Urban design, transport, and health 4

What next? Expanding our view of city planning and global health, and implementing and monitoring evidence-informed policy

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This Series on urban design, transport, and health aimed to facilitate development of a global system of health-related policy and spatial indicators to assess achievements and deficiencies in urban and transport policies and features. This final paper in the Series summarises key findings, considers what to do next, and outlines urgent key actions. Our study of 25 cities in 19 countries found that, despite many well intentioned policies, few cities had measurable standards and policy targets to achieve healthy and sustainable cities. Available standards and targets were often insufficient to promote health and wellbeing, and health-supportive urban design and transport features were often inadequate or inequitably distributed. City planning decisions affect human and planetary health and amplify city vulnerabilities, as the COVID-19 pandemic has highlighted. Hence, we offer an expanded framework of pathways through which city planning affects health, incorporating 11 integrated urban system policies and 11 integrated urban and transport interventions addressing current and emerging issues. Our call to action recommends widespread uptake and further development of our methods and open-source tools to create upstream policy and spatial indicators to benchmark and track progress; unmask spatial inequities; inform interventions and investments; and accelerate transitions to net zero, healthy, and sustainable cities.

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This is the fourth in a **Series** of four papers about urban design, transport, and health

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Introduction

Cities are powerhouses of the economy, providing access to employment, opportunities, and resources. Yet when poorly planned, cities foster unhealthy and unsustainable lifestyles, expose residents to environmental stressors (such as traffic; air, noise, and nocturnal light pollution; and heat), and exacerbate inequities in access to infrastructure and resources.[1,2] By 2050, around 70% of the world's population is projected to live in cities.[1] Cities generate 75% of global energy-related greenhouse gas emissions, with 24% of global emissions coming from road transport,[2] and urbanisation is a major cause of biodiversity loss.[3] High-income and upper-middle-income countries emit 86% of global CO_2 emissions.[4]

In the coming decades, city planning decisions will profoundly affect human and planetary health. In the first *Lancet* Series (Series 1) on urban design, transport, and health, we argued that cities should prioritise urban and transport policies and interventions that enable walking, cycling, and public transport, and we proposed a set of city planning indicators that could be used to benchmark and monitor progress.[1] The principal aim of the second Series (Series 2) was to facilitate development of a global system of health-related policy and spatial indicators that could assess achievements and deficiencies in urban and transport policies and features.

This final paper in Series 2 summarises key findings, considers what to do next, and outlines urgent key actions. City planning issues are often considered in silos (eg, focused either on transportation or urban planning or biodiversity), rather than in one comprehensive framework to achieve better outcomes for cities through integrated city planning. Transport, land use, green space, and infrastructure research and planning are typically undertaken by different disciplines, policies are devised by different government departments, and interventions are implemented by different sectors. In this final paper, we argue that to transition to healthy and sustainable cities there is an urgent need to rethink this siloed approach in favour of interdisciplinary research and cross-sector, integrated policy and practice.

Key findings of Series 2

The selection of policies and spatial indicators studied in Series 2 was based on the eight regional and local urban design intervention foci (the 8Ds) identified in Series 1 (figure),[1] which combine to create compact, walkable cities that support sustainable mobility. Compact, walkable cities affect individual, social, and environmental risk exposures and reduce non-communicable diseases (NCDs) and road trauma. The 8Ds are: destination accessibility, distribution of employment, demand management, design of movement networks, density, distance to public transport, diversity of housing and land uses, and desirability of active modes.[1] In 25 case study cities across 19 countries, Series 2 assessed the presence and quality of city planning policies that support the 8Ds,[5] and developed spatial indicators to measure access to urban design and transport features that would support healthy and sustainable lifestyles.[6] Spatial indicators were

