



## Urban design, transport, and health 3

# Use of science to guide city planning policy and practice: how to achieve healthy and sustainable future cities

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This is the third in a Series of three papers about urban design, transport, and health

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Land-use and transport policies contribute to worldwide epidemics of injuries and non-communicable diseases through traffic exposure, noise, air pollution, social isolation, low physical activity, and sedentary behaviours. Motorised transport is a major cause of the greenhouse gas emissions that are threatening human health. Urban and transport planning and urban design policies in many cities do not reflect the accumulating evidence that, if policies would take health effects into account, they could benefit a wide range of common health problems. Enhanced research translation to increase the influence of health research on urban and transport planning decisions could address many global health problems. This paper illustrates the potential for such change by presenting conceptual models and case studies of research translation applied to urban and transport planning and urban design. The primary recommendation of this paper is for cities to actively pursue compact and mixed-use urban designs that encourage a transport modal shift away from private motor vehicles towards walking, cycling, and public transport. This Series concludes by urging a systematic approach to city design to enhance health and sustainability through active transport and a move towards new urban mobility. Such an approach promises to be a powerful strategy for improvements in population health on a permanent basis.

### Introduction

Land-use and transport policies in cities around the world are having negative effects on health, primarily through road traffic injuries, air pollution, and physical inactivity.<sup>1–3</sup> Road traffic collisions kill and maim millions of people each year. Urban air pollution, mostly motor vehicle related, kills hundreds of thousands of people annually and contributes to climate change. Epidemic levels of physical inactivity contribute to the deaths of millions through effects on multiple non-communicable diseases (NCDs). Urban and transport planning and urban design are some of the most fundamental causes of many serious global problems.<sup>3,4</sup>

Evidence of the health effects of land-use and transport policies needs to be used more effectively to guide the design of cities so that they enhance health and environmental sustainability. The first paper<sup>5</sup> in this Series demonstrated that land-use and transport policies and practices can affect a wide range of health outcomes, especially NCDs and motor vehicle injuries. Eight health-promoting urban design and transport principles were identified, and evidence-informed indicators were proposed that can be used to monitor progress in the creation of health-promoting cities. In many countries, land-use and transport policies are the antithesis of healthy urban design.<sup>5</sup> The second paper<sup>6</sup> in this Series modelled land-use and transport policies—with an emphasis on compact cities that support a modal shift from private motor-vehicle use to walking, cycling, and public transport as a strategy for improvements in population health—and estimated the gains in population health that cities could achieve.

In this final paper of the Series, we consider the use of evidence as a tool for improved decision making in

urban design and transport, and we make recommendations for improvements in the application of evidence. This paper draws on a conceptual model of research translation, summarises evidence from the knowledge transfer field, and uses a diverse set of case studies to illustrate the potential for effective research translation to facilitate health-oriented land-use and transport practices and policies. We use the terms research translation, knowledge transfer, and knowledge exchange interchangeably to refer to the process of actively working to have research-based information used in policy making. We conclude with recommendations based on the entire Series, identifying research and policy actions needed to advance the creation of healthy and sustainable cities.

### Models and evidence to guide research translation

Research translation is a novel concept to many health researchers. Some investigators might not consider it their role to communicate research findings to decision makers, and those who would like to see research used in decision making might not have the necessary skills. Researchers need to understand policy processes to effectively promote the application of health research findings.

### Three streams of the policy process

Although policy making varies dramatically between and within countries, a simple model of the policy process can be useful to determine where health research can be applied. Kingdon and Thurber's model<sup>7</sup> describes three streams or conditions that need to converge before movement on a policy is likely. The

problem stream means that decision makers need to recognise the issue as a problem. Although epidemiological research documenting health problems is plentiful, evidence identifying solutions is scarce. The proposal stream requires identification of various feasible solutions. This criterion is demanding for research because evaluations of city planning interventions are costly and time consuming. The policy stream refers to politicians being willing to make a decision. For this stream, different types of research might be required, such as public opinion polls documenting support for alternative policies or evidence about the costs or cost-effectiveness of policy options. For example, consumer preferences for neighbourhoods that support walking and cycling are producing increased demand for housing in walkable neighbourhoods in the USA.<sup>8</sup> Convergence of all three streams creates a policy window that facilitates, but does not guarantee, action.<sup>8</sup>

#### Policy makers' views of research

Researchers and policy makers have been said not to understand each other or value each other's methods,<sup>9</sup> but researchers can benefit from an understanding of how policy makers view research. Petticrew and colleagues<sup>10</sup> conducted interviews with decision makers in various fields about their views on research. Although none were from city planning or transport, they said that researchers did not understand the policy-making process, especially the time constraints and how political pressure often outweighs evidence. Decision makers saw stories and case studies as being more compelling than rigorous studies or literature syntheses, although they valued evaluations of real-world interventions. Cost and cost-effectiveness analyses were considered more important than experimental controls and sophisticated statistics. Decision makers called for more research that is specifically designed to assist them in making decisions.

