Neighbourhood built environment and cardiovascular disease: knowledge and future directions

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Awareness of the effect of the neighbourhood built environment on cardiovascular diseases is growing. In this Comment, we identify major conceptual, methodological and policy-relevant issues in research related to the built environment and describe potential future directions to improve the scientific rigour of research in this field.

Neighbourhoods — spatial units consisting of land uses and roads — include built environment attributes (such as building design, transport infrastructure, residential density, public open spaces, street connectivity and access to healthy food) that influence individuals' health. Although modifying the neighbourhood built environment tends to be difficult in the short term, built environment strategies have long-term effects on behaviour and health[1]. Scientific and public interest in the role of the neighbourhood built environment in preventing cardiovascular disease (CVD) is growing[2]. In this Comment article, we aim to advance the research agenda by identifying major conceptual, methodological and policy-relevant issues related to research into the neighbourhood built environment and CVD. We also describe potential next steps and future directions to improve the scientific rigour of research on this topic.

Current knowledge

Several systematic and narrative reviews have provided preliminary evidence on the associations between various neighbourhood built environment attributes, behavioural pathways, CVD clinical risk factors and mortality[2–5] (FIG. 1). A systematic review of longitudinal studies and natural experiments found that better accessibility of destinations and greater land-use mix were associated with increased physical activity[5]. A meta-analysis of longitudinal studies found strong inverse relationships between neighbourhood walkability and CVD risk factors, such as obesity, hypertension and type 2 diabetes mellitus[3]. A meta-analysis found that more residential green space was associated with reduced CVD-specific mortality[4]. The links between air and noise pollution, stress and CVD have also been recognized[6,7]. Although this new, interdisciplinary field of research is promising, knowledge on the relationship between the neighbourhood built environment and CVD must be improved.

Conceptual issues

Time and place interactions. Identifying the neighbourhoods to which individuals are exposed is a crucial first step in examining built environment–CVD relationships. Spatial buffers centred on individuals' residential addresses or administrative boundaries have been used to conceptualize environmental exposures relevant to CVD. However, these approaches cannot identify the spatial areas within which people interact daily. People's daily mobility (activity spaces) must be considered when examining built environment–CVD relationships because people are exposed to different built environment attributes in different places during a day (for example, homes, workplaces and parks)[8]. Additionally, exposure to the neighbourhood built environment in terms of time (tenure) and intensity (frequency) is important for assuming causal links. The use of global positioning system points and ecological momentary assessment (the repeated collection of the behaviour and health data from participants in real time)[9] within a lifespan approach might help to address the time and place interactions in built environment–CVD research.

Mechanisms. The mechanisms by which the neighbourhood built environment might influence CVD are not well established. Researchers have examined associations between built environment attributes and CVD behavioural pathways (such as physical activity and diet), and many studies have linked these behaviours with CVD risk factors, but little evidence exists on the mediating roles of these behavioural factors in the observed associations between the neighbourhood built environment and CVD. Techniques such as path analysis, mediation analysis and structural equation models can be used to understand better how behaviours mediate links between the built environment and CVD. These studies

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https://doi.org/10.1038/s41569-020-0343-6

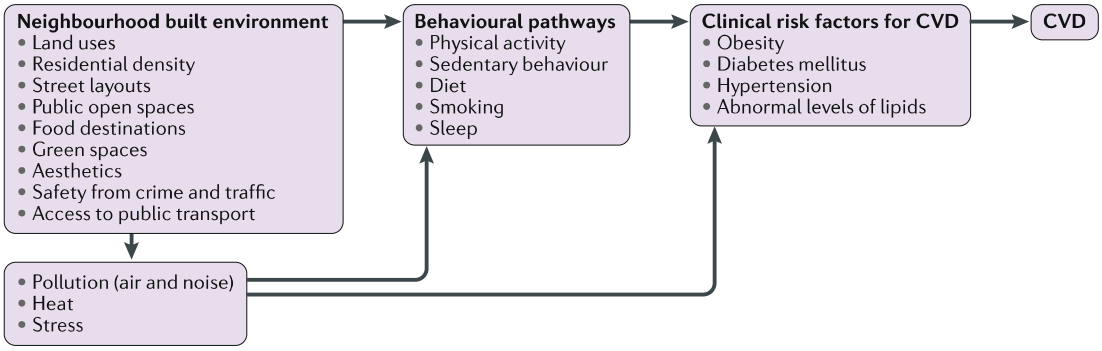

Fig. 1 | **Simplified relationships between the neighbourhood built environment and CVD.** Preliminary evidence supports the associations between various neighbourhood built environment attributes and behavioural pathways, and between behavioural pathways and clinical risk factors for cardiovascular disease (CVD). Research also suggests links between neighbourhood built environment attributes and pollution, heat and stress, and between these factors and behavioural pathways and clinical risk factors for CVD.

could provide additional evidence for a potential causal link between the built environment and CVD.

