

Perspective Essay

Advantages of public green spaces in enhancing population health

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ARTICLE INFO

Keywords:

Park
Natural area
Physical activity
Contact with nature

ABSTRACT

Since the burden of chronic diseases is rising globally, there is an urgent need to develop population-level approaches to reducing the risk of chronic diseases. Neighborhood environments, where people spend much of their time, are relevant in this context because they can influence residents' daily behaviors related to health. In particular, public green spaces (PGS) can confer health benefits through facilitating physical activity, contact with nature, and social interaction. PGS may also mitigate socio-economic inequalities in health. However, despite growing evidence, PGS are generally not fully utilized as a resource for physical activity. Thus, there is substantial scope for enhancing population health through increased visits and active use of PGS. This essay argues that PGS are not only health-enhancing but also practical and workable environmental resources to promote population health. We discuss three "advantages" of using PGS as health promotion initiatives: PGS are easier to modify (than are other structural environmental features); PGS can involve programs to help residents initiate physical activity; and PGS are valued by residents. The essay concludes with a discussion of future research topics, the result of which can be used to convince and assist local authorities and other key stakeholders to use PGS as readily available resources for health promotion.

1. Introduction

Chronic diseases, which include heart diseases, cancers, diabetes, respiratory diseases, and mental disorders, are the leading cause of poor health, disability, and death (World Health Organization., 2014). The burden of chronic diseases is rising globally with the contribution of chronic diseases to the total number of deaths increasing from approximately 60% in 2001 to 68% in 2012 (World Health Organization, 2014). Chronic diseases consume high levels of health care resources for treatment, and have an enduring detrimental impact on people's quality of life. In the case of mental disorders, health systems are failing to meet the demand for mental health treatment (World Health Organization., 2013). Since many chronic diseases are preventable, there has been a call for population-wide preventative action to address behavioral risk factors that contribute to chronic diseases, which include smoking, physical inactivity, alcohol consumption, and an unhealthy diet (Bauer, Briss, Goodman, & Bowman, 2014). An important concept in epidemiology is that a large number of people at a small risk may produce more cases of disease than the small number exposed to high risk (Rose, 1985). Along with programs targeting high-risk

individuals, more effort in population-based approaches, which aim at lowering the level of risk for the population, is needed to reduce the burden of chronic diseases and enhance population health.

To lower the risk of chronic diseases, "health behaviors" discussed above need to be modified. This is a challenging task, given that our daily behaviors are highly habitual (Marteau, Hollands, & Fletcher, 2012). An example of a successful population-based behavioral change program to prevent chronic diseases is tobacco cessation. In Australia, adult smoking rates decreased from 35% in 1980 to 13% in 2013, which contributed to declining deaths due to heart disease and stroke (Willcox, 2014). The significant reduction in smoking rates was attributable to a comprehensive effort acting on a wide range of determinants: health promotion campaigns, regulation (e.g., prohibiting smoking in public places, limiting tobacco advertising), and taxation worked together to achieve the reduction (Australian Institute of Health & Welfare, 2014). Such concerted multi-sectoral collaboration is key to effective population-based approaches to promoting people's health.

Physical inactivity, which is one of the major risk factors of chronic diseases (World Health Organization, 2014), is also habitual and requires multi-sectoral efforts influencing wider determinants to

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stimulate behavioral change. A non-health sector considered to contribute to addressing physical inactivity is urban design and planning. How neighborhood environments are designed and built can influence residents' daily physical activity such as walking (Sallis, Floyd, Rodríguez, & Saelens, 2012), which is known to have preventative effects on chronic diseases (Kelly et al., 2014; Murtagh, Murphy, & Boone-Heinonen, 2010). Among environmental features/elements, this essay discusses the role of public green spaces (PGS), which include parks, trails, nature reserves, and urban forest, in promoting physical activity and enhancing population health. Historically, PGS has been integrated into efforts to enhance population health (Ward Thompson, 2011). For instance, the Garden City Movement, proposed by Ebenezer Howard, integrated green space into settlements in response to overcrowding and unhygienic living conditions in cities following the Industrial Revolution in the U.K. (Howard, 1902). Frederick Law Olmsted, an influential landscape architect in the 19th century in the U.S.A., also designed urban parks as places that counteracted unhealthy urban environments (Sutton, 1971). We argue in this perspective essay that PGS have a unique and practical capacity to contribute to human health in our society. We briefly summarize the health benefits of PGS first, then discuss practical advantages of using PGS in reducing risk of chronic diseases and enhancing population health.

2. Health benefits of PGS

Some evidence suggests that PGS can provide health benefits (Lee & Maheswaran, 2011; Tzoulas et al., 2007). A framework developed building on existing research has conceptualized that PGS confer health benefits through facilitating physical activity, contact with nature, and social interaction (Lachowycz & Jones, 2013). In the following, we outline several pathways through which the use of PGS can benefit human health.