Because research is just one of several inputs into any policy-making process, the value of research to policy makers should be maximised. Recommendations for effective knowledge exchange based on models and evidence<sup>11,12</sup> include use of evidence that is applicable to the context, facilitation of ongoing partnerships between knowledge producers and users, communication tailored to research users, engagement of knowledge brokers who are familiar with both research and policy, and institutional support for the participation of both producers and users in knowledge exchange.

#### Four-phase model of research translation

A model<sup>13</sup> by Giles-Corti and colleagues identified four phases of the research translation process and suggested strategies to enhance the utility of research in land-use and transport decision making. A critical first step is to conduct policy-relevant research. Researchers should

#### Key messages

- Land-use and transport policies that were adopted for good reasons at the time are now having widespread negative effects on health through reduced physical activity, prolonged sitting, injuries, air pollution, social isolation, noise, stress, compromised personal safety, unhealthy diets, urban-heat-island effects, and greenhouse gas emissions driving climate change. Most of these negative consequences are related to the high priority given to motor vehicles in land-use and transport planning.
- Integrated regional and local land-use and transport interventions that support health include density, design, diversity, destination accessibility, distance to public transport, demand management, distribution of employment, and desirability. A diverse set of indicators to monitor progress towards healthier cities is proposed.
- Substantial reductions in the burden of non-communicable diseases were predicted by models that increased residential densities and diversity of the built environment, decreased travel distances to common destinations, and promoted walking, cycling, and the use of public transport over motor vehicles. The last scenario produced the greatest change in population health, but changes in transport mode can only be achieved through integrated land-use and transport interventions.
- Given the trends of growing populations and rapid urbanisation, improved knowledge translation is urgently needed so the evidence about health-enhancing urban planning, urban design, and transport policies is more quickly and effectively disseminated to, and adopted by, decision makers.
- Researchers are encouraged to conduct more innovative policy-relevant studies, develop better ways of communicating research to decision makers, and become involved in informing the policy process.
- Case studies of the effective use of research to inform land-use and transport policy were identified in several countries. These cases illustrate that research can influence policy, so efforts to improve research translation are justified.
- The unintended consequences of land-use and transport policies that favour motor-vehicle mobility are likely to worsen the global epidemics of non-communicable diseases and injuries, along with increasing the effects of air pollution and climate change. The solution with the likelihood of greatest health impact is to enact and implement integrated land-use and transport policies that prioritise investments that achieve safe and sustainable walking, cycling, and public transport while reducing private motor-vehicle dependence.

consult with policy stakeholders to develop policy-relevant research questions, rather than basing research questions only on theory or the scientific literature. This step can be aided by the formation of research teams that incorporate health and built-environment experts, including policy makers. The second step is to use research methods that are most compelling to policy makers. These methods include evaluations of real-world natural experiments and examinations of multiple outcomes, such as health, social, environmental, and economic benefits. The third step is to actively disseminate findings to policy makers via appropriate communication methods. The fourth step is to engage in advocacy as part of the policy change process. Researchers can do this either by communicating directly with decision makers or by working through knowledge brokers, which could include non-profit health organisations.

Experience in knowledge translation outside the health sector is growing—in urban planning, transport, and

city governance. An initial challenge is to engage researchers in knowledge translation, which might require changes in reward systems in academia, funding agencies, and professional societies. The following case study describes the actions of a research funding programme to increase the use of research in policy and practice decision making.

### Case study 1: Active Living Research, USA

Active Living Research (ALR) illustrates all phases of the four-phase research translation model.<sup>13</sup> ALR was supported by The Robert Wood Johnson Foundation with aims to build evidence about the role of environments and policies in physical activity, nurture investigative teams with members from diverse disciplines and personal backgrounds, and use research to inform policy and practice in multiple sectors.<sup>14</sup> We describe ALR's methods of research translation for each phase of the model,<sup>13</sup> with more details available elsewhere.<sup>14,15</sup>

#### Ensure policy-relevant research questions

ALR required a policy rationale in grant proposals and encouraged interdisciplinary teams that included a policy maker or practitioner. Conference presentations from policy makers and practitioners that focused on improvements in policy relevance of research were summarised in commentaries.<sup>16,17</sup>

#### Apply policy-relevant research methods

Interdisciplinary teams were expected to broaden the range of study designs and methods used to enhance scientific value and policy relevance. Input from policy makers indicated that they placed a high value on case studies and economic data, so calls for proposals requested studies to provide this information.

#### Undertake dissemination strategies with end users of research

ALR placed the most emphasis on enhanced communication of research findings to policy makers, advocates, and practitioners who could use evidence in their decision making. Calls for proposals required a dissemination strategy that addressed both researcher and non-researcher audiences. ALR built capacity and supported research dissemination through training in communication strategies, individual technical assistance from communication experts, and Translating Research into Policy awards.

ALR translated research by disseminating non-technical briefs and infographics that highlighted findings in illustrated formats that were appropriate for community members. Social media engagement, YouTube videos, and a blog were also used for communication of findings to non-researchers.