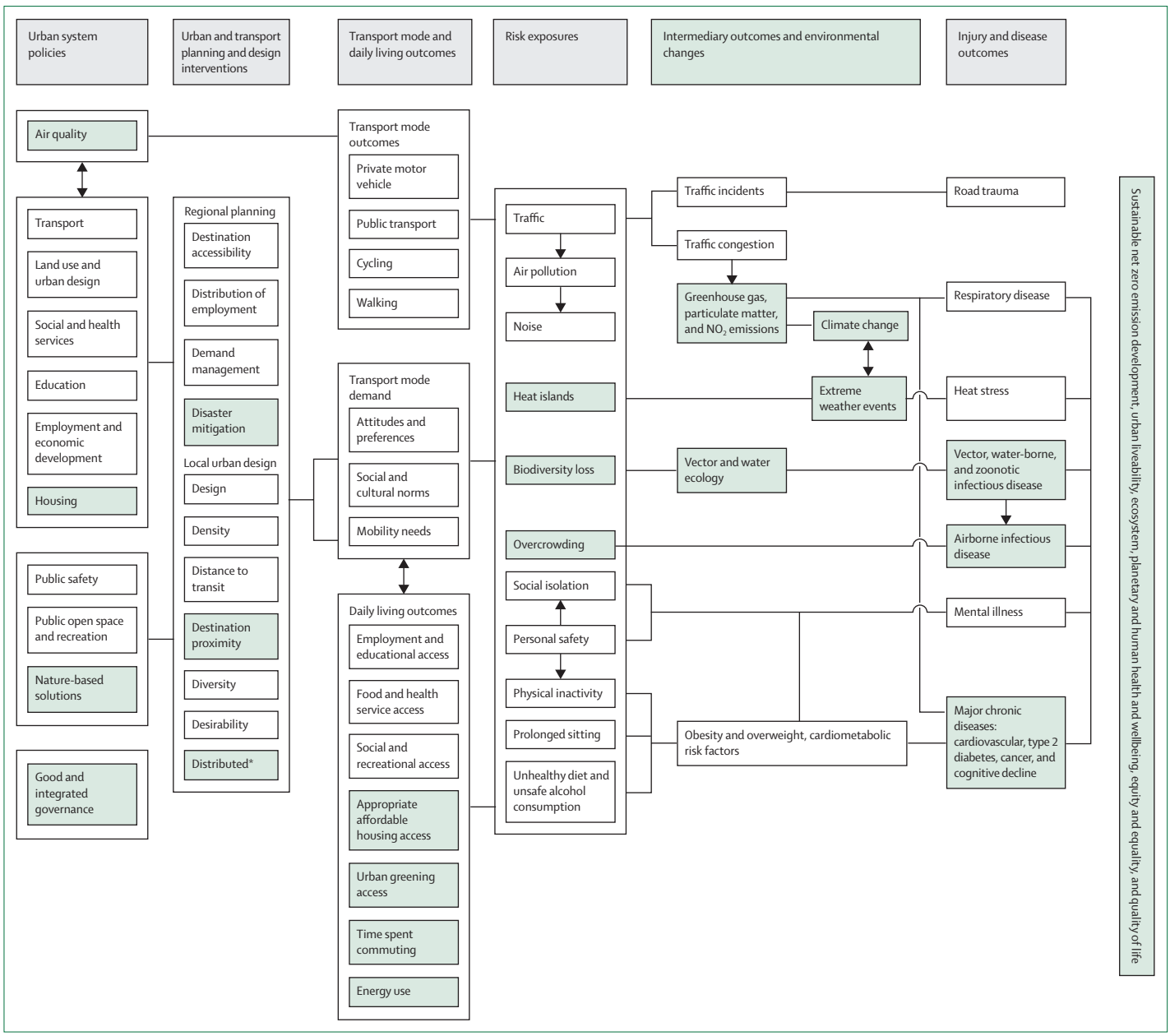

Figure: **The pathways through which urban and transport planning decisions affect health**
New and modified pathways, since 2016, are highlighted in green. *Interventions and resources accounting for age, gender, race, socioeconomic position, and area-level disadvantage.

