

The Benefits of Natural Environments for Physical Activity

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Abstract Urbanisation has a profound effect on both people and the environment, as levels of physical activity decline and many natural ecosystems become lost or degraded. Here we draw on emerging research to examine the role of green spaces in providing a venue for outdoor physical activity, and in enhancing the benefit of a given amount of physical activity for urban residents. We identify critical knowledge gaps, including (1) whether (and for whom) levels of physical activity increase as new green spaces are introduced or old spaces reinvigorated; (2) which characteristics of nature promote physical activity; (3) the extent to which barriers to outdoor physical activity are environmental or social; and (4) whether the benefits of physical activity and experiences of nature accrue separately or synergistically. A clear understanding of these issues will help guide effective investment in green space provision, ecological enhancement and green exercise promotion.

Key Points

Green spaces provide an important location for physical activity, but evidence suggests that ‘green exercise’ also provides greater health and well-being outcomes than physical activity in built-up or indoor environments.

Here, we review the evidence for the role of the green environment in (1) providing a venue and a motivation to engage in physical activity, and (2) enhancing the benefits from physical activity.

We suggest a range of new research directions. In particular, understanding whether the benefits of green space exposure and physical activity accrue separately, or synergistically, will reveal the scale of the added benefits that investment in green exercise promotion could provide.

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1 Introduction

Urbanisation constitutes a massive environmental transformation in which natural ecosystems are largely lost or degraded [1]. Services that can be provided by nature diminish as a consequence, including a range of important benefits to human health and well-being [2–4]. Urbanisation can also lead to reduced levels of physical activity for town and city residents [5–7], and this sedentariness is associated with a number of poor well-being outcomes [8–11]. Thus, while urbanisation has undoubtedly provided

enormous benefits for human society, there are also major impacts on human health and well-being that must be carefully managed [12]. This issue will become increasingly important as two-thirds of people are predicted to live in towns and cities by 2050 [13].

Cities around the world are investing heavily in urban green space (green infrastructure) as a key strategy to counter this emerging public health problem. Public policy objectives commonly include a minimum target area of parkland for each resident (e.g. the 8 m² target cited by UN-Habitat [14]), often within a minimum walking distance [15–17]. Such investment is supported by a growing body of evidence that shows levels of physical activity can be higher in greener neighbourhoods even after accounting for a range of potentially confounding socioeconomic and demographic variables [18, 19]. Yet in addition to the provision of a venue for physical activity, over 40 years of research provides evidence that nature itself can deliver a suite of physical, psychological and social well-being benefits that range from reduced mortality from cardiovascular disease [20, 21] to improved self-reported well-being [22–25] and cognitive performance [26, 27]. Perhaps as a consequence of such effects, emerging evidence suggests that physical activity in natural settings has benefits above and beyond those expected from the same activity in a built-up or indoor location [28].

Here, we chart progress to date in understanding the role of the green environment in (1) providing a venue and a motivation to engage in outdoor physical activity, and (2) enhancing the benefits from physical activity, and highlight key knowledge gaps. We suggest that the question of whether the benefits of green space exposure and physical activity accrue separately, or synergistically, is crucial as it will shed light on the scale of the added benefits and relative importance of investment in green space provision, ecological enhancement and green exercise promotion. Such research will provide an important step forward for understanding how urban green spaces enhance health and well-being outcomes from physical activity.

2 Green Spaces as a Venue for Physical Activity

Green spaces may promote physical activity first and foremost by providing free and readily accessible locations for active pastimes. Certainly, a number of studies suggest that people who live in neighbourhoods with higher levels of green space undertake more (and sometimes more vigorous) physical activity such as cycling and walking [18, 29–37]. Furthermore, there is evidence from Brisbane, Australia, that people who carry out higher levels of physical activity tend to visit green spaces more frequently