To overcome barriers to research translation, such as insufficient training and few rewards within academia, ALR developed research translation grants that provided

an incentive for research translation activities. Proposals had to identify actionable messages based on previously funded studies, key audiences, and dissemination activities.

#### Engage in advocacy for policy and practice change

Interdisciplinary teams are likely to be better prepared to identify policy and practice solutions than are individual investigators, and team members from urban planning, transport, education, and parks disciplines can serve as a bridge between researchers and research users. Often, investigators found it more feasible to work with knowledge brokers (such as advocacy groups) who routinely attempt to affect policy decisions than to directly contact policy makers.

#### Key lessons

ALR integrated actions into its research funding programme to support a culture of investigators translating research into policy. Research translation methods illustrated how all four phases of the model<sup>13</sup> can be integrated into a comprehensive approach. An evaluation of ALR provided indicators of success: 40% of grantees reported communication to policy or practice audiences in a given year, 50% of grantees had input into decision-making processes that contributed to a policy or practice change, and 80% of relevant policy and advocacy organisation leaders were familiar with ALR research briefs.<sup>15</sup>

Scepticism about the effect of health research on land-use and transport policy is justified. In the next sections, we highlight case studies that illustrate how health research can influence policy in non-health sectors.

### Case study 2: RESIDE, Perth, WA, Australia

The Residential Environment (RESIDE) study was a longitudinal natural experiment that evaluated health impacts of the state government's Liveable Neighbourhoods design code in new suburban neighbourhoods.<sup>18</sup> Although initiated by public-health researchers, active engagement of the Department of Planning took place before and during the study. The Chief Investigator and Department of Planning staff had collaborated on a prior study that had resulted in multiple presentations and a good working relationship. RESIDE operated at each phase of the research translation model.<sup>13</sup>

#### Ensure policy-relevant research questions

RESIDE aimed to contribute to evidence on the causal relationship between changes in urban design and physical activity (especially walking) and to undertake an independent assessment of the state government's Liveable Neighbourhoods policy. Department of Planning officials wanted evidence of the health benefits of their ambitious policy. Goals relevant to both researchers and policy makers justified a 10-year research collaboration that included co-funding by the department.

For more on Active Living Research see <http://www.activelivingresearch.org>

### Apply policy-relevant research methods

RESIDE applied a pre–post experimental design with intervention and matched comparison neighbourhoods. The study assessed the level of policy implementation and the impact of the Liveable Neighbourhoods design code on health outcomes. Results showed that policy recommendations were, on average, only 47% implemented (range 27–54%). However, for every 10% increase in implementation, the odds of walking increased by about 50%.<sup>19</sup>

### Undertake dissemination strategies with end-users of research

Throughout RESIDE, frequent communication with government officials established trust between the researchers and decision makers, resulting in the Department of Planning inviting direct input from the researchers into the review and update of the Liveable Neighbourhoods policy. A highlight of this research partnership was that Department of Planning guidance on performance indicators of the Liveable Neighbourhoods policy was directly based on RESIDE findings.

### Engage in advocacy for policy and practice change

RESIDE investigators communicated the health evidence to diverse stakeholder groups, including government departments, conferences outside the health field, and news media. Collaboration with the Planning Institute of Australia provided reach into the planning community. A partnership with the National Heart Foundation of Australia capitalised on its experience in advocacy. The knowledge translation and advocacy work by the research team contributed to improved knowledge of health impacts within the planning sector and inclusion of health-related design principles into planning policies.

### Key lessons

RESIDE researchers initiated the research relationship with policy makers after a sustained period of engagement on other projects. Because the evidence was directly related to specific policies and because the relationship was built over time, interest in the study findings grew to the point where evidence was explicitly used in the Liveable Neighbourhoods policy review. Details of the research methods were less important than the evidence itself and often not wanted by policy makers who trusted the researchers, especially when the research findings corresponded with the policy makers' preferences.

### Case study 3: SMARTRAQ, Atlanta, GA, USA

Strategies for Metropolitan Atlanta's Regional Transport and Air Quality (SMARTRAQ)<sup>20</sup> is another example of research undertaken as a successful partnership between researchers and government that resulted in strong knowledge translation to policy. In 1997, the Atlanta, GA,

region fell out of compliance with the USA's Federal Clean Air Act<sup>21</sup> owing to its low-density sprawling urban form, which created long distances between destinations and few competitive options to the car.<sup>22</sup>

### Ensure policy-relevant research questions

The Atlanta Regional Commission (a transport-planning agency), Georgia Department of Transportation, Georgia Regional Transportation Authority, Centers for Disease Control and Prevention, Environmental Protection Agency, and the Turner Foundation supported the interdisciplinary SMARTRAQ research programme,<sup>20</sup> which was innovative in its integrated health and transport data collection. Motivated by the ability to regain federal transport funding tied to air quality, diverse partners became sympathetic to funding health-related research and to a smarter growth approach to transport investment.

