, significant barriers for collaboration include speaking different professional languages and working on different policy agendas. For example, urban planners and architects are not often exposed to the field of public health through their studies, nor are they required to have such background in government agencies (5). Hence, the departmental structure of government by sectors intensifies sectoriality (36). Despite this limitation, there is a growing trend of vertical, horizontal, and outward collaborations.

Experience from current intersectoral collaborations reveals modest successes but also suggests that collaborations can be highly resource intensive. Funding is required to create and cultivate intersectoral interactions, to mitigate professional gaps, to conduct meaningful and informed public engagement, and to train and educate professionals and lay participants regarding the health cobenefits of CC policy (28, 29). For example, HIA can be time consuming and resource intensive and often requires demanding local data collection (28). All these aspects are very much accentuated in developing countries, where the need for inter- and trans-disciplinary collaborations may be even greater. Further unresolved developmental and health issues in developed countries, such as waste management and clean household energy, indeed compound challenges in the Global South (71). The influence of traditional, indigenous structures and knowledge, reinforced as cities and towns grow rapidly into more traditional rural lands, also makes collaborative approaches and systems frameworks increasingly important in such settings (6).

At the city level, formal collaborations can include intersectoral institutions, programs, and working groups, bringing together the relevant departments from the local authority. Informal and ad hoc communication channels may also be effective in breaking sectoral silos (4, 31). Such multidimensional collaborations can enable the coproduction of shared knowledge regarding the

integration of physical and mental health into climate policy (8). Requiring a public health course as part of training for urban planning and transportation and for key government positions may be another enabler for collaboration (5). Another incentive for collaboration is research funding that prioritizes intersectoral teams (77).

The lack of policy-oriented scientific evidence discussed above is also a barrier to intersectoral collaboration, hampering recognition of potential cobenefits as incentives for non-health sectors to integrate health into local climate policy (29). Cost-effectiveness and cost–benefit studies quantifying health cobenefits may help make informed climate decisions in sectors such as transportation, planning, energy, and agriculture (29). To produce research that will promote intersectoral collaborations, researchers should engage with public health and other relevant sectors, jointly select policies and scenarios for evaluation, and employ research methods that are persuasive for policy makers, for instance pretest–posttest experimental designs or tests to determine the cost-effectiveness of heat early warning systems (77, 86).

5. A WAY FORWARD: COLLABORATIVE APPROACHES TOWARD URBAN HEALTH

Cities are complex systems, and the integration of policy agendas, including those in relation to CC and health, is often difficult to achieve for a variety of evidential, institutional, and sociopolitical reasons. Although the health cobenefits of climate policies are widely reported in the scientific literature reviewed for this article, the resulting evidence base has been criticized for its lack of impact on decision making in real-world contexts. Our review has demonstrated that while there is a broad consensus around the need to strengthen the links between the CC and public health agendas, most review papers focus on the continuing need to expand and deepen the evidence base to inform policy change. The evaluation of real-world interventions was particularly highlighted. Perhaps the widest gap in the literature is with regard to understanding how research can be policy-relevant, deployed, and taken up to promote needed urban transformations (64). We found only limited coverage in the papers reviewed here on some of the underlying set of political factors that ultimately determine how decisions are made and resources are committed. In a literature contributed largely by health and environmental scientists, political barriers to integration of the CC and health agendas are rarely analyzed in any depth; likewise, there appears to be little cross-referencing to the work of political scientists and urban geographers who work on these topics.

