
【Review Article】

The Built Environment and Physical Activity Behaviour Change: New Directions for Research?

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ABSTRACT Environmental strategies to influence physical activity are considered effective for large populations, as supportive environments are likely to assist many people to be active for long periods. Ecological models - that recognise the importance of multiple influences on physical activity, including individual, social and environmental factors - provide theoretical underpinnings for research on environmental attributes. This commentary reflects upon past research in this area, and proposes an extended ecological model, in which physical activity is divided into adoption and maintenance. It is postulated that individual and social factors may help people to initiate physical activity, while environmental factors may be more relevant to the maintenance of physical activity. Future studies need to examine the roles of individual, social and environmental factors in bringing about wide-reaching and sustained changes in physical activity.

Key words: ecological model, neighbourhood, active living, behaviour change

Research on the built environment and physical activity: Background

The health benefits of regular physical activity, including reduced risk of developing chronic diseases such as diabetes, heart disease and some cancers, are well documented.¹⁾ Despite this compelling evidence base and numerous public health efforts to promote physical activity, the majority of adults are not sufficiently active. In Australia, more than 70% of adults do not meet the minimum level of physical activity necessary to achieve health benefits, i.e., engaging in at least 30 minutes of moderate-intensity physical activity on five days a week.²⁾ Increasing physical activity is a public health priority in the 21st century.³⁾

Conventional strategies to promote physical activity focus on individual-level factors such as motivation, self-efficacy and outcome expectations. Although such individual-level approaches can be effective in the short term, they tend to be less

successful in long-term maintenance of behaviour change.⁴⁾ Such strategies also work for the limited number of people who are willing to take part in a behavioural change program. To address these shortcomings, a more comprehensive approach addressing the context in which activity takes place has begun to be advocated. As physical activity occurs in certain settings, providing suitable opportunities for being active and removing barriers for doing so can be effective ways to facilitate physical activity. Building on *ecological models*, which recognise the importance of multi-level approaches encompassing individual, social and environmental factors in promoting physical activity (Figure 1),^{5,6)} increasing research has examined the role of environment in physical activity participation. Studies have shown consistent associations of particular environmental attributes with

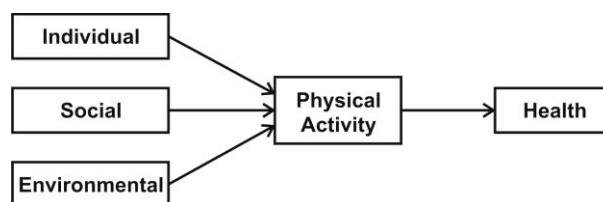


Figure 1 Schematic diagram of ecological model

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physical activity, and findings have been synthesised in several review papers.⁷⁻⁹⁾

However, there are some methodological issues and unanswered questions in this study area. This article briefly summarises past research on the built environment and physical activity, and identifies key stages in its progress. I propose an extended ecological model, in which physical activity is divided into adoption and maintenance, and discuss potential future research directions.

From overall physical activity levels to specific activities

Earlier research on the built environment and physical activity was concerned with the overall level of physical activity, which includes moderate as well as vigorous-intensity activity.¹⁰⁻¹²⁾ The overall activity level or total energy expenditure is obviously important from the perspective of health and fitness. However, as research showed the health benefits of moderate-intensity physical activity and its applicability for a larger population,¹³⁾ moderate activity such as walking, which can be incorporated into daily life, began to play a more important role in population-level physical activity promotion.¹⁴⁾ For research on environments and physical activity, the specific focus on moderate-intensity activity is the first step toward a better correspondence between behaviours and settings.

Physical activity has been further differentiated by its purposes. Typically, people engage in physical activity for transportation (to get to and from places); for recreation or exercise; for occupation; and for domestic work. These different purposes (domains) do not matter from a health perspective. However, in order to increase physical activity, the distinction needs to be recognised as physical activities in these specific domains are likely to be influenced by different factors and entail different approaches for promotion.^{7,15)} Of these four domains, the transportation and recreation domains are often the focus of research, as physical activity for these purposes is more likely to be discretionary (compared to occupational and domestic activity), and potentially amenable to change through multiple influences.