### Apply policy-relevant research methods

SMARTRAQ integrated air pollution, travel patterns, and walkability data to evaluate the air quality benefits of plans for three communities. Using scenario-planning software, the study compared the community-based plans with current motor vehicle-oriented trends and showed substantial air-quality improvements could be achieved through increased walking in existing population and activity centres.<sup>23</sup>

### Undertake dissemination strategies with end users of research

Policy partners were briefed throughout the project. Final results were communicated in meetings with stakeholders, technical reports, press releases, and journal articles. Accessible graphics, policy briefs, and responses to the key policy questions facilitated interpretation of findings.

### Engage in advocacy for policy and practice change

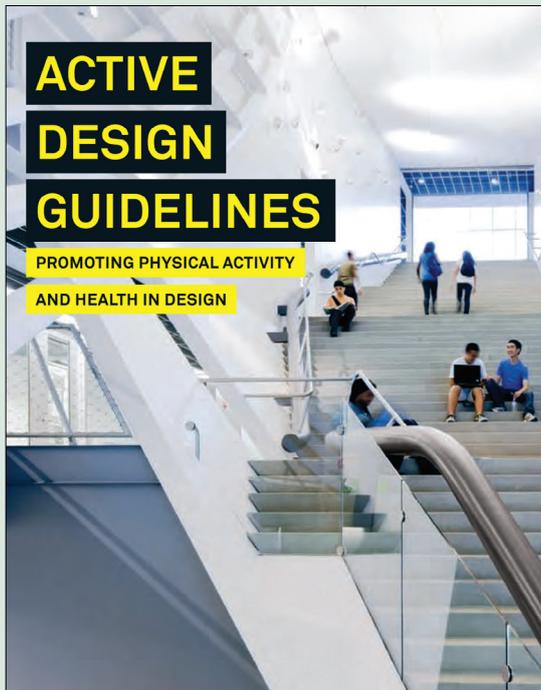
SMARTRAQ findings helped justify an initial US\$350 million from the Atlanta Regional Commission's Livable Centers Initiative for non-motorised and transit improvements that otherwise would have gone to highway expansion, thereby promoting further urban sprawl. An additional \$150 million has been approved for activities that are consistent with study recommendations.

### Key lessons

Transport officials initiated the research in an effort to qualify for federal funding. Nevertheless, the research needed to be designed so that it directly addressed the policy questions and communicated the findings with clear recommendations. This case study illustrates how federal policy related to health forced changes in regional transport policy and how interdisciplinary research was a critical mechanism for the change.

For more on the **Livable Centers Initiative** see <http://www.atlantaregional.com/land-use/livable-centers-initiative>

Panel 1: Active Design Guidelines



In the 2000s, the New York City Government prioritised the reduction of greenhouse gas emissions and identified built-environment supports for physical activity as an important part of the strategy. A built-environment and physical activity office was established within the Department of Health and Mental Hygiene, and the mayor instructed all city departments to contribute to this work. The multisector initiative included working groups, research and evaluation efforts, and annual Fit City conferences that featured many city agency heads.

A centrepiece of the effort was the development of the Active Design Guidelines, a resource that was based on academic research and best practice in the field, and provided architects and urban designers with strategies to create healthier buildings, streets, and urban spaces.

The Active Design Guidelines were developed in conjunction with the New York City Chapter of the American Institute of Architects and included illustrations and technical drawings—a format tailored to the intended audience of architects and designers. A critical feature of the Active Design Guidelines was a code for the level of evidence supporting each guideline, ranging from evidence based to expert consensus.

The Active Design Guidelines were adopted as official city policy to guide project design—an example of explicitly evidence-based policy. Subsequent design guideline documents were developed for affordable housing, sidewalks, and universal design.

For the Active Design Guidelines see <http://centerforactivedesign.org/guidelines>

For more on guideline documents please see <http://www1.nyc.gov/site/ddc/about/active-design.page>

## From individual studies to knowledge platforms

RESIDE and SMARTRAQ are examples of collaborations between researchers and policy makers opening channels for policy influence. However, development of a more systematic knowledge translation process for city planning and transport sectors is needed to integrate health goals and evidence. Several countries have shown progress in this area. An early example from the USA was an evidence-based report<sup>24</sup> on active transport that was jointly produced by the Transportation Research Board and the Institute of Medicine. Also in the USA, the Guide to Community Preventive Services<sup>25</sup>—published by the Centers for Disease Control and Prevention—produced recommendations on urban design interventions at the community and street scales.<sup>26</sup>

The National Heart Foundation of Australia reviewed the literature on built environments and physical activity, using the review to derive recommendations to support its advocacy work.<sup>27</sup> In the UK, the National Institute for Health and Care Excellence commissioned reviews of built-environment interventions to promote physical activity, resulting in public health guidance<sup>28</sup> (updated in 2014<sup>29</sup>) that provided authority for public health efforts to be directed to sectors outside of health. The 5-year review cycle is a good illustration of a systems approach to translation of evidence into policy.