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informed by Cerin and colleagues' study[7] of 14 cities in ten countries, identifying thresholds for reaching WHO's transport-related physical activity targets.[8]

Panel 1 summarises the main findings of Series 2. By working with local collaborators, we identified and assessed policies, and created corresponding policy and spatial indicators in cities worldwide. Data limitations were greater for cities in lower-income countries than cities in higher-income countries, which highlighted the importance of investing in partnerships and capacity building in low-income and middle-income countries (LMICs). Despite policy ambitions to create healthy and sustainable cities, we found that few cities had measurable standards and targets to achieve such aspirations.[5] This observation was reinforced by Cerin and colleagues' study,[7] which showed that, to reach WHO's physical activity targets by 2030,[8] population, transport, and intersection densities needed to be markedly different from those currently specified in many cities' policies.[5] Notably, Cerin and colleagues[7] also found upper limits for population density, beyond which the probability of walking appeared to decline. Boeing and colleagues'

***Panel 1:* Summary of the main findings from the second urban design, transport, and health Series**

- Working with a robust international network of local collaborators, we identified and measured city planning policies that lead to better health and wellbeing and developed comparable policy and spatial indicators to benchmark and monitor cities globally over time.
- Most cities did not have city planning policies to deliver healthy and sustainable cities, which was particularly evident in lower-middle-income countries.[5]
- Even when policies and standards existed, many did not have measurable targets, or fell short of thresholds for urban design and transport features that encourage healthy, active, and sustainable lifestyles.[5]
- Using comparable data from 14 cities in ten countries, we identified thresholds for urban design and transport features related to walking for achieving WHO targets for physical activity by 2030 that could inform standards and targets for city planning policies.[7]
- Compared with other neighbourhoods, urban neighbourhoods with more than 5700 people per km², approximately 100 street intersections per km², and about 25 public transport stops per km², and with proximate public parks, were associated with 80% or higher probability of walking for transport and 58% or higher probability of meeting physical activity guidelines via walking. However, unrestricted increases in population, street intersection, and public transport densities might not be desirable. We observed a decline in the probability of walking beyond about 14 000 people per km², approximately 230 street intersections per km², and about 45 public transport stops per km² in our sampled cities.[7]
- In many cities worldwide, free, editable open data sources (such as OpenStreetMap, built by volunteers) provide relatively consistent spatial data, making it feasible to create spatial indicators that can be used to benchmark, monitor, map, and compare urban design and transport features between and within cities. In some cities—particularly in low-income and middle-income countries (LMICs)—open data are not readily available. Nevertheless, momentum to create and use open data sources such as OpenStreetMap is likely to grow in the future. We created open-source tools to facilitate replication of our spatial indicators.[6] However, open data require validation by local experts.
- Both between and within cities, we found substantial inequities in access to urban design and transport features that enable healthy and sustainable lifestyles. For example, the percentage of the population with a healthy food market within a 500 m walk varied from 6% (Phoenix, AZ, USA) to 70% (Bern, Switzerland).[6]
- The percentages of the population living in local areas that meet the thresholds for population, street intersection, and public transport stop densities associated with increased physical activity through walking, and sufficient to reach WHO physical activity targets for 2030, varied substantially—both between and within cities.[6]
- Cities in LMICs tended to be more walkable than cities in the USA, Australasia, and some European countries, despite few of the cities in LMICs having policy frameworks to achieve healthy and sustainable cities. Conversely, many residents of cities in LMICs had very poor access to public open space.[6]
- Our spatial indicators and maps offer local planners insights about where and how to invest and target interventions to enable healthy and sustainable lifestyles and reduce inequities in access to health-supportive environments.
- To create healthy and sustainable cities, we recommend that cities implement comprehensive integrated policies with evidence-informed standards for implementation, to create urban and transport planning and design interventions that deliver an expanded set of 11 regional and local urban design intervention foci (11Ds).

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spatial indicators of urban design and transport features unmasked inequities within and between cities.[6] Among the cities studied, a substantial proportion of urban dwellers lived in neighbourhoods with urban design and transport features well below thresholds that support active and sustainable lifestyles, particularly in North America and Australia. Although many cities in lower-middle-income countries were walkable, many residents lacked access to public open space.

What to do next?