Where policy impact is discussed, consensus indicates that more effort needs to be directed into the coproduction of knowledge by researchers, policy makers, and stakeholders. Knowledge coproduction engages diverse stakeholders in problem identification, the design of an analytical framework, data interpretation, and the formulation of recommendations (57). Engaging policy makers and other urban stakeholders in developing research questions and methods that can be policy relevant is an important way to raise their awareness of health cobenefits and to generate policy-relevant research. For instance, engaging end users in identifying vulnerabilities may guide informed investment in the adaptation of cities to CC (22). Meaningful stakeholder engagement requires improving communications at the science–policy–society interface. As a first step, stakeholder engagement requires communicating the health impacts of climate change and the potential for health cobenefits to policy makers, including those in the health sector, to politicians, and to the general public (94). In parallel, scientists' understanding of decision-making processes, political barriers and enablers, and public acceptability of solutions, including behavior change and social practice, should be improved. Then, scientists can aim to raise policy makers' awareness of the value of evidence and the potential for specific negative or positive health impacts and then codesign innovative research methods that are intuitive and applicable to policy-making contexts.

Like policy makers, scientists form a diverse community that often works in silos. Projecting health cobenefits, identifying policy barriers and enablers, and generating policy-relevant research in different geographical, cultural, and socioeconomic contexts will require greater collaboration and knowledge sharing between health researchers and a wider community of behavioral scientists, climatologists, urban planning experts, and political scientists. A bibliometric analysis of the review papers that we identified on the barriers and enablers of integrating health into urban CC policies revealed that 78% of publications were written by public health experts or environmental scientists. Only 15% of authors came from urban development fields, and 6% were experts in other disciplines. This limited pool of expertise is clearly a lost opportunity for cross-disciplinary learning, given the deeper knowledge and understanding of urban governance in fields such as city planning, urban geography, or political science (10, 18, 37, 44, 50, 67). Insights are particularly needed to understand how to increase political will to adopt more ambitious and transformative urban policies, including through the creation of alliances across sectors working toward common goals and through societal engagement that puts pressure on politicians and counteracts powerful private lobbies (17, 56, 95).

The review papers we identified were dominated by European and North American researchers, accounting for 41% and 37% of publications respectively, the United States and United Kingdom being the most prominent countries. These trends are also manifest when examining related research fields such as urban public health, health cobenefits of CC mitigation, and resilient cities, where UK and US authors are responsible for the large majority of studies (38, 41, 96). This domination of European and North American researchers can generate bias in research results, lessening their applicability to other regions. In the Global South, the challenges of integrating health cobenefits are accentuated by the fact that cities are growing rapidly, with a relatively weak institutional capacity, a lack of technical expertise, and financial limitations (16).

While many authors hail coproduction as essential to ensuring that useful policy-relevant research is developed and implemented, it seems so far largely conceptual in the field of urban CC policies and is rarely put into practice. The bibliometric analysis of review papers revealed that 74% of the identified article coauthors were affiliated with universities. Coproduction is likely to bring multiple benefits, from the empowerment of local communities and their buy-in to the development of research, which will better address the complexities and political realities in a way that otherwise sophisticated quantitative HIAs could not (3). Processes of coproduction can create new spaces for involvement and for sharing knowledge that are sustained over the long term and can help legitimize possibilities that were unanticipated, for example through new research insights and the redistribution of resources (26). Coproduction is, however, in itself a complex and time-consuming process that requires careful planning to set boundaries and include the variety of interests needed for the decision context at hand (3, 59).

Consensus in the literature reviewed here indicates that adoption of a systems thinking approach would promote a greater understanding of the complexity and interconnectedness of urban areas (8, 21). Indeed, a systems approach may highlight interactions between climate policies and other policy priorities, including health, and the trade-offs that will need to be made. In terms of practical governance, meanwhile, systems thinking would help bring together stakeholders across the system, including different government, nongovernmental, and private actors. This approach is likely to require a restructuring of governance arrangements in order to integrate fragmented sectors and forge better interdepartmental relationships, with budgets invested in initiatives that seek to maximize joint benefits across the urban landscape.

In conclusion, urban environments present significant opportunities to improve public health while mitigating and adapting to CC, but such a transition requires changes both to research

processes and methods for understanding how urban systems operate and are governed, and to the actual policies and processes of governing.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

AUTHOR CONTRIBUTIONS

A.d.N. conceived the idea of the article. A.d.N., M.N., G.W., and C.P. developed the article, L.Z.R. conducted the review of reviews on barriers and enablers, L.Z.R. and G.W. conducted the inclusion/exclusion process, L.C. conducted and wrote the first draft of the health cobenefits section, each coauthor wrote a first draft of a section of the article, and M.N. led the writing of the first full draft. All authors contributed to writing and finalizing the article.