## Evidence-based design guidelines

An effective research translation approach is the development of guidelines based on health evidence that built-environment practitioners can use in daily practice. Active Design Guidelines<sup>30</sup> (panel 1) and Healthy Active by Design<sup>30</sup> (panel 2) focus on communication of the key features of urban design that facilitate or hinder physical activity, with a particular focus on walking and cycling. Both documents were developed in partnership with industry, provide direct links to relevant policy, were developed with a strong integration of evidence, and specify a level of evidence support (eg, strong, emerging, and best practice).

## How cities use evidence in transport planning

Panel 3 describes how three major cities used research and evaluation in making plans to increase walking and cycling for transport. Although these examples are not connected with specific research projects, each city used research differently and used different types of research. One lesson from these case studies is that opportunities to improve the practice of research translation exist, even when the use of research is not required. A surprising finding was that the news media emerged as a stimulus for the use of research in transport planning.

## Key lessons

These examples, which highlight the use of health research to inform land-use and transport policy, show

### Panel 2: Healthy Active by Design



Australia is an urbanised nation with over 70% of the population living in major cities. Many Australian cities rank among the world's worst for environmental sustainability.

Restriction of urban sprawl and improvements in environmental sustainability with continued high standards of liveability are critical issues for federal, state, and local governments.

Healthy Active by Design was developed in Western Australia by a partnership of a non-government health agency (National Heart Foundation of Australia), academics from the Centre for Built Environment and Health, government departments, and planning professionals. and is a free web-based resource aimed at urban planners and interested stakeholders, including health advocates. Healthy Active by Design provides information and evidence on how places, spaces, and buildings can be designed to promote active, healthy lifestyle choices and provide pedestrian-friendly environments.

Healthy Active by Design is structured around nine design elements: movement network, mixed use, town centre, main street, housing diversity, sense of place, shared facilities, schools, and buildings. Each design element has evidence summaries, practical guidance, policies, annotated examples of good design (with local, national, and international case studies), and a planners' checklist.

Launched in March, 2014, Healthy Active by Design dissemination activities have included a series of metropolitan and regional presentations, tailored local-government workshops, professional development seminars (including hands-on design projects), and general promotional activities. In 2015, Healthy Active by Design won two awards from the Planning Institute of Australia. Future developments include a partnership with a national research consortium (National Health and Medical Research Council's Centre for Research Excellence on Healthy Liveable Communities<sup>31</sup>), expansion of the professional-development training programme (online and in person), and upscaling of Healthy Active by Design to a national platform.

For the **Healthy Active by Design** website see <http://www.healthyactivebydesign.com.au>

that research can be an influential instrument for achievement of environmental changes that produce health and other benefits. The continuing challenge is to develop a more systematic approach to research translation that involves ongoing collaboration among researchers, practitioners, and policy makers in health, urban planning, urban design, and transport sectors. Strategies for research translation derived from case studies, the Giles-Corti model,<sup>13</sup> and knowledge-exchange literature<sup>11,12</sup> can be recommended to improve the practice of research translation (panel 4).

### Conclusions about research translation

Motor vehicle-oriented land-use and transport policies in cities are contributing to global epidemics of NCDs and injuries.<sup>5,6</sup> The health impacts create an imperative to make use of research evidence to move city planning

and transport policies in directions that are health promoting. The diverse case studies presented here demonstrate that health research can play an influential role in land-use and transport decision making. The challenge is to ensure that health research is used in a more routine and effective way. Because the policy process varies so much by country, research is required in all countries so that policy makers have local data to guide local decisions. Generalisation of evidence and best practices between countries should be done with caution, particularly in attempts to extrapolate methods of research translation that are effective in high-income countries to low-income and middle-income countries. Funding is usually specific to disciplines and sectors and research translation is, by definition, multisectorial, creating doubts on where funding for such research will come from. Philanthropies with an international

### Panel 3: Use of research by transport planners in London, Stockholm, and Bogotá

City transport officials in London, Stockholm, and Bogotá were willing to answer several questions regarding the relationship between research and investment in walking and cycling. Each city has made substantial progress towards increasing walking and cycling, and each city has applied the evidence differently to guide their decision making.

#### London: The Mayor's Vision for Cycling in London

As a city with worldwide visibility, London's actions are likely to have a substantial effect on future active-travel policies globally. Through the Mayor's Vision for Cycling in London, the city aims to double the number of cyclists within a decade. Funding will be tripled to £913 million<sup>32</sup> over the next decade to support investment in not only central London, but also in outer London boroughs in which land-use policies are often heavily skewed in favour of single-use residential neighbourhoods and car-dominated infrastructure. Cycling infrastructure will indicate a change in priorities, with scarce road space redistributed from cars to cycling and the broader public realm. Because cyclists have been found to be more likely to visit neighbourhood shops, increased cycling might help to recover main shopping streets that have gone into decline.<sup>32</sup>

Transport for London surveyed 14 other cities to inform best practice in active-transport infrastructure and governance.<sup>33</sup> Locally, research was conducted to determine the physical and social potential for cycling by postcode. Areas of high cycling-density potential were mapped against the propensity to cycle by postcode.<sup>34</sup> This research has been used to inform where to build cycle infrastructure.