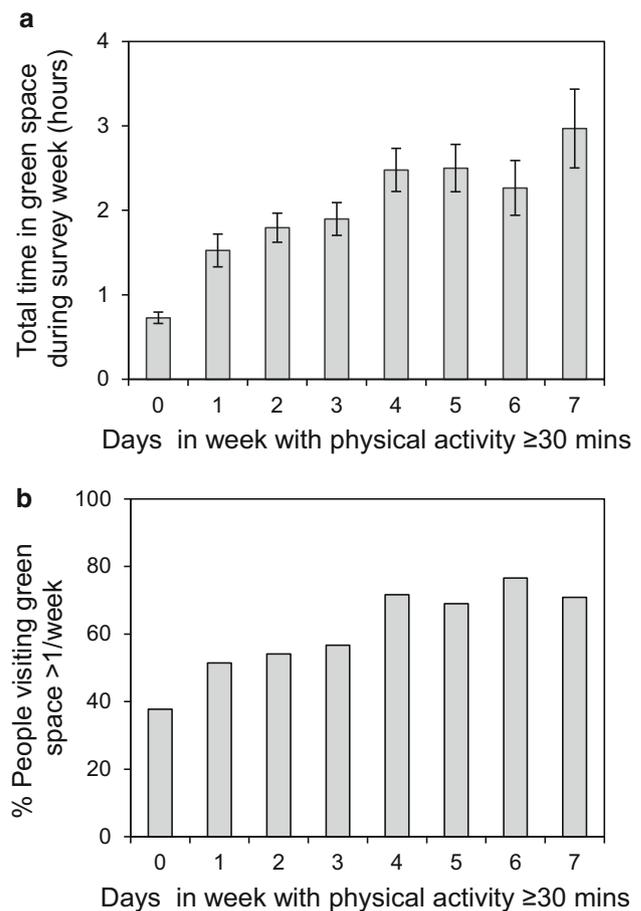


Fig. 1 Relationship between the number of days in a survey week in which 1538 residents of Brisbane, Australia, reported carrying out physical activity in any environment for more than 30 min, and three domains of exposure to nature [38]: **a** total duration of all green space visits during that week (with standard errors), and **b** proportion of respondents who normally visit green spaces once a week or more. The survey was conducted in November 2012, and further details on the protocol are provided in Lin et al. [39] and Shanahan et al. [40]

and for a longer duration (Fig. 1a, b). Thus, exposure to nature and physical activity can be inextricably linked.

Importantly, green spaces are thought to facilitate the kinds of physical activity that tend to attract greater long-term adherence—that is, walking or other activities that do not require specialist equipment or attendance at a particular facility [41]. However, the evidence that provision of green spaces promotes physical activity is not unequivocal. Many studies are cross-sectional, raising questions as to whether people who elect to live in greener environments are simply generally more active. Mytton et al. [42] provide some support for this, finding that the higher levels of physical activity in the study region’s greener neighbourhoods were due to activities unrelated to the provision of public green space, such as gardening. Furthermore, in a longitudinal study Sugiyama et al. [43] found that green spaces may be important for maintaining recreational

walking over time, but not for initiating it. Natural experiments that examine whether (and for whom) levels of physical activity increase as new green spaces are introduced or old spaces reinvigorated will help shed further light on the relationship between physical activity and green space, and what characteristics of park design might be important for physical activity promotion [44].

Nature itself is a key feature of green spaces, either as a secondary feature (e.g. sports fields), or integrated into the green space design. Thus, a second pathway through which the natural environment can promote exercise is where nature itself, or the need for ‘fresh air’, acts as an incentive to visit and physical activity becomes a secondary benefit. Indeed, experiencing nature is a commonly stated reason for visiting green spaces [45–47], and the presence of attractive views of nature around people’s homes is associated with higher levels of physical activity [48]. However, there is variation among people in the quantity and quality of nature that they prefer, and this has a critical role in who uses green spaces of varying designs [40]. For example, many studies have observed a tendency at least in Western cultures toward a visual preference for ‘open savannah’ green spaces, with few scattered trees over grass [49, 50]. These preferences could in part be influenced by a perception of declining safety as the vegetation cover or density increases [51, 52]. Green space visitation patterns tend to reflect these broad preferences, with one study demonstrating that parks with 30–40 % tree cover attract a higher number of visitors [40], as do formal manicured green spaces [53].

Interestingly, in most instances (but depending on the ecological context of a city) open savannah landscapes have relatively low biodiversity value. Yet somewhat paradoxically, some studies have found that areas with higher levels of biodiversity provide greater restoration benefits for people [22, 23]. There are several possible interpretations of these patterns. Aspects of nature that attract the most people may not necessarily deliver the greatest health and well-being benefits for those users—that is, there could be a mismatch between places that people prefer to visit and those that provide the most restorative benefits. This could conceivably arise because people’s experiences of nature have become poorer in quantity and quality, potentially leading to a shifting understanding of nature itself [54, 55]. On the other hand, if wilder or more natural spaces make people feel unsafe and threatened, the well-being benefits of these areas may be considerably negated [56]. Consequently, a key area for future research is exploring how the benefits from physical activity in natural settings scale with both landscape preference and the nature content of the setting, and how improved levels of biodiversity can be incorporated into green spaces in ways that ensure people still feel safe.