Many recent studies on environments with physical activity focus on moderate-intensity, domain-specific activities (e.g., walking for recreation, cycling for transport). Review papers synthesising findings from such studies report that different environmental attributes are relevant to physical activity for transport and for recreation, suggesting the importance of examining domain-specific activities.⁷⁻⁹⁾

From overall environmental measures to specific attributes

Empirical research examining the relationship of the built environment with physical activity began around the 1990s,^{16,17)} following the Ottawa Charter for Health Promotion (1986), which argued the importance of creating supportive environments for physical activity.¹⁸⁾ The initial challenge for public health researchers working on this topic was how to operationalise the built environment. Concepts and methods developed in the urban planning and transport sectors provided a theoretical and methodological basis for this interdisciplinary research field.¹⁹⁾ A fundamental principle that is embraced in later development is the concept of the 3Ds (density, diversity and design), which characterise environmental factors that influence people's travel behaviours.²⁰⁾ Higher population *density* and land use *diversity* are important for physical activity, as neighbourhoods with these characteristics tend to provide residents with better access to a range of destinations, such as shops, services, transport stops and recreational facilities. *Design*, on the other hand, is mainly concerned with the process to reach such destinations, including sidewalk availability, street connectedness and neighbourhood aesthetics. Thus, these 3Ds capture both opportunities for physical activity (e.g., places to walk to) and factors that make being active an easy and pleasant choice. This conceptualisation led to the development of 'walkability', a composite measure consisting of residential density, land use mix and street connectivity.^{21,22)} A number of studies have found such overall measures to be significantly associated with residents' physical activity.^{21,23,24)} These studies have shown the relevance of neighbourhood environments to residents' activity patterns,

and provided empirical underpinnings for further investigation of this topic.

The increased specificity of research focus happened not only in physical activity but also in relation to the environment. Overall measures such as walkability advanced research by showing their associations with physical activity. However, in order to assist practitioners (planners, designers) to build or modify environments that facilitate physical activity, specific environmental attributes that have higher leverage in influencing behaviours needs to be identified. Major constituents of the environment relevant to active living are destinations and routes.⁹⁾ Destinations provide opportunities for being active, and routes are concerned with the process to get to destinations. For destinations, their presence, distance, mixture of different types, and quality (e.g., attractiveness of parks) are likely to be related to residents' activity. Potentially relevant route attributes include the presence of sidewalks, patterns of street network, safety from crime and traffic (volume and speed). Evidence accumulated from research examining such specific neighbourhood environmental attributes is expected to inform planning policy and practice that aim to facilitate residents' physical activity. Research to date seems to suggest that a compact neighbourhood with a range of destinations is likely to facilitate active transport, and the quality of accessible facilities such as neighbourhood parks is relevant to recreational physical activity.⁹⁾

The match of physical activity behaviours to the settings in which they take place

A methodological issue in the research on the built environment and physical activity is the mismatch between where activity occurs and a setting where environmental attributes are measured. Physical activity can take place in different settings (e.g., neighbourhood, recreational facilities and workplace), but most existing studies measure non-location specific activity, and examine if it is associated with neighbourhood environments. This has been pointed out in a commentary by Giles-Corti,¹⁵⁾ but lack of correspondence between activity and setting is an on-going research issue. A recent study using

accelerometer and GPS (Global Positioning System) has found that about three quarters of participants' activity occurred outside the 1 km buffer of their home.²⁵⁾ This suggests that the majority of people's activity may be happening outside their neighbourhood, and that existing studies using non-location specific activity measures may underestimate the magnitude of the association between neighbourhood environmental attributes and physical activity. Although defining a neighbourhood is itself a difficult task,²⁶⁾ future studies need to strive for a contextual match in examining associations of environmental attributes with physical activity.

New directions for research: Understanding and influencing the determinants of long-term physical activity patterns

Natural experiments.

A frequently-raised criticism about research on environments and physical activity is that most studies are cross-sectional and do not provide causal evidence. In order to examine the causality between environmental changes and physical activity, some studies have used 'natural experiments', and evaluated physical activity levels before and after substantial environmental changes.²⁷⁻³⁰⁾ However, evidence from such studies appears to be mixed. Natural experiments are important to advance our understanding and add more confidence about the effectiveness of environmental approaches to promote physical activity. However, researchers planning such studies have to be kept informed about what environmental changes (new housing developments, new transport infrastructure, park improvements) are scheduled to take place in advance, so that they can arrange baseline data collection. In addition, a longer study period may be needed to detect the impact of environmental changes. Natural experiments are thus opportunistic and entail significant challenges to researchers.

Examining the determinants of physical activity adoption and maintenance.

Another unanswered question, which has not been well recognised, is whether environmental approaches help residents to maintain physical activity. Habitual

physical activity that is sustained over time is known to provide greater health benefits.^{31,32)} Current physical activity guidelines also recommend ‘regular’ participation in physical activity.³³⁾ People start to engage in physical activity for various reasons, including encouragement from family or friends, recommendations by experts, exposure to social marketing or physical activity campaigns. The initial behaviour change may be influenced more by psychosocial factors such as motivation and support. However, for those who have started physical activity, the availability of infrastructure for activity (e.g., sidewalks, bike paths, parks) or access to settings where they can engage in activity may be required for them to continue physical activity. Although previous studies have suggested this as a potential advantage of environmental approaches over individual-level approaches,^{5,34)} only a small number of empirical studies to date have examined associations of environmental attributes (either overall or specific measures) with a long-term pattern of physical activity. For instance, an Australian study has shown that middle-to-older aged adults living in high walkable areas are less likely to decrease their walking for transport over four years.³⁵⁾ Another Australian study, focusing on mothers, identified positive perceptions of local environmental attributes to be associated with increasing and maintaining walking.³⁶⁾ Further studies in different countries using broader samples are needed to identify environmental attributes that facilitate habitual participation in physical activity.