PGS provide a venue for residents to engage in recreational physical activity within its boundaries and as a walkable destination (Koohsari et al., 2015). Studies have shown that the presence of and access to PGS are positively associated with physical activity among youth (Limstrand, 2008; Oliveira, Moreira, Abreu, Mota, & Santos, 2013), adults (Kaczynski, Potwarka, & Saelens, 2008; Sallis et al., 2016), and older adults (Eronen, von Bonsdorff, Rantakokko, & Rantanen, 2014; Rosso, Auchincloss, & Michael, 2011). However, non-significant associations of PGS with physical activity have also been reported (Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008; Saelens et al., 2012; Schipperijn, Bentsen, Troelsen, Toftager, & Stigsdotter, 2013; Triguero-Mas et al., 2015), suggesting that some PGS are not performing well as a physical activity facility. It can be argued that PGS in general have the capacity to enable participation in physical activity, but some are not well-resourced or may pose safety concerns, which can act as a barrier (Cohen et al., 2010). This can be interpreted as suggesting the potential of PGS to further promote physical activity.

Research has also shown mental health benefits of PGS. It has been found that the presence of and access to PGS are associated with better mental well-being (Sturm & Cohen, 2014; Wood, Hooper, Foster, & Bull, 2017). Stress, which is common in modern life, is a known risk factor of mental illness such as depression (Cohen, Janicki-Deverts, & Miller, 2007). Research suggests that PGS can alleviate stress. It has been shown that a greater amount of PGS is associated with lower levels of stress measured by cortisol (Ward Thompson et al., 2012) and with a lower risk of psychological distress (Astell-Burt, Feng, & Kolt, 2013). Contact with nature is likely to be a key factor as physical and visual exposure to green space has been shown to be associated with lower stress (Hazer, Formica, Dieterlen, & Morley, 2018; Honold, Lakes, Beyer, & van der Meer, 2016), and to produce positive physiological responses indicative of a relaxed state (Tsunetsugu et al., 2013). Evidence also suggests that physical activity in natural settings is more beneficial to mental health than physical activity in other settings (Hartig, Evans, Jamner, Davis, & Garling, 2003; Mitchell, 2013). PGS

may also facilitate incidental social interaction among nearby residents (Kazmierczak, 2013), and social ties developed in PGS can contribute to mental health. The importance of social ties on mental health is well known (Umberson & Montez, 2010). PGS can help nurture “weak ties”, i.e., interaction with people on the periphery of one's social network (e.g., neighbors), which are known to have positive effect on mental well-being (Sandstrom & Dunn, 2014).

Another potential benefit of PGS is that they might mitigate health inequalities between those living in low and high socio-economic status (SES) areas. A study in England reported that differences in mortality (from all causes and from cardiovascular disease) between low and high SES areas were less pronounced among those who had the highest exposure to green space (Mitchell & Popham, 2008). It was also found that higher levels of greenness were associated with reduced risk of chronic diseases and mental health problems (depression) more strongly among residents of lower SES neighborhoods, in comparison to those of higher SES neighborhoods (Brown et al., 2016; Brown et al., 2018), suggesting a possibility that the presence of greenspace may mitigate socio-economic disparity in health. It should be noted that these studies examined all types of greenspaces in the neighborhood, including non-public greenspaces. We will further discuss how PGS may contribute to narrowing the health gaps in the Discussion section.

3. Advantages of PGS for enhancing population health

Despite growing evidence on the health benefits of PGS, they are generally not used to their full capacity as a resource for physical activity. For instance, a study in which participant's activities and their location were identified using accelerometer and global positioning systems data found that only 3% of light physical activity, 5% of lower moderate physical activity, and 8% of moderate-to-vigorous physical activity was conducted in PGS (Evenson, Wen, Hillier, & Cohen, 2013). It has been also shown that the majority of PGS use is sedentary or low in activity level: a study observing two metropolitan parks in Australia (size: 120 ha and 329 ha, with facilities such as walking/cycling paths and playgrounds) found that over 60% of the users observed were either standing, sitting, or lying (Veitch et al., 2015). Another observational study in the U.S. found that 68% of the individuals observed in 30 urban parks were sedentary (Cohen et al., 2010). Thus, there is substantial scope for enhancing population health through increased visits and active use of PGS. A few commentary papers have already emphasized the health benefits of natural spaces including PGS (Lachowycz & Jones, 2013; Shanahan et al., 2015). We argue in this essay that PGS are not only health-enhancing but also practical and workable environmental resources for health promotion, and describe their specific advantages compared with initiatives involving other neighborhood environmental attributes, such as population density, street connectivity, land use diversity, and access to public transit.

3.1. PGS are easier to modify (compared to other features of the built environment)

A major challenge in urban design/planning approaches to health promotion is the difficulties associated with modifying existing environments. For instance, access to utilitarian destinations (e.g., local shops and services) is known to be a strong predictor of walking for transport (Sugiyama, Neuhaus, Cole, Giles-Corti, & Owen, 2012); however, it is not easy to increase these destinations in existing neighborhoods. Simply assigning commercial use to more land is unlikely to be effective: higher population density is needed to attract and support more shops and services. Similarly, other factors that can facilitate active travel, such as well-connected street layout and infrastructure for public transport, are structural elements of the built environment and are difficult to change in existing neighborhoods. In contrast, existing PGS are considered by a range of stakeholders to be relatively easy to modify (Stankov, Howard, Daniel, & Cargo, 2017).