Although cycling in London is safer than it was a decade ago,<sup>35</sup> perceived risk of injury is the main reason for not cycling in the capital.<sup>32,36</sup> The response has been to lower speed limits to 32 km/h or build segregated routes along busy roads.<sup>32</sup> Cycling coaching sessions and awareness training for heavy goods vehicles drivers—identified through research as the greatest risk to cyclists—have also been implemented.

Segregated routes will be complemented with routes along quiet residential streets for more cautious cyclists. Transport for London has conducted regular research into attitudes relating to cycling to understand market segmentation. For example, the modal shift away from inactive car travel is far higher for non-cyclists planning to start cycling than it is for cyclists planning to cycle more.

Transport for London commissioned research by Cambridge University's Centre for Diet and Activity Research to model the health impacts of policy options. Models estimated the health benefits of being more active in a less polluted city against the increased risk of injury to be worth £250 million if the increased

cycling expected by 2031 in the Mayor's Transport Strategy is attained.<sup>36</sup> Academic research to assess Transport for London's policies and guide new policies resulted in indicators to measure success, including physical activity, on-street air-quality monitoring, road traffic collisions, transport noise, perception of the urban realm, and access to services.<sup>37</sup>

Despite a growing population, motor vehicle traffic volumes across London decreased by 7% between 2004 and 2014, whereas cycling has increased.<sup>38</sup>

#### Stockholm: Urban Mobility Strategy and Vision 2030

Stockholm shares many characteristics with Copenhagen—the cycling capital—including weather and city size. Both cities share a history of integrated regional planning and land use that support cycling given the proximity between homes and places of work. However, cycling mode shares are far lower in Stockholm than in Copenhagen. Like London, Stockholm plans to double the percentage of cyclists and has implemented a congestion charge to discourage car trips into the city centre. Stockholm has seen a 20% reduction in car trips since implementation of the congestion charge in 2007.<sup>39</sup>

Stockholm has responded to cold, snowy winters by conducting research on winter cycling habits and infrastructure maintenance requirements.<sup>39</sup> Questions on winter cycling are included in regular travel-behaviour surveys and before-and-after studies of infrastructure interventions to inform future projects. At a city-wide level, indicators are used to inform what transport infrastructure should be prioritised. Indicators include mode share, collisions, cycle speeds, number of safe cycle and pedestrian crossings, and number of cycle parking spaces.

Stockholm collects local neighbourhood data while also drawing on national and international studies. The city adopts best practice from other cities in development of specific solutions in specific locations—especially in the area of cycling infrastructure. Stockholm is also invested in meeting the European Union's Air Quality Standards for nitrogen dioxide and PM<sub>10</sub> levels, which require substantial reductions in transport emissions.

#### Bogotá: Cicloruta cycle network

Bogotá has pursued an ambitious agenda of creating separate cycle paths, most of which have required repurposing road space from cars. Over 300 km of separate cycle paths have been installed at a cost of US\$46 million.<sup>40</sup> Unlike London and Stockholm, which generally followed an incremental approach to building of cycling infrastructure, Bogotá pursued a rapid roll-out of cycle and public transport infrastructure. This strategy partly reflected Bogotá's relatively limited cycle infrastructure two decades ago, alongside the city's different

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political and demographic make-up. The two main effects of improved cycling access to the city were politically aligned—namely, promotion of sustainability and enhanced equity for poorer residents who are unable to afford public transport fares. Frequent mayoral changes might also have shortened the timeframe available for completion of politically driven projects.

The administration that implemented the cycle network in Bogotá did not focus on research in the same way as had London and Stockholm. Bogotá had an in-house special adviser with a research team that was informed by best and worst practices globally to establish how to implement cycling infrastructure. The team found published studies and invited experts to train city officials and make presentations to the general public in support of the project. As with London, interactions with the media were important, but the goal was also to inform the public, whom the local government assumed had limited experience with cycling infrastructure.

However, measurement of the effect of the cycle network was not a priority. For the administration, the new policy, which resulted in visible changes to travel modes in the city, was sufficient. Similarly, the effect of the *Ciclovía* activation—which closes 121 km of city streets on Sundays and public holidays<sup>41</sup> to allow safe passage for cyclists and pedestrians—on the uptake of cycling was not used to gauge success. However, people taking part in *Ciclovía* at least once a month scored higher on health-related quality of life than did those who did not.<sup>42</sup> A study<sup>43</sup> measuring particulate pollution along closed roads showed that  $PM_{10}$  was 13 times higher on a regular weekday ( $65 \mu\text{g}/\text{m}^3$ ) than on a Sunday ( $5 \mu\text{g}/\text{m}^3$ ), pointing to potential health benefits from reduced vehicle

use in the city centre. Bogotá does, however, measure mode share, which showed an increase in cycle share from 2.2% in 2005 to 3.8% in 2011.