Expanding ecological models.

The subdivision of physical activity into adoption and maintenance may be applied to ecological models. This will add a new dimension to these models as it can be postulated that factors at different levels may

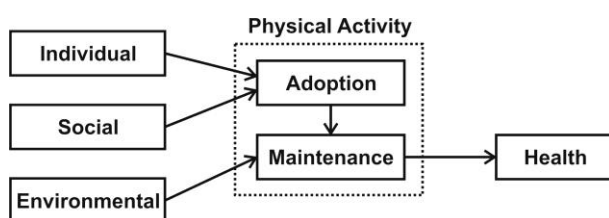


Figure 2 Schematic diagram of extended ecological model (with hypothetical paths)

have different roles in physical activity adoption and maintenance. Figure 2 shows a schematic diagram of this extended ecological model with hypothetical paths. A major research question derived from such a model is to identify environmental factors that will lead to maintenance of physical activity, which is initiated by individual-level or community-level interventions. For instance, social marketing for active commuting may encourage people to try cycling for commuting, but this behaviour change may be sustained only in areas where there are accessible cycle paths to central business districts.

Measures to accurately characterise long-term physical activity patterns.

Longitudinal studies rely on measures collected at discrete observation points to identify changes in variables of interest. Such methods are used to infer the pattern of physical activity, i.e., a survey instrument administered at several time points.³⁷⁾ However, most physical activity questionnaires measure behaviours within a short timeframe, such as in the last seven days or in a typical week.^{38,39)} Fluctuation in physical activity behaviours between the observation points may lead to misclassification of participants. In order to accurately characterise long-term physical activity patterns, new measures may need to be developed. Such measures may involve a retrospective questionnaire,⁴⁰⁾ conventional or technology-based activity log⁴¹⁾ or continuous device-based monitoring.³¹⁾ Developing easy-to-implement and reliable measures to identify the adoption and maintenance of physical activity is an important research agenda.

Applying ecological models to sedentary behaviour.

Emerging research has shown that in addition to lack of physical activity, prolonged sitting at home, in transport and at work is associated with increased risk of diabetes, cardiovascular disease and premature mortality.⁴²⁻⁴⁴⁾ The built environment is likely to be relevant to how long people sit in these domains, and an ecological model for this behaviour has been developed.⁴⁵⁾ However, relatively little is known about environmental factors associated with sedentary behaviour, except for a few studies that investigated

the role of neighbourhood walkability in sitting.^{46,47)} Further studies examining determinants of prolonged sitting (cross-sectional) and reduction of sitting (longitudinal) are recommended.

Conclusion

A large number of studies have consistently shown neighbourhood environmental attributes to be associated with residents' physical activity. One way to advance research on this topic, building on the existing cross-sectional studies, is to evaluate natural experiments, examining the impact of environmental changes. However, such studies have to rely on appropriate opportunities and involve practical implementation issues. In this commentary, I proposed investigation of environmental factors that facilitate long-term maintenance of physical activity. This research topic is framed within an extended ecological model, which distinguishes adoption and maintenance of physical activity. This model suggests that individual, social and environmental factors may work at different stages in the process toward habitual participation in physical activity. In order to move this research agenda forward, researchers working on physical activity interventions, psychosocial correlates and environmental correlates of physical activity need to work together to identify a broader set of approaches that will help people to achieve physical activity maintenance.

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【要 約】

環境と身体活動の変化：新しい研究の方向性

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身体活動の地域レベルでの推進を図るうえで環境を用いたアプローチが有効であると考えられている。身体活動には個人、集団、環境等の異なる要因がかかわっており、エコロジカルモデルはこれらの多レベルの要因を取り込んだ介入の重要性を指摘している。本総説はこれまでの身体活動と環境に関する研究を振り返り、身体活動を実行（開始）と維持の異なる段階に分ける新しいモデルを提示している。このモデルにおいて個人、集団の要因はより実行段階にかかわっており、環境要因はより維持に貢献していると仮定することができる。今後の研究においてはどのレベルの要因が身体活動の定着へのプロセスにどのようにかかわっているかを検討することが必要である。

Key words: エコロジカルモデル, 近隣環境, 生活スタイル, 行動変容

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