LITERATURE CITED

1. 6 P. 2004. Joined-up government in the Western world in comparative perspective: a preliminary literature review and exploration. *J. Public Adm. Res. Theory* 14(1):103–38
2. Aldred R, Croft J, Goodman A. 2019. Impacts of an active travel intervention with a cycling focus in a suburban context: one-year findings from an evaluation of London's in-progress mini-Hollands programme. *Transp. Res. Part A Policy Pract.* 123:147–69
3. Audia C, Berkhout F, Owusu G, Quayyum Z, Agyei-Mensah S. 2021. Loops and building blocks: a knowledge co-production framework for equitable urban health. *J. Urban Health* 98(3):394–403
4. Austin SE, Biesbroek R, Berrang-Ford L, Ford JD, Parker S, Fleury MD. 2016. Public health adaptation to climate change in OECD countries. *Int. J. Environ. Res. Public Health* 13(9):889
5. Azzopardi-Muscat N, Brambilla A, Caracci F, Capolongo S. 2020. Synergies in design and health. The role of architects and urban health planners in tackling key contemporary public health challenges. *Acta Biomed.* 91(3-S):9–20
6. Beall J, Parnell S, Albertyn C. 2015. Elite compacts in Africa: the role of area-based management in the new governmentality of the Durban City-region. *Int. J. Urban Reg. Res.* 39(2):390–406
7. Bedinger M, Beevers L, Collet L, Visser A. 2019. Are we doing "systems" research? An assessment of methods for climate change adaptation to hydrohazards in a complex world. *Sustainability* 11(4):1163
8. Berry HL, Waite TD, Dear KBG, Capon AG, Murray V. 2018. The case for systems thinking about climate change and mental health. *Nat. Clim. Chang.* 8(4):282–90
9. Bikomeye JC, Rublee CS, Beyer KMM. 2021. Positive externalities of climate change mitigation and adaptation for human health: a review and conceptual framework for public health research. *Int. J. Environ. Res. Public Health* 18(5):2481
10. Bulkeley H. 2010. Cities and the governing of climate change. *Annu. Rev. Environ. Resour.* 35:229–53
11. Bulkeley H, Betsill M. 2003. *Cities and Climate Change: Urban Sustainability and Global Environmental Governance*. London/New York: Routledge. 1st ed.
12. Carmichael L, Barton H, Gray S, Lease H. 2013. Health-integrated planning at the local level in England: impediments and opportunities. *Land Use Policy* 31:259–66
13. Chapman R, Keall M, Howden-Chapman P, Grams M, Witten K, et al. 2018. A cost benefit analysis of an active travel intervention with health and carbon emission reduction benefits. *Int. J. Environ. Res. Public Health* 15(5):962
14. Cheng JJ, Berry P. 2013. Health co-benefits and risks of public health adaptation strategies to climate change: a review of current literature. *Int. J. Public Health* 58(2):305–11
15. Clark WC, van Kerkhoff L, Lebel L, Gallopin GC. 2016. Crafting usable knowledge for sustainable development. *PNAS* 113(17):4570–78
16. Cohen B. 2006. Urbanization in developing countries: current trends, future projections, and key challenges for sustainability. *Technol. Soc.* 28(1):63–80