London, Stockholm, and Bogotá demonstrate the use of shared learning, in which international evidence about the strengths and weaknesses of cycle infrastructure is used in local decision making. London and Stockholm both test how local markets respond to the adoption of new strategies. This research has enabled these cities to use policy to more specifically target different market segments, an approach that could make transport policy more effective.<sup>44</sup> Bogotá did not focus on this type of research because the goal was to provide infrastructure in an environment in which previously safe passage by cycle was not possible. In each city, research was partly motivated to provide evidence in support of cycling projects to either the general public or the media. Some form of democratic oversight provides an important incentive for these cities to give evidence to support plans. Desire for recognition as a city that is able to share best practices in active transport is also a powerful incentive to provide indicators of success. Although London and Stockholm conducted evaluations of their cycle infrastructure, the evidence would contribute to knowledge translation more effectively if the results were published in more accessible formats than internal reports. Evaluations of natural experiments are valued by both researchers and policy makers, so a compilation of the lessons from large infrastructure investments and policy changes worldwide would be a worthwhile project. The Bogotá case study is an example of a major intervention that was not fully evaluated, which is a type of missed opportunity likely to become more common.

focus might be the most promising source of funds to support research leading to context-specific research translation.

Growing evidence suggests that healthy urban design and transport policies can have benefits beyond health for environmental sustainability and economic vitality.<sup>45</sup> Evidence of diverse benefits provides additional opportunities to ensure that the full range of societal consequences of land-use and transport decisions is adequately considered in decision making. A systems approach to reform in governmental decision making, alongside routine collaborations between researchers, practitioners, and policy makers to consider the full range of health and environmental impacts of urban planning, urban design, and transport decision making, is likely to be required. Because of the societal significance of land-use and transport decisions being enhanced by research, we recommend that an international working group be established to propose changes within academia, government, and non-governmental

organisations that would lead to a more systematic approach to research translation.

### Series conclusions and recommendations

Land-use and transport policies are contributing to worldwide epidemics of NCDs and injuries through traffic exposure, noise, air pollution, social isolation, low physical activity, and sedentary behaviours. Motorised transport is a major cause of greenhouse gas emissions that threaten human health, especially in low-income countries.<sup>46</sup> Traditional single-problem and single-discipline approaches to research, practice, and policy are insufficient to solve the serious inter-related problems described in this Series. Better systems are required in government and academia to facilitate policy-relevant interdisciplinary research and its timely translation into city-planning policy and practice.

The health, environmental, and economic consequences of motor vehicle-driven development have become so obvious that many cities are taking serious

#### Panel 4: Recommendations for improving translation of research to policy and practice

The recommendations below are organised by the four steps of the Giles-Corti and colleagues<sup>13</sup> research translation model and are drawn from that model, the knowledge exchange literature,<sup>12</sup> a qualitative study of decision makers,<sup>10</sup> and ALR.<sup>14</sup>

##### Policy-relevant research questions

- Collaborations among researchers, practitioners, and policy makers
- Interdisciplinary teams
- Research questions designed to address timely policy questions
- Research questions about economics and public opinion
- Funders or professional organisations offer training in researcher and policy-maker collaboration

##### Policy-relevant research methods

- Design and measures selected for relevance to policy makers
- Natural experiments and case studies
- Emphasis on local evidence
- Multiple outcomes and measures to enhance relevance to multiple sectors
- Training in policy-relevant research methods at conferences
- Institutional support from universities and governments can facilitate collaboration of knowledge producers and users in the research process

##### Dissemination strategy to decision makers

- Target journals and professional conferences that reach practitioners
- Target communication modes to decision makers, including in-person, print, video, websites, and social media
- Research briefs and infographics with clear policy implications to be accessible to non-technical audiences
- Evidence should be relevant to context of decision making, with local data preferred
- Evidence should be supplemented with stories to illustrate how findings relate to specific people
- Practitioners and policy makers collaborate to help plan dissemination strategy and materials
- Communications with policy makers should be at the time the information can be most useful
- Funders provide grants to support research translation
- Training for research translation at conferences

##### Engagement in advocacy

- Develop relationships with knowledge brokers who can take research findings to decision makers
- Become known by decision makers as a source of useful and credible information
- Schedule one-on-one meetings, group briefings, and testimony to policy makers
- Press releases and stories in mass media
- Training in advocacy offered by funders or professional organisations

steps towards reform. In the Netherlands, Denmark, and Germany, for example, a number of cities have been working for decades to encourage walking and cycling for transport and create barriers to motor vehicle use.<sup>47</sup> Many other cities from all income categories are pursuing similar policies for various reasons.<sup>48</sup>

The findings outlined in this Series<sup>6</sup> indicate that the approach to city planning likely to produce the greatest health benefit is one where walking, cycling, and public transport are supported by a safe infrastructure and are prioritised over private motorised transport. Although this might seem a substantial challenge in motor vehicle-dependent cities across North America and Australasia, and in rapidly motorising Asian cities, cities were car free for thousands of years—an important point to remember.