Since the 2016 *Lancet* urban design, transport, and health Series,[1] evidence about the effects of city planning on sustainable mobility and health has strengthened. Longitudinal evidence shows that proximate destinations and public transportation increase physical activity, and investments in active and public transport infrastructure can increase demand for walking and cycling.[9] Growing longitudinal evidence also shows that well connected, higher-density, walkable, mixed-use neighbourhoods might reduce the risk of obesity, type 2 diabetes, and hypertension. Conversely, urban sprawl might increase risk of obesity.[10] Simulation research predicts meaningful gains in road traffic safety, local air quality, and climate change mitigation resulting from increased and equitable access to active transportation and recreational opportunities in high-income, middle-income, and low-income cities, particularly when combined with bold policies to reduce car dependency.[11]

Given an ageing population globally, age-friendly city planning that reduces risk of dementia and ageing-related cognitive decline has also been called for.[12] With declining physical functionality, ageing populations rely more on their local neighbourhoods for daily living. Some evidence suggests that urban design and transport features are linked to several dementia

risk factors, including physical inactivity, depression, social isolation, obesity, diabetes, hypertension, and air pollution exposure.[13] However, the benefits of walkable neighbourhoods with mixed land uses might be offset by increases in air and noise pollution and traffic, if travel demand by car is not reduced.[14] Failure to consider traffic-related air and noise pollution might mask positive effects of proximate destinations on cognitive health, underlining the need for studies to include all inter-related environmental factors.[15]

WHO air-quality guidelines reflect the urgency for action on air pollution.[16] Cities are hotspots for air pollution, with 25% of $PM_{2·5}$ caused by vehicular transportation.[2] With no safe limit of exposure, air pollution is the fourth largest risk factor for global mortality.[17] Air pollution not only causes cardiovascular and respiratory disease and premature mortality, but might also contribute to diabetes, obesity, low birthweight, poor mental health, and impaired cognitive development.[18] Although the net health effect of walking and bicycling in polluted areas remains positive, active travel—particularly bicycling—can increase air pollution exposure.[19]

The findings of Series 2 show that there is still much to do, and cities must urgently move from evidence to action. Without comprehensive and integrated implementation of the 8Ds, human health will be harmed by car-centric planning.[1]

The urgency to act is now palpable.[20] In the face of dangers from climate change,[20] rapid urbanisation, and growing spatial, social, economic, and environmental problems, disparate sectors must work together to harness integrated city planning to protect human and planetary health.[1,2,20] Greater emphasis must be placed on anticipating and avoiding unintended consequences.[2,3] Moreover, as the COVID-19 pandemic has shown, cities must be designed to be resilient in preparation for future crises. The next section therefore considers several additional emerging issues that we recommend city planners prioritise to protect human health.

Optimising the compact city: the 11Ds

Compact cities are necessary for sustainable development—they reduce urban footprints while providing access to proximate destinations; reduce automobile dependence, travel distances, commute times, traffic congestion, and greenhouse gas emissions; and enable sustainable mobility.[1,20] However, the COVID-19 and climate crises highlight the importance of broader considerations to optimise compact city development to benefit health.

Hence, we have expanded our 2016 conceptual framework of how city planning affects health. The framework now includes 11 integrated urban systems policies that create 11 integrated urban and transport planning and design interventions. The revised framework reinforces earlier recommendations (ie, high-density housing and integrated governance) and adds two upstream urban system policies (ie, air quality and nature-based solutions) that enable downstream health-supportive interventions (figure). We have also expanded the foci of recommended urban and transport planning and design interventions from 8Ds to 11Ds. Destination proximity reflects the strengthened evidence for the importance of local destinations for walkable cities.[5–7] Disaster mitigation underscores the role played by city planning in adapting to, and mitigating, the effects of climate change. Distributed interventions and resources reinforce city planning's role in embedding equity in decision making.

COVID-19 and city planning

The COVID-19 pandemic had a rapid and catastrophic effect on cities, and spatial and socioeconomic inequities soon emerged.[21] Crowded conditions, poor air circulation, and ambient air pollution increased disease risk.[21] In some cities, the pandemic triggered migration to suburbs and rural areas, with the potential to intensify urban sprawl, encroach on natural habitats, and reduce biodiversity.[21] Other evidence suggested that amenity-rich urban density might protect residents by reducing travel distances and COVID-19 exposure and transmission,[21] although this protection is not equally shared, with less affluent populations unable to work from home.[21]

In some cities, the pandemic prompted rapid transformations that supported health. Air quality improved as teleworking reduced travel by private vehicle; road space was reallocated to enable physically distanced walking, cycling, commerce, and recreation;[21] and cycling infrastructure was fast-tracked.[21] Many city leaders have vowed to "build back better" through 15-min or car-free neighbourhoods or zero emission areas, with proximate destinations, public open space, and expanded walking and bicycle infrastructure. However, these vows will not create a healthier, fairer, and greener future unless they are maintained and expanded over time, and only if affordable and appropriate high-density housing are prioritised.