17. Crane M, Lloyd S, Haines A, Ding D, Hutchinson E, et al. 2021. Transforming cities for sustainability: a health perspective. *Environ. Int.* 147:106366
18. Davies JS, Imbroscio DL. 2008. *Theories of Urban Politics*. London: SAGE. 2nd ed.
19. Dawson RJ. 2011. Potential pitfalls on the transition to more sustainable cities and how they might be avoided. *Carbon Manag.* 2(2):175–88
20. de Leeuw E. 2017. Engagement of sectors other than health in integrated health governance, policy, and action. *Annu. Rev. Public Health* 38:329–49
21. de Oliveira JAP, Doll CNH, Siri J, Dreyfus M, Farzaneh H, Capon A. 2015. Urban governance and the systems approaches to health-environment co-benefits in cities. *Cad. Saude Publica* 31:S25–38
22. de Sherbinin A, Bukvic A, Rohat G, Gall M, McCusker B, et al. 2019. Climate vulnerability mapping: a systematic review and future prospects. *WIREs Clim. Chang.* 10(5):e600
23. Delpla I, Diallo TA, Keeling M, Bellefleur O. 2021. Tools and methods to include health in climate change adaptation and mitigation strategies and policies: a scoping review. *Int. J. Environ. Res. Public Health* 18(5):2547
24. Deng H-M, Liang Q-M, Liu L-J, Anadon LD. 2017. Co-benefits of greenhouse gas mitigation: a review and classification by type, mitigation sector, and geography. *Environ. Res. Lett.* 12(12):123001
25. Ebi KL, Vanos J, Baldwin JW, Bell JE, Hondula DM, et al. 2021. Extreme weather and climate change: population health and health system implications. *Annu. Rev. Public Health* 42:293–315
26. Filipe A, Renedo A, Marston C. 2017. The co-production of what? Knowledge, values, and social relations in health care. *PLOS Biol.* 15(5):e2001403
27. Fleming LE, Leonardi GS, White MP, Medlock J, Alcock I, et al. 2018. Beyond climate change and health: integrating broader environmental change and natural environments for public health protection and promotion in the UK. *Atmosphere* 9(7):245
28. Fox M, Zuidema C, Bauman B, Burke T, Sheehan M. 2019. Integrating public health into climate change policy and planning: state of practice update. *Int. J. Environ. Res. Public Health* 16(18):3232
29. Gao J, Hou H, Zhai Y, Woodward A, Vardoulakis S, et al. 2018. Greenhouse gas emissions reduction in different economic sectors: mitigation measures, health co-benefits, knowledge gaps, and policy implications. *Environ. Pollut.* 240:683–98
30. Gao J, Kovats S, Vardoulakis S, Wilkinson P, Woodward A, et al. 2018. Public health co-benefits of greenhouse gas emissions reduction: a systematic review. *Sci. Total Environ.* 627:388–402
31. Georgeson L, Maslin M, Poessinouw M. 2017. Global disparity in the supply of commercial weather and climate information services. *Sci. Adv.* 3(5):e1602632
32. Giles-Corti B, Sallis JF, Sugiyama T, Frank LD, Lowe M, Owen N. 2015. Translating active living research into policy and practice: one important pathway to chronic disease prevention. *J. Public Health Policy* 36(2):231–43
33. Guell C, Mackett R, Ogilvie D. 2017. Negotiating multisectoral evidence: a qualitative study of knowledge exchange at the intersection of transport and public health. *BMC Public Health* 17(1):17
34. Holland M. 2019. *Reducing the health risks of the copper, rare earth and cobalt industries. Transition to a circular low-carbon economy*. Green Growth Papers 2020/03, OECD, Paris
35. Hoornweg D, Freire M, Lee MJ, Bhada-Tata P, Yuen B. 2011. *Cities and Climate Change: Responding to an Urgent Agenda*. Washington, DC: World Bank
36. Huang C, Vaneckova P, Wang X, Fitzgerald G, Guo Y, Tong S. 2011. Constraints and barriers to public health adaptation to climate change: a review of the literature. *Am. J. Prev. Med.* 40(2):183–90
37. Hunter DJ. 2015. Role of politics in understanding complex, messy health systems: an essay by David J Hunter. *BMJ* 350:h1214
38. Ibrahim F, Toha H, Din SNACM. 2019. Global landscape of urban health research: a bibliometric analysis. *Med. J. Malaysia* 74(Suppl. 2):93
39. Johansson C, Lövenheim B, Schantz P, Wahlgren L, Almström P, et al. 2017. Impacts on air pollution and health by changing commuting from car to bicycle. *Sci. Total Environ.* 584–585:55–63
40. Kanhai G, Fobil JN, Nartey BA, Spadaro JV, Mudu P. 2021. Urban municipal solid waste management: modeling air pollution scenarios and health impacts in the case of Accra, Ghana. *Waste Manag.* 123:15–22
41. Karlsson M, Alfredsson E, Westling N. 2020. Climate policy co-benefits: a review. *Clim. Policy* 20(3):292–316