This is mainly because PGS are generally managed by local authorities, and their features (vegetation, facilities, and amenities) are less expensive to alter in comparison to elements such as street networks and public transport. It is important to note that research on PGS often suggest the primacy of quality over quantity (Francis, Wood, Knuiman, & Giles-Corti, 2012; Kaczynski, Potwarka, & Saelens, 2008; van Dillen, de Vries, Groenewegen, & Spreeuwenberg, 2012). One study indeed suggested that building one high-quality park in a neighborhood may be more effective in promoting recreational walking than providing many average-quality parks (Sugiyama et al., 2015). This means that building new PGS may not be entirely necessary to promote better health: improving one particular park may be suffice to help residents in the local area increase active PGS use. Natural experiments have shown that refurbishing existing PGS can have a positive impact on both park visitation and park-based physical activity (Cohen et al., 2015; Veitch, Ball, Crawford, Abbott, & Salmon, 2012; Veitch et al., 2018). For example, the installation of a play area in a large, regional park resulted in significant increases in visitation and in observed moderate-to-vigorous intensity physical activity among park visitors (Veitch et al., 2018). Woodland improvements were also found to result in more frequent visitors to the woodland and better perception (safety) of the woodland (Ward Thompson, Roe, & Aspinall, 2013).

3.2. PGS can involve programs to help residents initiate physical activity

People's behaviors are highly habitual and automatic (Marteau et al., 2012). Considering that our lifestyles are becoming increasingly sedentary, simply improving the quality of PGS (or creating new PGS) may not be enough to induce behavior change for many people. It has been found that the presence of and proximity to PGS are associated with maintenance of recreational walking, but not with initiation of walking (Sugiyama et al., 2013). Additional individual- and community-level incentives may be needed to motivate people to initiate physical activity. As argued in ecological models, strategies involving multiple levels of influence, including individual, social, and environmental, are expected to be more effective than single-level approaches (Sallis & Owen, 2015). Thus, physical activity programs that promote awareness and active use of PGS may have synergistic effects by providing an incentive to start physical activity and a place to continue engaging in activity. For example, park-based exercise programs have been shown to increase moderate-to-vigorous physical activity within PGS (Calogiuri, Patil, & Aamodt, 2016; Han et al., 2015). In particular, those programs that are offered free of charge and require only a low threshold of fitness for participation have shown success in attracting higher-risk subgroups such as women and those who are overweight (Han et al., 2015; Stevinson & Hickson, 2014). The long-term effect of physical activity programs in PGS is yet to be examined (Hunter et al., 2015). However, activity programs within PGS are promising as motivational support and physical opportunities are essential elements to sustain behavior change (Michie, van Stralen, & West, 2011).

3.3. PGS are valued by residents

People value having PGS in their local neighborhoods and are willing to pay for PGS, as they appreciate their worth as places for being active, having contact with nature, relaxing, and socializing (Henderson-Wilson et al., 2017; Ives et al., 2017). Preference to live near PGS is reflected in higher prices of properties in closer proximity to PGS (McCord et al., 2014). On the other hand, people express their concern about quality issues, such as lack of maintenance and presence of incivilities (Smiley et al., 2016), which can generate fear of crime (Maruthaveeran & van den Bosch, 2014) and deter residents from visiting PGS (Sugiyama & Ward Thompson, 2008; Veitch et al., 2017). These studies suggest that residents appreciate having high-quality, well-maintained, and safe PGS in their neighborhood, and are likely to support public expenditure on PGS improvement. Public demand for

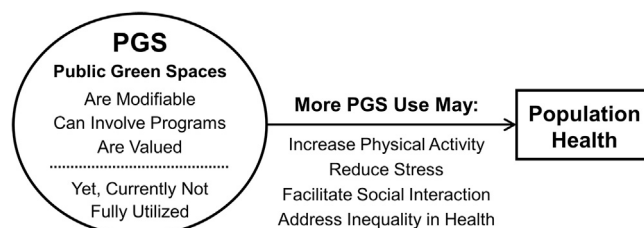


Fig. 1.

high-quality PGS may increase with forecasted urban population growth and resulting higher density in urban areas. For instance, Hong Kong residents, who live in very high density environments, expressed their strong desire to spend more time in PGS and to have more green areas in their neighborhood (Lo & Jim, 2012). Public support for PGS is high, and this can be used as a leverage to facilitate policy change and implementation.

Fig. 1 shows how more frequent and active use of PGS might contribute to population health and the practical advantages of PGS to facilitate greater use.