The importance of green spaces for physical activity varies across the life-course, and a range of factors has been shown to correlate with green space use. This includes social and environmental factors such as sex, age, education, socioeconomic advantage, distance to green spaces, as well as how connected with nature a person feels [39, 53, 57–64]. For example, green spaces are important for maintaining regular physical activity for the elderly [58, 65], providing a location for children’s play [66] and providing a crucial location for sports such as ball games. Perhaps as a consequence of this variation among people, strategies beyond the physical provision and improvement of green spaces alone can be required to promote their use by various communities [62, 67]. Reflecting this need, there has been a recent surge in programmes such as the Wild Play programme for UK children [68], and ‘park prescriptions’, where health practitioners recommend or prescribe time in green spaces [69]. However, careful evaluation of the efficacy of such programmes is still rare, and so research that explores what type of programme is most effective to engage different communities will help guide investment.

3 Health and Well-being Outcomes from Urban Nature

While green space may play an important role in physical activity promotion through the provision of a venue, experiences of urban nature itself are associated with many health and well-being benefits; thus a key question is whether and how the benefits of physical activity are enhanced by a natural setting. For example, at the population level higher amounts of green space within neighbourhoods have been found to correlate with reduced all-cause mortality and mortality from cardiovascular disease [20, 21], reduced respiratory illness and allergies [70, 71], better self-perceived general health [72], fewer cases of diabetes [73] and reduced anxiety and depression [74]. Some studies report a lack of relationship, for example Richardson et al. [74] showed no association between mortality rates and levels of neighbourhood green space in New Zealand [75]. This result suggests that health and well-being outcomes may vary according to the national, societal or environmental context. Population-level studies present a particular challenge for disentangling the effects of exposure to nature from that of physical activity, in part because the two can be so highly correlated (e.g. Fig. 1). However, studies that assess how individual-level measures of well-being vary in response to experimentally manipulated environments are generally considered to provide a better indicator of a causal relationship [76], with such studies showing improvements in cognitive ability [26, 27, 77], improved healing times [78] and reduced stress [79].

There are many potential pathways through which green spaces could conceivably deliver the benefits listed above, several of which could act simultaneously but independently from the benefits of physical activity [4, 80]. For example, vegetation can directly improve air quality by filtering pollutants, and it buffers the urban heat island effect by providing shade and through absorbing and reflecting heat [81]. These effects not only create a healthier living environment, but may have the additional benefit of further contributing to the creation of spaces that may be more attractive for, and conducive to, physical activity. Nature can also indirectly influence health by mitigating risks associated with other areas of people's lives. For example, exposure to nature has been tied to a reduction in stress and blood pressure [82, 83], and feelings of restoration from nature may actually increase with higher levels of biodiversity, such as the number of plant or bird species that can be seen in an area [22, 23]. This effect is thought to arise by providing relief from mental fatigue (the attention restoration theory [49]), and/or by providing a low stress environment (the stress reduction theory [84]).

4 How do the Benefits of Physical Activity and Green Space Interact?

Reflecting the multiple pathways through which people gain benefits from nature, there is intriguing evidence to suggest that physical activity in natural environments can provide greater health and well-being outcomes than the same activity in built-up or indoor environments [37, 85–87]. For example, a systematic review by Coon et al. [28] found that while methodological dissimilarities make

comparisons between studies challenging, there is evidence that the self-reported psychological well-being benefits of physical activity appear to be higher following exercise in natural versus alternative locations, with the restorative effects felt in as little as 5 min [88]. Similarly, exercise in green environments has been associated with better emotional well-being, although not necessarily general health [89]. However, while a growing body of evidence suggests that exposure to nature enhances the benefits of physical activity, a key question that has received little attention is how the benefits of physical activity and nature exposure interact, and whether these benefits are sub-additive (the benefits are less than the sum of the parts), additive (the benefits of both can simply be added together) or synergistic (the benefits are more than the sum of the parts; Fig. 2).