42. Kheirbek I, Haney J, Douglas S, Ito K, Caputo S Jr., Matte T. 2014. The public health benefits of reducing fine particulate matter through conversion to cleaner heating fuels in New York City. *Environ. Sci. Technol.* 48(23):13573–82
43. Khreis H, Warsow KM, Verlinghieri E, Guzman A, Pellecuer L, et al. 2016. The health impacts of traffic-related exposures in urban areas: understanding real effects, underlying driving forces and co-producing future directions. *J. Transp. Health* 3(3):249–67
44. Kickbusch I. 2015. The political determinants of health—10 years on. *BMJ* 350:h81
45. Kidd LR, Garrard GE, Bekessy SA, Mills M, Camilleri AR, et al. 2019. Messaging matters: a systematic review of the conservation messaging literature. *Biol. Conserv.* 236:92–99
46. Koch F, Kabisch S, Krellenberg K. 2018. A transformative turn towards sustainability in the context of urban-related studies? A systematic review from 1957 to 2016. *Sustainability* 10(2):58
47. Leas EC, Althouse BM, Dredze M, Obradovich N, Fowler JH, et al. 2016. Big data sensors of organic advocacy: the case of Leonardo DiCaprio and climate change. *PLOS ONE* 11(8):e0159885
48. Lindsay G, Macmillan A, Woodward A. 2011. Moving urban trips from cars to bicycles: impact on health and emissions. *Aust. N. Z. J. Public Health* 35(1):54–60
49. Liu M, Huang Y, Jin Z, Liu X, Bi J, Jantunen MJ. 2017. Estimating health co-benefits of greenhouse gas reduction strategies with a simplified energy balance based model: the Suzhou City case. *J. Clean. Prod.* 142:3332–42
50. Mackenbach JP. 2014. Political determinants of health. *Eur. J. Public Health* 24(1):2
51. MacNaughton P, Cao X, Buonocore J, Cedeno-Laurent J, Spengler J, et al. 2018. Energy savings, emission reductions, and health co-benefits of the green building movement review-article. *J. Expo. Sci. Environ. Epidemiol.* 28(4):307–18
52. Maizlish N, Woodcock J, Co S, Ostro B, Fanai A, Fairley D. 2013. Health cobenefits and transportation-related reductions in greenhouse gas emissions in the San Francisco Bay Area. *Am. J. Public Health* 103(4):703–9
53. Maniatakou S, Berg H, Maneas G, Daw TM. 2020. Unravelling diverse values of ecosystem services: a socio-cultural valuation using Q methodology in Messenia, Greece. *Sustainability* 12(24):10320
54. Marvuglia A, Koppelaar R, Rugani B. 2020. The effect of green roofs on the reduction of mortality due to heatwaves: results from the application of a spatial microsimulation model to four European cities. *Ecol. Model.* 438:109351
55. Mayrhofer JP, Gupta J. 2016. The science and politics of co-benefits in climate policy. *Environ. Sci. Policy* 57:22–30
56. McCosker A, Matan A, Marinova D. 2018. Policies, politics, and paradigms: healthy planning in Australian local government. *Sustainability* 10(4):1008
57. Meadow AM, Ferguson DB, Guido Z, Horangic A, Owen G, Wall T. 2015. Moving toward the deliberate coproduction of climate science knowledge. *Weather. Clim. Soc.* 7(2):179–91
58. Methley AM, Campbell S, Chew-Graham C, McNally R, Cheraghi-Sohi S. 2014. PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC Health Serv. Res.* 14(1):579
59. Miller CA, Wyborn C. 2020. Co-production in global sustainability: histories and theories. *Environ. Sci. Policy* 113:88–95
60. Miller JT, Vu AT. 2021. Emerging research methods in environmental displacement and forced migration research. *Geogr. Compass* 15(4):e12558
61. Mueller N, Daher C, Rojas-Rueda D, Delgado L, Vicioso H, et al. 2021. Integrating health indicators into urban and transport planning: a narrative literature review and participatory process. *Int. J. Hyg. Environ. Health* 235:113772
62. Mueller N, Rojas-Rueda D, Khreis H, Cirach M, Andrés D, et al. 2020. Changing the urban design of cities for health: the superblock model. *Environ. Int.* 134:105132
63. Murdoch Univ. 2021. Systematic reviews—research guide. Recommended databases. *Murdoch University Library*. **https://libguides.murdoch.edu.au/systematic/databases**
64. Negev M, Kovats RS. 2016. Climate change adaptation in the reorganized UK public health system: a view from local government. *Public Health* 134:102–4