4. Research directions to promote further PGS use for health promotion

PGS are important community resources for health promotion. Since local authorities are typically responsible for the design and management of PGS, they have opportunities to address community health issues through improving local PGS. However, as discussed above, studies have shown that time spent in PGS is often low and the majority of PGS use is sedentary (Cohen et al., 2010; Evenson et al., 2013; Veitch et al., 2015), suggesting that PGS in general are not fully utilized. Much research evidence has been accumulated on the health benefits of PGS, but it is possible that such evidence on the health impact alone may not be sufficient to engage decision makers to take action. It is important to publicize that improving PGS is likely to be a feasible health-enhancing initiative that is at the discretion of local authorities. In the following section, we discuss future research topics that would assist key stakeholders to make informed decisions around PGS planning and design.

4.1. Modifiability and cost effectiveness

One of the crucial characteristics of PGS is their modifiability, although there is limited knowledge about to what extent particular environmental factors are amenable to change (Stankov et al., 2017). Modifiability is a difficult construct to measure, but cost-benefit analysis may provide more insights into modifiability (cost) and their health impact (benefit). A limited number of cost-effectiveness studies on outdoor exercise equipment (Cohen, Marsh, Williamson, Golinelli, & McKenzie, 2012) and trails (Wang et al., 2004) have produced preliminary yet promising findings about their effectiveness. Further research is needed to identify specific PGS features that encourage active use of PGS for a wide range of potential users. Synthesizing findings from observational studies in PGS may provide better understanding of what features of PGS contribute to attracting more users and promoting active use. Natural experiments may be used to identify which modified features are more cost-effective and have the greatest impact on increasing physical activity within PGS.

4.2. Role of PGS in addressing health inequalities

How to use PGS more effectively to close the socioeconomic gap in health is another important issue for future research. Although low SES areas are not necessarily deprived in the quantity of PGS in comparison to high SES areas (Moore, Diez Roux, Evenson, McGinn, & Brines, 2008; Vaughan et al., 2013), studies report that PGS in deprived areas tend to

have poor-quality amenities and safety concerns (Crawford et al., 2008; Vaughan et al., 2013). This suggests that encouraging active use of PGS in deprived areas by improving existing PGS may help close the health gap, particularly considering that residents of deprived areas are generally less active during their leisure time (Beenackers et al., 2012; Turrell et al., 2010). Natural experiments examining the impact of improving PGS in low SES neighborhoods have shown positive effects for increasing visitation and park-based physical activity (Veitch et al., 2012; Veitch et al., 2018). However, renovation of PGS in deprived areas has to meet the needs of diverse groups. Mitigating socio-economic inequalities in health is a key goal in public health, and local-level efforts to address this issue are needed. It is thus important to understand which specific PGS attributes can facilitate or discourage PGS use in deprived areas, so that PGS can serve as resource to enhance health in disadvantaged areas. In addition, PGS can be particularly important in rural areas, where it may not be practical to walk for transport due to limited access to public transit and retail destinations. Facilitating recreational walking or exercise within PGS is potentially a viable option to promote physical activity in rural areas. However, previous studies have reported that PGS in rural areas are used less often, and tend to have lower quality (Banda et al., 2014) and fewer amenities (Veitch, Salmon, Ball, Crawford, & Timperio, 2013), in comparison to urban PGS. To date, most park-based research has been conducted in urban settings with few studies examining rural PGS. It is essential to ensure PGS in rural areas are supportive of physical activity.

4.3. Community engagement in PGS renovation and use

In light of the high value residents place on PGS, there is a scope for collaboration between residents and local authorities in creating supportive social and physical environments in PGS. Actively involving community groups in the renovation of PGS would help local authorities to understand the needs of residents across the lifespan and to make PGS more attractive to them (Ives et al., 2017). PGS enhancement was one of the recommendations of a partnership between the community, public and academic sectors that sought to increase community-level physical activity (Davis, Cruz, & Kozoll, 2017). Studies to identify key factors that help implement such collaboration in designing new or retrofitting existing PGS are needed. Community groups can also be involved in the development of physical activity programs in PGS. Such programs can further enhance what PGS offer: place for physical activity, contact with nature, and an opportunity for social interaction. However, more research is needed to better understand how to involve community groups in developing and running activity programs and what programs are more effective for particular groups. The approach of engaging community groups is promising because those involved in the process can be PGS users and also actively promote PGS use within the community.

4.4. Other research topics

To facilitate evidence-based re-design of PGS, research needs to generate more practical and prescriptive information about which PGS features are relevant to encourage more frequent and active use. Given that local governments are often limited in financial resources, they may have to prioritize their investment focusing on more effective aspects of PGS. The use of marketing research techniques (such as choice-based conjoint analysis) is promising to better understand which attributes would be more relevant to potential PGS users (Veitch et al., 2017). PGS are often categorized according to size. For instance, American Planning Association (2006) categorizes PGS into neighborhood (1–4 ha), community (up to 20 ha), and large urban parks (larger than 20 ha). PGS in each category may serve different purposes and require different features. Research on PGS needs to take such PGS classification into consideration, and produce evidence that is consistent with local practice. In addition, linking existing PGS by linear