High-density housing

High-density housing underpins compact cities, making proximate destinations and high frequency public transport viable.[1] However, apartments with insufficient space, inflexible layouts, poor light, limited control over indoor air quality and temperature, and inadequate communal space might expose residents to environmental stressors (eg, insufficient daylight or natural ventilation, poor thermal comfort, and lack of visual and acoustic privacy), impede physical distancing within and between households, and reduce ease of home-based activities (eg, school, work, and exercise).[22]

The COVID-19 pandemic revealed and reinforced global inequities in housing. Densely populated low-income areas with underserviced housing were hotspots for disease spread.[23] Overcrowded dwellings—rather than housing density per se—increases disease transmission

risk,[24] highlighting the urgent need for affordable and appropriate housing.

Housing located along heavily trafficked roads or in areas with insufficient green space exposes residents to air pollution and noise,[1] and exacerbates urban heat islands. Yet, affordable, low-density housing, located on the urban fringe and poorly served by amenities and public transport, increases urban sprawl, motor vehicle dependence, and social segregation. Hence, there are calls for apartment standards based on health-supportive principles,[22] including design features that mitigate and adapt to climate change.

Mitigating and adapting to climate change in compact cities

Cities both contribute to greenhouse gas emissions and are vulnerable to the consequences of climate change, including more frequent and severe disasters (eg, floods, droughts, fire, and extreme heat), in-migration from drought-stricken rural areas, and infectious diseases.[25] Cities therefore exemplify the nexus between climate change and health, and need cross-sectoral, integrated governance and planning to reduce risks.

Although high-income countries are the primary contributors to greenhouse gas emissions, rapidly urbanising areas in LMICs are more vulnerable to disasters, with fewer resources and underdeveloped infrastructure. Low-income populations, particularly in LMICs, also suffer the harshest health, social, and economic consequences of climate-induced disasters.[26] Equity must therefore be at the forefront of urban climate mitigation and adaptation efforts, particularly given the concentrations of poverty in risk prone locations in many cities. Disaster mitigation should become an integral element of city planning, and a priority in LMICs.

Integrated city planning should prioritise mitigation strategies, including reducing direct and indirect greenhouse gas emissions by transitioning to sustainable mobility, clean renewable energy, and energy-efficient buildings. Adaptation is also essential, including reducing disaster risk through development controls in locations prone to floods and fires, improved stormwater management, urban greening (such as tree canopy cover and green roofs), and planning for large, abrupt in-migration following climate-related disasters.

Biodiversity and urban greening

Biodiversity underpins life on earth. Intact ecosystems provide services that are fundamental to human health, such as food production, clean air, quantity and quality of fresh water, and regulation of climate, pests, and disease.[27] Growing evidence suggests that more biodiverse urban greening provides greater health, wellbeing, and social benefits.[27]

Yet urban expansion—occurring at more than twice the rate of urban population growth—together with agriculture and resource mining, threatens biodiversity by polluting, degrading, and fragmenting habitat and displacing endemic species with introduced ones.[3] Nature-based solutions that harness nature's ability to regulate, restore, and regenerate resources are urgently needed. These solutions should include biodiversity-sensitive design that minimises harm from urban development, such as protecting wildlife corridors that connect green spaces, maintaining local plant populations, minimising pesticide use, and controlling non-native predators.[28]

Urban greening yields several human health benefits, such as longer life expectancy, better mental health, and improved birth outcomes and child development.[29] Well designed green spaces provide venues for social and physical activity, mitigate urban heat island effects, improve air quality, reduce noise, and sequester CO_2. WHO proposes that, for good health, green spaces of 0·5–1 hectare be located within 300 m of residences.[30] However, green space access and quality varies between and within cities. This Series' findings revealed poor access to large public open spaces in many cities in lower-middle-income countries.[6] This finding reinforces the need to prioritise equity of access within cities, particularly given that low-income neighbourhoods are commonly deprived of high-quality green space. To achieve health-supportive compact cities that mitigate and adapt to climate change, evidence-informed urban planning standards are needed for the size and proximity of biodiverse green spaces and minimum thresholds for tree canopy cover.