65. Otto IM, Reckien D, Reyer CPO, Marcus R, Le Masson V, et al. 2017. Social vulnerability to climate change: a review of concepts and evidence. *Reg. Environ. Chang.* 17(6):1651–62
66. Pérez K, Olabarria M, Rojas-Rueda D, Santamariña-Rubio E, Borrell C, Nieuwenhuijsen M. 2017. The health and economic benefits of active transport policies in Barcelona. *J. Transp. Health* 4:316–24
67. Phillips G, Green J. 2015. Working for the public health: politics, localism and epistemologies of practice. *Sociol. Health Illn.* 37(4):491–505
68. Praharaj S, Han JH, Hawken S. 2018. Urban innovation through policy integration: critical perspectives from 100 smart cities mission in India. *City Cult. Soc.* 12:35–43
69. Ramírez-Agudelo NA, Anento RP, Villares M, Roca E. 2020. Nature-based solutions for water management in peri-urban areas: barriers and lessons learned from implementation experiences. *Sustainability* 12(23):9799
70. Rashidi K, Stadelmann M, Patt A. 2017. Valuing co-benefits to make low-carbon investments in cities bankable: the case of waste and transportation projects. *Sustain. Cities Soc.* 34:69–78
71. Ray I, Smith KR. 2021. Towards safe drinking water and clean cooking for all. *Lancet Glob. Health* 9(3):e361–65
72. Remais JV, Hess JJ, Ebi KL, Markandya A, Balbus JM, et al. 2014. Estimating the health effects of greenhouse gas mitigation strategies: addressing parametric, model, and valuation challenges. *Environ. Health Perspect.* 122(5):447–55
73. Richard L, Gauvin L, Raine K. 2011. Ecological models revisited: their uses and evolution in health promotion over two decades. *Annu. Rev. Public Health* 32:307–26
74. Riley R, de Nazelle A. 2019. Barriers and enablers of integrating health evidence into transport and urban planning and decision making. In *Integrating Human Health into Urban and Transport Planning: A Framework*, ed. M Nieuwenhuijsen, H Khreis, pp. 641–54. Cham, Switz.: Springer Int.
75. Rojas-Rueda D, de Nazelle A, Andersen ZJ, Braun-Fahrländer C, Bruha J, et al. 2016. Health impacts of active transportation in Europe. *PLOS ONE* 11(3):e0149990
76. Rojas-Rueda D, de Nazelle A, Teixidó O, Nieuwenhuijsen MJ. 2012. Replacing car trips by increasing bike and public transport in the greater Barcelona metropolitan area: a health impact assessment study. *Environ. Int.* 49:100–9
77. Sallis JF, Bull F, Burdett R, Frank LD, Griffiths P, et al. 2016. Use of science to guide city planning policy and practice: how to achieve healthy and sustainable future cities. *Lancet* 388(10062):2936–47
78. Sharifi A. 2021. Co-benefits and synergies between urban climate change mitigation and adaptation measures: a literature review. *Sci. Total Environ.* 750:141642
79. Simon D, Arfvidsson H, Anand G, Bazaz A, Fenna G, et al. 2015. Developing and testing the Urban Sustainable Development Goal's targets and indicators—a five-city study. *Environ. Urban.* 28(1):49–63
80. Smargiassi A, Plante C, Morency P, Hatzopoulou M, Morency C, et al. 2020. Environmental and health impacts of transportation and land use scenarios in 2061. *Environ. Res.* 187:109622
81. Stead D, Meijers E. 2009. Spatial planning and policy integration: concepts, facilitators and inhibitors. *Plan. Theory Pract.* 10(3):317–32
82. Steiner S, Bisig C, Petri-Fink A, Rothen-Rutishauser B. 2016. Diesel exhaust: current knowledge of adverse effects and underlying cellular mechanisms. *Arch. Toxicol.* 90(7):1541–53
83. Stevenson M, Thompson J, de Sá TH, Ewing R, Mohan D, et al. 2016. Land use, transport, and population health: estimating the health benefits of compact cities. *Lancet* 388(10062):2925–35
84. Tainio M, Monsivais P, Jones NR, Brand C, Woodcock J. 2017. Mortality, greenhouse gas emissions and consumer cost impacts of combined diet and physical activity scenarios: a health impact assessment study. *BMJ Open* 7(2):e014199
85. Tétreault LF, Eluru N, Hatzopoulou M, Morency P, Plante C, et al. 2018. Estimating the health benefits of planned public transit investments in Montreal. *Environ. Res.* 160:412–19
86. Toloo G, Fitzgerald G, Aitken P, Verrall K, Tong S. 2013. Evaluating the effectiveness of heat warning systems: systematic review of epidemiological evidence. *Int. J. Public Health* 58(5):667–81
87. Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, et al. 2015. Health and climate change: policy responses to protect public health. *Lancet* 386(10006):1861–914
88. Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Beagley J, et al. 2021. The 2020 report of The *Lancet* Countdown on health and climate change: responding to converging crises. *Lancet* 397(10269):129–70