green space may be a potential strategy for local governments to promote physical activity. Some design guidelines suggest producing such networks of PGS (National Heart Foundation of Australia, 2012), however, research on the impact of greenway network is limited (Fitzhugh, Bassett, & Evans, 2010). Future research needs to examine the effect of such environmental initiatives. We acknowledge that physical activity in PGS may displace activity undertaken in other settings. However, providing more settings for people to be active while also gaining other benefits (i.e., exposure to nature, mental health benefits) has many potential benefits for public health. There is inconclusive evidence about “compensation” whereby increasing physical activity in one domain may have limited effect on overall daily physical activity (Gomersall et al., 2016; Ridgers, Timperio, Cerin, & Salmon, 2014). Future research is needed to better understand whether increasing PGS-based activity results in an increase in overall physical activity levels.

5. Conclusion

This commentary argues that improving local PGS can be a feasible approach to enhancing community health. Producing PGS that are easily accessible and designed to be appealing for people of all ages could reduce chronic disease risk through facilitating physical activity and alleviating stress. Research needs to produce practical evidence that assists local authorities to make informed decisions on how to enhance existing PGS to promote active use. In addition, dissemination efforts are essential to persuade relevant stakeholders to consider PGS as an underutilized yet readily available resource for health promotion. Such research and dissemination efforts can stimulate multi-sectoral collaboration between relevant fields, such as public health, urban design/planning, and sports and recreation, which may enhance population health through the use of PGS.

Acknowledgements

MJK is supported by a Japan Society for the Promotion of Science Postdoctoral Fellowship for Research (#17716). JV is supported by a National Health and Medical Research Council Early Career Fellowship (#1053426).

References

- Astell-Burt, T., Feng, X. Q., & Kolt, G. S. (2013). Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: Evidence from 260,061 Australians. *Preventive Medicine*, 57(5), 601–606.
- Australian Institute of Health and Welfare (2014). *Australia's health 2014*. Canberra: AIHW.
- Banda, J. A., Wilcox, S., Colabianchi, N., Hooker, S. P., Kaczynski, A. T., & Hussey, J. (2014). The associations between park environments and park use in southern US communities. *Journal of Rural Health*, 30, 369–378.
- Bauer, U. E., Briss, P. A., Goodman, R. A., & Bowman, B. A. (2014). Prevention of chronic disease in the 21st century: Elimination of the leading preventable causes of premature death and disability in the USA. *The Lancet*, 384(9937), 45–52.
- Beenackers, M. A., Kamphuis, C. B. M., Giskes, K., Brug, J., Kunst, A. E., Burdorf, A., et al. (2012). Socioeconomic inequalities in occupational, leisure-time, and transport related physical activity among European adults: A systematic review. *International Journal of Behavioral Nutrition & Physical Activity*, 9, 116.
- Brown, S. C., Lombard, J., Wang, K., Byrne, M. M., Toro, M., Plater-Zyberk, E., et al. (2016). Neighborhood greenness and chronic health conditions in Medicare beneficiaries. *American Journal of Preventive Medicine*, 51(1), 78–89.
- Brown, S. C., Perrino, T., Lombard, J., Wang, K., Toro, M., Rundek, T., et al. (2018). Health disparities in the relationship of neighborhood greenness to mental health outcomes in 249,405 U.S. Medicare beneficiaries. *International Journal of Environmental Research & Public Health*, 15, 430.
- Calogiuri, G., Patil, G. G., & Aamodt, G. (2016). Is green exercise for all? A descriptive study of green exercise habits and promoting factors in adult Norwegians. *International Journal of Environmental Research & Public Health*, 13, 11.
- Cohen, D. A., Han, B., Isacoff, J., Shulaker, B., Williamson, S., Marsh, T., et al. (2015). Impact of park renovations on park use and park-based physical activity. *Journal of Physical Activity & Health*, 12(2), 289–295.
- Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *JAMA*, 298(14), 1685–1687.
- Cohen, D. A., Marsh, T., Williamson, S., Derose, K. P., Martinez, H., Setodji, C., et al.