This Series highlights that a move from motor vehicle to active transport modes in cities, mixed land-use, and safe facilities for walking and cycling represent an integrated solution that is likely to increase physical activity and reduce NCDs, injuries, air pollution, and greenhouse gas emissions. In this Series, we propose implementation of eight integrated regional and local land-use and transport planning and urban design interventions to support active travel modes, rather than prioritisation of mobility of private motor vehicles.

##### Recommendations for research

The consequences of motor vehicle-oriented land-use and transport policies on physical activity, NCDs, injuries, pollution, climate change, stress of driving, congestion, and overall quality of life should be quantified in as many countries as possible to maximise the value of data in local decision making. As cities become more compact and residential density increases, research is needed that monitors unintended health consequences that might arise. The second paper<sup>6</sup> in this Series highlights the challenge associated with road trauma in the move to increased levels of active transport and enhanced public transport use (new urban mobility). The modelling showed how road trauma risk could be mitigated by the provision of enhanced urban design and safe infrastructure for walking and cycling. Another concern is that high residential density is a well-documented risk factor for increased incidence of infectious diseases,<sup>49,50</sup> so future land-use policies also need to consider approaches for reduction of this risk. Health researchers should work in interdisciplinary teams and focus on the studying and influencing of decisions made in non-health sectors (such as urban design, transport, and energy) that affect health.

Research priorities in applied areas such as public health and city planning should not only advance science but also be driven by relevance to the policy process. Research teams need to include multisector policy

makers and incorporate policy-relevant methods including case studies, evaluations of natural experiments, and cost-effectiveness studies. Topics such as the economics of land-use and transport policies, evaluations of policy implementation, and public opinion about policy change are probably of more interest to policy makers than are studies of health outcomes.

Improving research translation related to healthy urban design and transport policies is a topic of research itself. A small evidence base has identified barriers to research translation such as insufficient access to relevant evidence among decision makers,<sup>51</sup> limited skilled application of evidence into local contexts,<sup>52</sup> and an absence of timeliness in communication of research.<sup>53</sup> Research to develop and evaluate possible solutions to these barriers is warranted.

Most health-oriented land-use and transport research comes from high-income countries. Thus, research funding for low-income and middle-income countries should be prioritised to identify relevant local solutions.

### Recommendations for policy

Policies that prioritise the needs and safety of pedestrians, cyclists, and public transport users should be encouraged. Stevenson and colleagues' findings<sup>6</sup> highlight that a modal shift away from private motor vehicles would deliver substantial population health benefit. This recommendation is globally relevant, given that NCDs are the leading causes of death on all continents and that the NCD burden is increasing in the most populous regions.<sup>54</sup> The urban design and transport policies and practices highlighted by Giles-Corti and colleagues<sup>5</sup> provide a set of integrated interventions for cities to work towards. Implementation of these interventions might vary between cities depending on the context, but a multimodal transport system that prioritises walking, cycling, and public transport is a necessity for population health. Young, low-density, and highly motorised cities, such as those in North America, Australia, and New Zealand, have unhealthy patterns of land use. These cities will need to change density and zoning policies to retrofit established areas and revise regional, transport, and employment-planning and urban-design policies to create more accessible, pedestrian-friendly and cycling-friendly greenfield developments. In contrast, older cities in Europe are well designed for walking and have good public transport, but many cities in Europe are yet to develop high-quality cycle facilities, and new growth is often motor vehicle-oriented. High-density cities in Asia and Latin America typically have a good mix of land use to support walking. However, in some of these cities, pedestrian and cycling facilities are absent, unsafe, or not functional. The priorities in these cities are to improve infrastructure for walking and cycling and to invest in affordable public transport to provide attractive alternatives to private vehicles.

Accountability is critical. Building on WHO's Health Equity Indicators, Giles-Corti and colleagues<sup>5</sup> proposed indicators that could be used to monitor progress towards development of healthier cities. We recommend that a healthy liveable cities scorecard be created for cities worldwide.

Despite land use and transport having interconnected effects, city planning and transport agencies are seldom integrated. The largely independent functioning of these agencies has resulted in communities with destinations within walking distance of residences but road designs that create barriers to walking and cycling. Limited coordination of regional transport infrastructure planning and urban design can result in incomplete networks of facilities that support walking, cycling, and public transport. Thus, integration of urban planning, urban design, and transport policies and practices is needed, at both local and regional levels.

Funders need to support training in, and implementation of, research translation activities by investigators—eg, the Canadian Institute of Health Research programme.<sup>12</sup>

Most countries are concerned by costs associated with the mounting burden of NCDs and injury. Although strategies have been recommended to mitigate the growing burden,<sup>54–56</sup> few address the topic of this Series, namely to actively pursue compact and mixed-use urban designs that encourage a transport modal shift away from private motor vehicles towards walking, cycling and public transport. Systematic designing of cities to enhance health through active transport promises to be a powerful strategy for improvements in population health on a permanent basis.

### Contributors

JFS, BG-C, and MS conceptualised the paper. All authors drafted sections and critically edited the entire manuscript.

### Declaration of interests

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