Differential effects. The same neighbourhood built environment attribute might have different effects on different CVD risk factors and for different population subgroups. For example, whereas high population density might be helpful for improving adults' weight status (through better availability of physical activity destinations and healthy food options), high population density might also have negative effects on older adults' blood pressure (through more exposure to air pollution). Examining multiple environmental attributes with multiple behaviours and CVD risk factors in single studies can provide insights into the differential effects of the built environment on CVD.

Methodological issues

Variability in built environment exposures. Most previous studies have been conducted in fairly homogeneous areas of low-density, Western countries[3]. Of note, the effects of the neighbourhood built environment on CVD in high-density, compact areas remain unknown. Studies on high-density areas could provide important insights into how extreme levels of built environment attributes are related to CVD. Even within a single study, maximizing variability in built environment exposure is important to enable the detection of dose–response relationships and to improve the external validity of the range of built environment attributes represented in the sample.

Co-existence of built environment attributes. Built environment attributes co-exist and act together in the real-world environment. For instance, although well-connected, dense neighbourhoods with various destinations encourage walking, air pollution might be higher in these neighbourhoods, or food destinations might sell both healthy and unhealthy food. Accounting for all possible built environment attributes could provide more accurate estimates of the relative contributions of each individual environmental attribute to the risk of CVD. One study reported a significant negative association between the availability of healthy food shops and the risk of incident atrial fibrillation when accounting for the availability of unhealthy food shops[10]. Future studies need to acknowledge and account for the complex relationships between different built environment exposures and CVD.

Causality. Conducting cross-sectional studies is a necessary exploratory step; however, conducting prospective studies that account for residential self-selection could help to establish causality between the built environment and CVD. Of note, the lack of data on historical built environment attributes to be linked to the current cohort studies of CVD is one of the major limitations. Additionally, residential address information for participants in cohort studies on CVD might not be available across all study waves or might not be updated during a participant's involvement in the study. Therefore, identifying whether residents who moved to a more or less health-supportive built environment have better or worse CVD risk profiles, respectively, than non-movers remains challenging. The length of time for follow-up study must also be considered, given that substantial changes in clinical CVD risk factors are less likely over a short period of time. Further awareness of the relevance of the built environment for CVD can help in updating current cohort studies on CVD with full spatial information to facilitate longitudinal studies.

Policy-relevant issues

Developing built environment benchmarks. Previous studies have mainly been concerned with 'associations' between neighbourhood built environment and CVD. Although investigating these associations is a necessary initial step, these studies cannot provide urban designers and policymakers with 'benchmarks' for translating the findings into practice. For example, when we find a significant association between residential density and CVD, the next important question is 'how much' and 'where' residential density is needed to influence CVD. These built environment benchmarks might also vary depending on different regions and countries. Future research should identify the optimal levels and spatial locations of neighbourhood built environment attributes that are beneficial for CVD.

Dissecting built environment composite indices. Built environment composite indices, such as walkability (for example, the Walk Score) and sprawl indices, have been examined in relation to CVD. Many built environment attributes co-exist, but overhauling entire communities is not always possible, although individual features might be more amendable to modification (such as installing pedestrian pavements). Examining the effects of individual neighbourhood built environment attributes (along with composite indices) on CVD is necessary to provide an evidence base for urban designers and policymakers. The focus on individual built environment attributes also identifies those attributes that have the greatest effect on CVD.

Conclusions

To summarize, the following issues need to be considered to move research in this field forwards:

- Consider time and place interactions in conceptualizing the neighbourhood built environment to which people are exposed
- Explore pathways through which neighbourhood built environment might influence CVD
- Understand the differential effects of built environment attributes on CVD
- Conduct studies with high variability in built environment exposure to enable the detection of dose–response relationships
- Understand the co-existence and interactions between built environment attributes in relation to CVD
- Move towards prospective study designs for the built environment and CVD
- Identify the built environment benchmarks needed to influence CVD
- Examine the effects of individual built environment attributes and composite indices on CVD

Further interdisciplinary research initiatives involving cardiology and urban design researchers are necessary to disentangle the complex relationships between the neighbourhood built environment and CVD.

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Acknowledgements

G.R.M. is supported by a Canadian Institutes of Health Research Foundations Scheme Grant (FDN-154331). K.O. is supported by the MEXT-Supported Program for the Strategic Research Foundation at Private Universities, 2015–2019, from the Japan Ministry of Education, Culture, Sports, Science and Technology (S1511017).

Competing interests

The authors declare no competing interests. In particular, none of the authors has a financial interest in Walk Score.

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