- (2010). Parks and physical activity: Why are some parks used more than others? *Preventive Medicine*, 50, S9–S12.
- Cohen, D. A., Marsh, T., Williamson, S., Golinelli, D., & McKenzie, T. L. (2012). Impact and cost-effectiveness of family fitness zones: A natural experiment in urban public parks. *Health & Place*, 18(1), 39–45.
- Crawford, D., Timperio, A., Giles-Corti, B., Ball, K., Hume, C., Roberts, R., et al. (2008). Do features of public open spaces vary according to neighbourhood socio-economic status? *Health & Place*, 14(4), 889–893.
- Davis, S. M., Cruz, T. H., & Kozoll, R. L. (2017). Research to practice: Implementing physical activity recommendations. *American Journal of Preventive Medicine*, 52, S300–S303.
- Eronen, J., von Bonsdorff, M., Rantakokko, M., & Rantanen, T. (2014). Environmental facilitators for outdoor walking and development of walking difficulty in community-dwelling older adults. *European Journal of Ageing*, 11(1), 67–75.
- Evenson, K. R., Wen, F., Hillier, A., & Cohen, D. A. (2013). Assessing the contribution of parks to physical activity using global positioning system and accelerometry. *Medicine & Science in Sports & Exercise*, 45(10), 1981–1987.
- Fitzhugh, E. C., Bassett, D. R., Jr., & Evans, M. F. (2010). Urban trails and physical activity: A natural experiment. *American Journal of Preventive Medicine*, 39(3), 259–262.
- Francis, J., Wood, L. J., Knuiman, M., & Giles-Corti, B. (2012). Quality or quantity? Exploring the relationship between public open space attributes and mental health in Perth. *Western Australia. Social Science & Medicine*, 74(10), 1570–1577.
- Gomersall, S. R., Maher, C., English, C., Rowlands, A. V., Dollman, J., Norton, K., et al. (2016). Testing the activitystat hypothesis: A randomised controlled trial. *BMC Public Health*, 16(1), 900.
- Han, B., Cohen, D. A., Derosé, K. P., Marsh, T., Williamson, S., & Loy, S. (2015). Effectiveness of a free exercise program in a neighborhood park. *Preventive Medicine Reports*, 2, 255–258.
- Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Garling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, 23(2), 109–123.
- Hazer, M., Formica, M. K., Dieterlen, S., & Morley, C. P. (2018). The relationship between self-reported exposure to greenspace and human stress in Baltimore, MD. *Landscape & Urban Planning*, 169, 47–56.
- Henderson-Wilson, C., Sia, K. L., Veitch, J., Staiger, P. K., Davidson, P., & Nicholls, P. (2017). Perceived health benefits and willingness to pay for parks by park users: Quantitative and qualitative research. *International Journal of Environmental Research & Public Health*, 14, 5.
- Honold, J., Lakes, T., Beyer, R., & van der Meer, E. (2016). Restoration in urban spaces: Nature views from home, greenways, and public parks. *Environment & Behavior*, 48, 796–825.
- Howard, E. (1902). *Garden cities of to-morrow*. London: Swan Sonnenschein & Co.
- Hunter, R. F., Christian, H., Veitch, J., Astell-Burt, T., Hipp, J. A., & Schipperijn, J. (2015). The impact of interventions to promote physical activity in urban green space: A systematic review and recommendations for future research. *Social Science & Medicine*, 124, 246–256.
- Ives, C. D., Oke, C., Hehir, A., Gordon, A., Wang, Y., & Bekessy, S. A. (2017). Capturing residents' values for urban green space: Mapping, analysis and guidance for practice. *Landscape & Urban Planning*, 161, 32–43.
- Kaczynski, A. T., Potwarka, L. R., & Saelens, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. *American Journal of Public Health*, 98(8), 1451–1456.
- Kazmierczak, A. (2013). The contribution of local parks to neighbourhood social ties. *Landscape & Urban Planning*, 109(1), 31–44.
- Kelly, P., Kahlmeier, S., Götschi, T., Orsini, N., Richards, J., Roberts, N., et al. (2014). Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship. *International Journal of Behavioral Nutrition & Physical Activity*, 11, 132.
- Koohsari, M. J., Mavoja, S., Villanueva, K., Sugiyama, T., Badland, H., Kaczynski, A. T., et al. (2015). Public open space, physical activity, urban design and public health: Concepts, methods and research agenda. *Health & Place*, 33, 75–82.
- Lachowycz, K., & Jones, A. P. (2013). Towards a better understanding of the relationship between greenspace and health: Development of a theoretical framework. *Landscape & Urban Planning*, 118, 62–69.
- Lee, A. C. K., & Maheswaran, R. (2011). The health benefits of urban green spaces: A review of the evidence. *Journal of Public Health*, 33(2), 212–222.
- Limstrand, T. (2008). Environmental characteristics relevant to young people's use of sports facilities: A review. *Scandinavian Journal of Medicine & Science in Sports*, 18(3), 275–287.
- Lo, A. Y. H., & Jim, C. Y. (2012). Citizen attitude and expectation towards greenspace provision in compact urban milieu. *Land Use Policy*, 29(3), 577–586.
- Maas, J., Verheij, R., Spreeuwenberg, P., & Groenewegen, P. (2008). Physical activity as a possible mechanism behind the relationship between green space and health: A multilevel analysis. *BMC Public Health*, 8, 206.
- Marteau, T. M., Hollands, G. J., & Fletcher, P. C. (2012). Changing human behavior to prevent disease: The importance of targeting automatic processes. *Science*, 337(6101), 1492–1495.
- Maruthaveeran, S., & van den Bosch, C. C. K. (2014). A socio-ecological exploration of fear of crime in urban green spaces: A systematic review. *Urban Forestry & Urban Greening*, 13(1), 1–18.
- McCord, J., McCord, M., McCluskey, W., Davis, P. T., McIlhatton, D., & Haran, M. (2014). Effect of public green space on residential property values in Belfast metropolitan area. *Journal of Financial Management of Property & Construction*, 19(2), 117–137.
- Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, 6, 42.
- Mitchell, R. (2013). Is physical activity in natural environments better for mental health than physical activity in other environments? *Social Science & Medicine*, 91, 130–134.
- Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *The Lancet*, 372(9650), 1655–1660.