From a theoretical perspective, sub-additive, additive and synergistic relationships are all possible. A sub-additive relationship might occur when there is a threshold to a benefit. For example, a reduction in blood pressure is likely to reach a threshold beyond which further improvement is not possible. Alternatively, some aspect of either physical activity or the natural environment could diminish the full potential of the benefits of the other; for example, strenuous activities in natural environments may limit the extent to which a person can appreciate and so benefit from the restorative environment. An additive relationship may occur where the ancillary benefits of spending time in nature add different dimensions to the benefits of physical activity itself. Finally a synergistic effect might be possible when enhanced benefits occur only when physical activity is performed while being exposed to nature and vice versa. One study that provides some indication of a synergy found

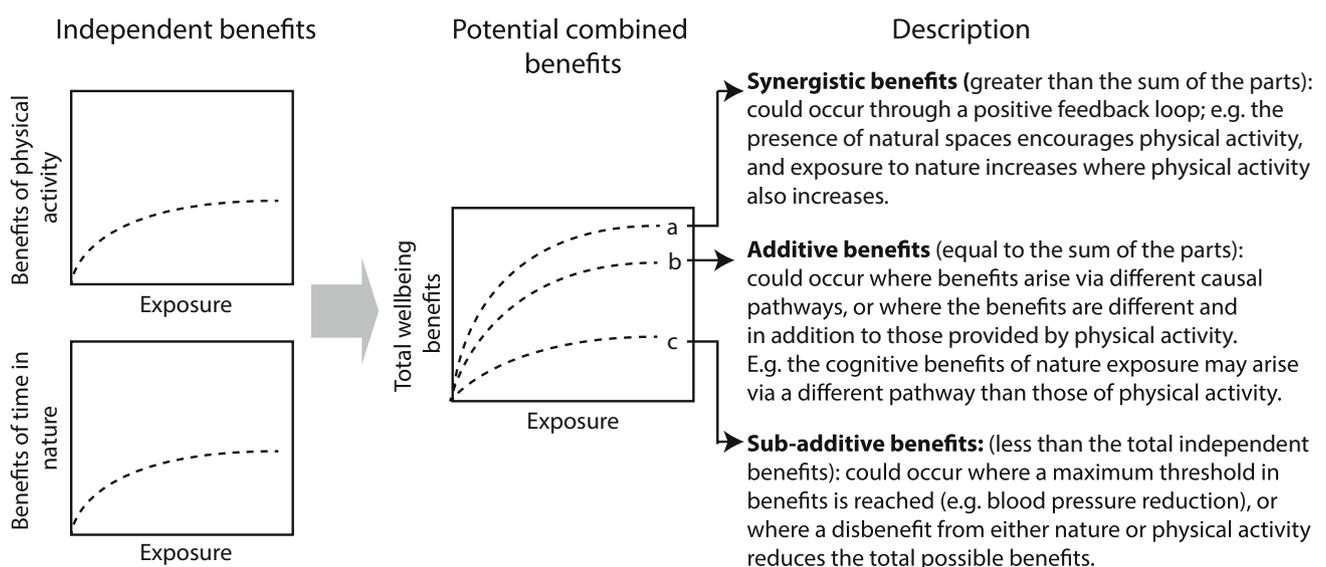


Fig. 2 Possible variation in the accumulation of health and well-being benefits from physical activity and nature exposure

that reductions in psychological distress associated with green spaces predominantly accrued for adults who were also physically active [19]. We urge careful experimental design to explore not only how the benefits of physical activity vary between natural and non-natural environments, but how the benefits of nature are enhanced by physical activity. A better understanding of how aspects of exposure to nature interact with the benefits of physical activity could help generate guidelines for green space designs that maximise health and well-being outcomes through physical activity.

5 Conclusion

While urbanisation has led to enormous benefits for human society, the associated reduction and loss of green spaces can negatively impact human health and well-being. Although physical activity in and of itself is highly beneficial for people, the potential for added benefits from nature provides a compelling reason to understand the interactions between green space and physical activity. Here we have highlighted important knowledge gaps that could contribute to an improved understanding of how the health and well-being of growing urban populations might be enhanced through physical activity in green environments. These knowledge gaps include (1) whether and for whom physical activity increases as new green spaces are provided or old spaces enhanced; (2) which particular characteristics of nature promote physical activity; (3) what programmes might benefit different populations to promote physical activity in green spaces; and (4) whether the benefits of physical activity and experiences of nature accrue separately or synergistically.

Ultimately, a key policy goal is to create urban systems in which human populations can improve their quality of life, undertaking recreation in safe, restorative environments that allow for a variety of physical activities to occur. For each individual, the level of environmental complexity, the type of physical activity and the time required to attain desired benefits may differ, but rigorous research is needed to discover how the interaction between the green environment and physical activity works. Only then can we inform the design of public health interventions that aim to maximise the benefits of physical activity, enhance interactions with nature and foster a lifelong desire to experience physical activity in natural environments.

Compliance with Ethical Standards

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Conflict of interest Danielle Shanahan, Lara Franco, Brenda Lin, Kevin Gaston and Richard Fuller declare that they have no conflicts of interest relevant to the content of this article.

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