89. Whitmee S, Haines A, Beyrer C, Boltz F, Capon AG, et al. 2015. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–*Lancet* Commission on planetary health. *Lancet* 386(10007):1973–2028
90. WHO (World Health Organ.). 2015. *Promoting health while mitigating climate change*. Tech. Brief., World Health Organ. Conf. Health Clim., Geneva. **https://www.who.int/phe/climate/conference_briefing_2_promotinghealth_27aug.pdf**
91. Wolkinger B, Haas W, Bachner G, Weisz U, Steininger K, et al. 2018. Evaluating health co-benefits of climate change mitigation in urban mobility. *Int. J. Environ. Res. Public Health* 15(5):880
92. Woodcock J, Edwards P, Tonne C, Armstrong BG, Ashiru O, et al. 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *Lancet* 374(9705):1930–43
93. Woodcock J, Givoni M, Morgan AS. 2013. Health impact modelling of active travel visions for England and Wales using an integrated transport and health impact modelling tool (ITHIM). *PLOS ONE* 8(1):e51462
94. Woodhall SC, Landeg O, Kovats S. 2021. Public health and climate change: How are local authorities preparing for the health impacts of our changing climate? *J. Public Health* 43(2):425–32
95. Workman A, Blashki G, Bowen K, Karoly D, Wiseman J. 2018. The political economy of health co-benefits: embedding health in the climate change agenda. *Int. J. Environ. Res. Public Health* 15(4):674
96. Yang Q, Yang D, Li P, Liang S, Zhang Z. 2021. Resilient city: a bibliometric analysis and visualization. *Discret. Dyn. Nat. Soc.* 2021:5558497