- Moore, L. V., Diez Roux, A. V., Evenson, K. R., McGinn, A. P., & Brines, S. J. (2008). Availability of recreational resources in minority and low socioeconomic status areas. *American Journal of Preventive Medicine*, 34(1), 16–22.
- Murtagh, E. M., Murphy, M. H., & Boone-Heinonen, J. (2010). Walking: The first steps in cardiovascular disease prevention. *Current Opinion in Cardiology*, 25, 490–496.
- National Heart Foundation of Australia (2012). *Healthy by Design SA. A guide for planning, designing and developing healthy urban environments in South Australia*. Adelaide, Australia: National Heart Foundation of Australia.
- Oliveira, A. F., Moreira, C., Abreu, S., Mota, J., & Santos, R. (2013). Environmental determinants of physical activity in children: A systematic review. *Archives of Exercise in Health & Disease*, 4(2), 254–261.
- Ridgers, N. D., Timperio, A., Cerin, E., & Salmon, J. (2014). Compensation of physical activity and sedentary time in primary school children. *Medicine & Science in Sports & Exercise*, 46, 1564–1569.
- Rose, G. (1985). Sick individuals and sick populations. *International Journal of Epidemiology*, 14(1), 32–38.
- Rosso, A. L., Auchincloss, A. H., & Michael, Y. L. (2011). The urban built environment and mobility in older adults: A comprehensive review. *Journal of Aging Research*, 2011, 816106.
- Saelens, B. E., Sallis, J. F., Frank, L. D., Cain, K. L., Conway, T. L., Chapman, J. E., ... Kerr, J., et al. (2012). Neighborhood environment and psychosocial correlates of adults' physical activity. *Medicine & Science in Sports & Exercise*, 44(4), 637–646.
- Sallis, J. F., Cerin, E., Conway, T. L., Adams, M. A., Frank, L. D., Pratt, M., et al. (2016). Physical activity in relation to urban environments in 14 cities worldwide: A cross-sectional study. *The Lancet*, 387(10034), 2207–2217.
- Sallis, J. F., Floyd, M. F., Rodríguez, D. A., & Saelens, B. E. (2012). Role of built environments in physical activity, obesity, and cardiovascular disease. *Circulation*, 125, 729–737.
- Sallis, J., & Owen, N. (2015). Ecological models of health behavior. In K. Glanz, B. Rimer, & K. Viswanath (Eds.). *Health behavior theory research and practice* (pp. 43–64). (5th Ed.). San Francisco: Jossey-Bass.
- Sandstrom, G. M., & Dunn, E. W. (2014). Social interactions and well-being: The surprising power of weak ties. *Personality & Social Psychology Bulletin*, 40(7), 910–922.
- Schipperijn, J., Bentsen, P., Troelsen, J., Toftager, M., & Stigsdottir, U. K. (2013). Associations between physical activity and characteristics of urban green space. *Urban Forestry & Urban Greening*, 12(1), 109–116.
- Shanahan, D. F., Lin, B. B., Bush, R., Gaston, K. J., Dean, J. H., Barber, E., et al. (2015). Toward improved public health outcomes from urban nature. *American Journal of Public Health*, 105, 470–477.
- Smiley, K. T., Sharma, T., Steinberg, A., Hodges-Copple, S., Jacobson, E., & Matveeva, L. (2016). More inclusive parks planning: Park quality and preferences for park access and amenities. *Environmental Justice*, 9(1), 1–7.
- Stankov, I., Howard, N. J., Daniel, M., & Cargo, M. (2017). Policy, research and residents' perspectives on built environments implicated in heart disease: A concept mapping approach. *International Journal of Environmental Research & Public Health*, 14, 2.
- American Planning Association, Steiner, F. R., & Butler, K. (2006). *Planning and urban design standards*. Hoboken, NJ: John Wiley & Sons Student Ed.
- Stevinson, C., & Hickson, M. (2014). Exploring the public health potential of a mass community participation event. *Journal of Public Health*, 36(2), 268–274.
- Sturm, R., & Cohen, D. (2014). Proximity to urban parks and mental health. *Journal of Mental Health Policy & Economics*, 17(1), 19–24.
- Sugiyama, T., Giles-Corti, B., Summers, J., du Toit, L., Leslie, E., & Owen, N. (2013). Initiating and maintaining recreational walking: A longitudinal study on the influence of neighborhood green space. *Preventive Medicine*, 57(3), 178–182.
- Sugiyama, T., Gunn, L. D., Christian, H., Francis, J., Foster, S., Hooper, P., et al. (2015). Quality of public open spaces and recreational walking. *American Journal of Public Health*, 105(12), 2490–2495.
- Sugiyama, T., Neuhaus, M., Cole, R., Giles-Corti, B., & Owen, N. (2012). Destination and route attributes associated with adults' walking: A review. *Medicine & Science in Sports & Exercise*, 44(7), 1275–1286.
- Sugiyama, T., & Ward Thompson, C. (2008). Associations between characteristics of neighbourhood open space and older people's walking. *Urban Forestry & Urban Greening*, 7(1), 41–51.
- Sutton, S. B. (Ed.). (1971). *Civilizing american cities: A selection of frederick law olmsted's writings on city landscapes*. Cambridge, MA: MIT Press.
- Triguero-Mas, M., Dadvand, P., Cirach, M., Martinez, D., Medina, A., Mompert, A., et al. (2015). Natural outdoor environments and mental and physical health: Relationships and mechanisms. *Environment International*, 77, 35–41.
- Tsunetsugu, Y., Lee, J., Park, B. J., Tyrvaainen, L., Kagawa, T., & Miyazaki, Y. (2013). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape & Urban Planning*, 113, 90–93.
- Turrell, G., Haynes, M., Burton, N. W., Giles-Corti, B., Oldenburg, B., Wilson, L. A., et al. (2010). Neighborhood disadvantage and physical activity: Baseline results from the HABITAT multilevel longitudinal study. *Annals of Epidemiology*, 20(3), 171–181.
- Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemela, J., et al. (2007). Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape & Urban Planning*, 81(3), 167–178.
- Umberson, D., & Montez, J. K. (2010). Social relationships and health: A flashpoint for health policy. *Journal of Health & Social Behavior*, 51(Suppl.), S54–66.
- van Dillen, S. M., de Vries, S., Groenewegen, P. P., & Spreeuwenberg, P. (2012). Greenspace in urban neighbourhoods and residents' health: Adding quality to quantity. *Journal of Epidemiology & Community Health*, 66(6), e8.