Call to action

In a rapidly urbanising world in which cities—particularly high-income cities—are the major contributor to greenhouse gas emissions, future human and planetary health will be determined by our ability to transform city planning to achieve healthy and sustainable development and lifestyles. Based on this Series' findings, we have summarised the key actions urgently required (panel 2).

The Series shows that few cities have measurable standards and targets to drive the necessary transition,[5] and that health-supportive urban design and transport features are inadequate and inequitably distributed in most cities.[6] Evidence-informed thresholds for standards for urban design and transport features—such as those estimated by Cerin and colleagues[7]—are urgently needed for all 11Ds (figure). To develop sustainably and promote health and wellbeing, cities need comprehensive integrated—rather than selective one-off—interventions for all 11Ds, with short-term, medium-term, and long-term targets for their implementation.

We have shown the feasibility of creating comparable policy and spatial indicators and recommended additional policy and spatial indicators aligned with the 11Ds (panel 2), including indicators measuring biodiversity, tree canopy, and heat islands.

Achieving integrated governance across sectors and between all levels of government is essential to

Panel 2: Actions for the transition to healthy and sustainable cities

We urge international governmental, non-governmental, and professional organisations to:

Encourage all cities to benchmark and monitor progress

- Provide guidance, tools, and technical support to incorporate health, sustainability, net zero emissions, and equity in all urban policies, including procurement and financing mechanisms
- Lead the way in expanding and disseminating the open-source tools we developed to enable cities across the globe to replicate and expand our evidence-informed indicators, and to benchmark and monitor progress every 5 years
- Commit to investing in cities in low-income and middle-income countries (LMICs) to support data infrastructure and technical capacity building
- Develop an expanded set of evidence-informed indicators that measure the consequences of city planning for human and planetary health; these should include changes in biodiversity, tree canopy, heat island, levels of low-income housing built in areas prone to floods and fires, distribution of urban infrastructure, levels of crime, traffic injuries, and resources that enable healthy and sustainable development
- Activate a worldwide citizen-science programme (we propose a 1000 cities challenge) and encourage collection of open data, such as OpenStreetMap, to improve the knowledge base and inform decision making, with a focus on the most data-scarce areas
- Create multidisciplinary teams with content and technical experts (including computer and geospatial scientists) to use big data and technology ethically, to create replicable, routinely collected indicators

We urge city mayors and leaders of regional and national governments to:

Transform urban governance

- Create an authorising environment that encourages and actively works towards integrated urban governance: horizontally across sectors, and vertically between levels of government and jurisdictions
- Make the transition to integrated, transparent, inclusive, accountable, and nimble urban governance, to respond to emerging urban problems and create net zero emission cities
- Encourage participatory planning, monitoring, and budgeting; listen to the voices of unheard groups, including children, youth, those living in poverty, Indigenous communities, and other marginalised people

Strengthen policy frameworks

- Develop city planning policy frameworks that are integrated across sectors and between levels of government; all such frameworks should:
- Enable sustainable mobility and create healthy and sustainable net zero emission cities
- Specify accountability and funding, with clear goals, measurable standards, and specific targets, using evidence-informed thresholds to achieve desired results
- Maximise co-benefits for human and planetary health by mitigating and adapting to climate change
- Provide equitable access to health-supportive resources, infrastructure, and environments
- Incorporate actions to achieve the 11 regional and local urban design intervention foci (or 11Ds)
- Create 15-min neighbourhoods
- Reduce residents' exposure to environmental stressors (such as air and noise pollution)
- Incorporate standards for the size and proximity of biodiverse green spaces and minimum thresholds for tree canopy cover
- Incorporate biodiversity-sensitive design guidelines that minimise harm from urban development
- Avoid residential development in risk-prone locations
- Incorporate health-supportive design principles into land use and high-density housing
- Implement national and regional urban policy that builds capacity and consistency in responding to health and sustainability problems