- Vaughan, K. B., Kaczynski, A. T., Stanis, S. A. W., Besenyi, G. M., Bergstrom, R., & Heinrich, K. M. (2013). Exploring the distribution of park availability, features, and quality across Kansas City, Missouri by income and race/ethnicity: An environmental justice investigation. *Annals of Behavioral Medicine*, *45*, S28–S38.
- Veitch, J., Ball, K., Crawford, D., Abbott, G. R., & Salmon, J. (2012). Park improvements and park activity: A natural experiment. *American Journal of Preventive Medicine*, *42*(6), 616–619.
- Veitch, J., Carver, A., Abbott, G., Giles-Corti, B., Timperio, A., & Salmon, J. (2015). How active are people in metropolitan parks? An observational study of park visitation in Australia. *BMC Public Health*, *15*, 610.
- Veitch, J., Salmon, J., Ball, K., Crawford, D., & Timperio, A. (2013). Do features of public open spaces vary between urban and rural areas? *Preventive Medicine*, *56*, 107–111.
- Veitch, J., Salmon, S., Crawford, D., Abbott, G., Giles-Corti, B., Carver, A., et al. (2018). The REVAMP natural experiment study: The impact of a play-scape installation on park visitation and park-based physical activity. *International Journal of Behavioral Nutrition & Physical Activity*, *15*(1), 10.
- Veitch, J., Salmon, J., Deforche, B., Ghekiere, A., Van Cauwenberg, J., Bangay, S., et al. (2017). Park attributes that encourage park visitation among adolescents: A conjoint analysis. *Landscape & Urban Planning*, *161*, 52–58.
- Wang, G. J., Macera, C. A., Scudder-Soucie, B., Schmid, T., Pratt, M., & Buchner, D. (2004). Cost effectiveness of a bicycle/pedestrian trail development in health promotion. *Preventive Medicine*, *38*(2), 237–242.
- Ward Thompson, C. (2011). Linking landscape and health: The recurring theme. *Landscape & Urban Planning*, *99*(3–4), 187–195.
- Ward Thompson, C., Roe, J., & Aspinall, P. (2013). Woodland improvements in deprived urban communities: What impact do they have on people's activities and quality of life? *Landscape & Urban Planning*, *118*, 79–89.
- Ward Thompson, C., Roe, J., Aspinall, P., Mitchell, R., Clow, A., & Miller, D. (2012). More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape & Urban Planning*, *105*(3), 221–229.
- Willcox, S. (2014). *Chronic diseases in Australia: The case for changing course*. Australian health policy collaboration issues paper No. 2014-02. Melbourne: Australian Health Policy Collaboration.
- Wood, L., Hooper, P., Foster, S., & Bull, F. (2017). Public green spaces and positive mental health: Investigating the relationship between access, quantity and types of parks and mental wellbeing. *Health & Place*, *48*, 63–71.
- World Health Organization. (2013). *Mental Health Action Plan 2013–2020*. Retrieved from < http://www.who.int/mental_health/publications/action_plan/en/ > .
- World Health Organization. (2014). *Global Status Report on Noncommunicable Diseases 2014*. Retrieved from: < http://www.who.int/nmh/publications/ncd_report2010/en/ > .