Benchmark and monitor progress

- Adopt (and expand) our evidence-informed spatial indicators, to create a consistent set of upstream policy and intervention indicators that enable the consequences of city planning decisions to be benchmarked, monitored, and tracked over time; these could include indicators of greenhouse gas emissions, air and noise pollution, biodiversity, tree canopy, and heat island effects
- Use spatial indicators to unmask within-city inequities and design interventions, to ensure equitable access to urban design and transport features that enable healthy and sustainable lifestyles and foster health and wellbeing
- Measure each city's transport use and health and wellbeing outcomes, so that the consequences of policies can be monitored over time, and any inequalities in each city can be identified and remedied

Monitor policy implementation

- Make city planning decision-making accountable, by conducting natural experiments of policy interventions in partnership with universities; such experiments should assess and track policy implementation and health, social, environmental, and equity outcomes
- Assess effects on chronic disease, sustainability, mobility, air pollution, greenhouse gas emissions, biodiversity, and heat island effects when developing, financing, or implementing urban policies and interventions
- Equip the health sector to develop, evaluate, and support the implementation of all decisions arising from these health and environmental impact assessments

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(Panel 2 continued from previous page)

We urge citizens and civil society to:

Create and use open data

- Become and encourage citizen scientists and support the growth of open data sources, like OpenStreetMap, which can be used for both research and local advocacy
- Advocate locally and nationally for governments to create healthy and sustainable cities and to use policy and spatial indicators to monitor progress
- Actively demand and become involved in participatory processes to plan, finance, build, and monitor urban environments

We urge teaching and research academics to:

- Co-design policy-relevant research with citizens and policy makers, including the interpretation and translation of findings
- Conduct natural experiments of policy initiatives designed to improve the healthfulness and sustainability of cities
- Study cities as a complex system
- Fill the gap in city planning research and help build capacity in LMICs and other disadvantaged places
- Conduct international studies with common protocols and measures to assess thresholds for built environment features that can inform measurable standards in city planning policies
- Develop, and evaluate the use of, policy and spatial indicators locally, nationally, and globally, and incorporate this work into degree programmes
- Provide interdisciplinary tertiary and professional education on the planning of healthy and sustainable cities for all relevant professions, including public health, city planning, urban design, transport, environmental studies, architecture, parks and recreation, geography, and public administration

We urge research funders to:

- Prioritise multisector, multi-outcome studies (including natural experiment study designs) that incorporate systems thinking and provide comprehensive evaluations of integrated governance approaches
- Prioritise research in LMICs and other disadvantaged settings, and research on under studied urban design and transport features and their links to health and sustainability

transform cities and enable nimble responses to emerging urban problems. Integrated governance ensures alignment of actions across government, and shared responsibility for, and funding of, transformation. Leadership is vital to create the authorising environment that will enable cross-sector integrated governance and policies to deliver all 11Ds needed for healthy and sustainable cities. To capitalise on the post-COVID-19 pandemic global aspirations to "build back better" governments must reduce traffic and prioritise sustainable transport through safe walking and cycling infrastructure by creating 15-min neighbourhoods with proximate amenities, building healthy and affordable housing, and improving and enlarging green spaces.

Closing statement

Given multiple challenges confronting cities worldwide—preventable chronic disease, infectious disease pandemics, deep social disparities, ageing populations, biodiversity loss, and climate change—there is an urgent need for evidence-informed city planning policies and standards aligned with our framework's 11Ds, which will lead to healthy and sustainable cities for all. We recommend widespread and rapid uptake and further development of our methods and open-source tools,[6] with high-income countries supporting adoption of our methods and tools in LMICs. Widespread adoption will enable city planning policy and spatial indicators to be used to benchmark and track progress, unmask spatial inequities in access to health-supportive built environments, inform interventions and investments, accelerate changes that could help solve multiple related problems, and hold governments to account, with cobenefits for human and planetary health.

Contributors

BG-C led the study executive team, conceptualisation, writing of the original draft, review, and editing. AVM, ML, EC, GB, DS, and JFS were part of the study executive team and contributed to the conceptualisation, writing of the original draft, review, and editing. HF, SF, AK, THdS, SB, and MN contributed to the conceptualisation, writing sections of the original draft, and reviewing and editing critically for important intellectual content. CH, DA, EH, JA, and SL were part of the study executive team and contributed to the conceptualisation, writing and review, and editing critically for important intellectual content. ALO and KN coordinated and contributed to collection of local data, conceptualisation, writing, and review, and editing critically for important intellectual content.

Declaration of interests

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