



Streetscape greenery and health: Stress, social cohesion and physical activity as mediators



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ABSTRACT

Several studies have shown a positive relationship between local greenspace availability and residents' health, which may offer opportunities for health improvement. This study focuses on three mechanisms through which greenery might exert its positive effect on health: stress reduction, stimulating physical activity and facilitating social cohesion. Knowledge on mechanisms helps to identify which type of greenspace is most effective in generating health benefits. In eighty neighbourhoods in four Dutch cities data on quantity and quality of streetscape greenery were collected by observations. Data on self-reported health and proposed mediators were obtained for adults by mail questionnaires ($N = 1641$). Multilevel regression analyses, controlling for socio-demographic characteristics, revealed that both quantity and quality of streetscape greenery were related to perceived general health, acute health-related complaints, and mental health. Relationships were generally stronger for quality than for quantity. Stress and social cohesion were the strongest mediators. Total physical activity was not a mediator. Physical activity that could be undertaken in the public space (green activity) was, but less so than stress and social cohesion. With all three mediators included in the analysis, complete mediation could statistically be proven in five out of six cases. In these analyses the contribution of green activity was often not significant. The possibility that the effect of green activity is mediated by stress and social cohesion, rather than that it has a direct health effect, is discussed.

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Introduction

Evidence is mounting that greenspace in the residential environment is associated with health. However promising, more detailed knowledge on this association is needed to assess the opportunities it offers for health improvement (Frumkin, 2013). Several studies have shown a positive relationship between local greenspace availability and peoples' health and wellbeing (De Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; Maas, Verheij, Groenewegen, & De Vries, 2006; Maas, Van Dillen, Verheij, & Groenewegen, 2009; Mitchell & Popham, 2007, 2008; Sugiyama, Leslie, Giles-Corti, & Owen, 2008; Takano, Nakamura, & Watanabe, 2002). Sometimes no such relationship is observed (see e.g. Richardson & Mitchell, 2010; Richardson et al., 2012). This may have to do with different operationalizations of greenspace and/or the quality of the greenspace. Two studies found a positive relationship between the (perceived) quality of greenery and health (Agyemang

et al., 2007; Van Dillen, De Vries, Groenewegen, & Spreeuwenberg, 2012), whereas no such relationship was found for yet another operationalization of quality (Björk et al., 2007). Finally, little research has been conducted to identify which processes are responsible for the relationship between nearby greenspace and neighbourhood health, and to what extent (Maas et al., 2009; Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008; Sugiyama et al., 2008; Van den Berg, Maas, Verheij, & Groenewegen, 2010).

Lee and Maheswaran (2011) conclude that while most studies support the view that greenspace has a beneficial health effect, establishing a causal relationship is difficult. Insight in the operating mechanism(s) might help, because it indicates which type of greenery is effective and what type(s) of health benefit(s) are generated (De Vries, 2010). This study builds on Van Dillen et al. (2012), which showed that especially the quantity and quality of streetscape greenery is associated with health, more so than the quantity and quality of nearby green areas. Streetscape greenery includes all kinds of vegetation that give the street a green appearance. This follow-up study investigates to what extent stress, physical activity, and social cohesion mediate the relationship between

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streetscape greenery and health. Doing so may give insight into which types of greenspace are most effective in generating health benefits, and thereby help to exploit these benefits more fully.

Stress and availability of greenspace

Contact with nature is hypothesised to help people restore from attentional fatigue and reduce stress. This is important because chronic stress negatively affects both physical (Brotman, Golden, & Wittstein, 2007; Smith et al., 2005) and mental health (Bovier, Chamot, & Perneger, 2004; Marin et al., 2011). Experimental evidence shows that contact with nature indeed provides restoration from (short term) stress and attentional fatigue (see e.g. Hartig, Evans, Jamner, & Davis, 2003; Morita et al., 2007). Since it seems to be related to health more clearly, we will focus on stress. Three cross-sectional studies have shown a negative relationship between the perceived availability of local greenspace and stress levels of residents (Grahn & Stigsdotter, 2003; Nielsen & Hansen, 2007; Stigsdotter et al., 2010). We are not aware of studies addressing local greenspace quality and stress levels.

Physical activity and availability of greenspace

People with much greenspace in their living environment might be more physically active because of this. Higher levels of physical activity contribute to better health (Pate et al., 1995; Pretty et al., 2007). Empirical support for more greenspace being associated with more total physical activity is mixed. Several studies do find such a relationship (Coombes, Jones, & Hillsdon, 2012; Ellaway, Macintyre, & Bonnefoy, 2005), whereas others do not (King et al., 2005). Sometimes even a negative relationship is found (Duncan & Mummery, 2005). For reviews, see Kaczynsky and Henderson (2007) and Lachowycz and Jones (2010). The latter conclude that while the majority of papers found a positive or weak association between greenspace and obesity-related health indicators, findings were inconsistent and varied across studies. Green aspects of the neighbourhood environment are perhaps more likely to affect participation in a subset of activities, namely those that take place in this environment, such as walking for pleasure or transport. Although more common (Li, Fisher, Brownson, & Bosworth, 2005; Sugiyama et al., 2008), even for this subset of activities not always positive relationships with greenspace availability are observed (e.g. Maas et al., 2008). Note that, when looking at energy expenditure, there is no reason why green physical activity should be more effective than other types of physical activity.

Physical activity and quality of greenspace

As for the quality of the greenery, several studies have shown a more general relationship between the aesthetics or attractiveness of the streetscape and specific types of activity. Attractiveness was positively related to peoples' walking behaviour (Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003), for exercise (Ball, Bauman, Leslie, & Owen, 2001) as well as for leisure (Owen, Humpel, Leslie, Bauman, & Sallis, 2004). Quality aspects of neighbourhood greenspace (such as pleasantness, lack of nuisance, good paths) have also been associated with more walking time (Sugiyama & Ward Thompson, 2008). Björk et al. (2007) did find a relationship between how many out of five green recreational values (serene, wild, lush, spacious, and culture) were present near one's residence and physical activity (but not health). In another study, with a different operationalization of quality, no relationship was found (Van Lenthe, Brug, & Mackenbach, 2005).

Finally, two studies paid attention to greenspace availability as well as quality. Hillsdon, Panter, Foster and Jones (2006) looked at

distance, size and quality of urban greenspace, and observed no relationships with recreational physical activity. On the other hand, Giles-Corti et al. (2005) also took distance, size and attractiveness of public open spaces simultaneously into account, and observed positive relationships between attractiveness and walking.

Social cohesion and availability of greenspace

Social cohesion has been defined in many ways. In this study, we use it as an equivalent of sense of community, with a focus on trust, shared norms and values, positive and friendly relationships, and feelings of being accepted and belonging (Forrest & Kearns, 2001). Previous research has shown a positive relationship between social cohesion and health (Echeverria, Diez-Roux, Shea, Borrell, & Jackson, 2008; Rios, Aiken, & Zautra, 2012). In two studies neighbourhood greenness was related to social cohesion (Maas et al., 2009; Sugiyama et al., 2008). In both studies, social cohesion itself was positively associated with health and wellbeing. We are not aware of studies explicitly addressing the relationship between quality of local greenspace and social cohesion.

To what extent may these three mechanisms explain the relationship between greenspace and health? Sugiyama et al. (2008) found that walking for recreation helped explain the relationship between perceived neighbourhood greenness and physical health, while the somewhat stronger relationship between perceived neighbourhood greenness and mental health was partially accounted for by walking for recreation and social cohesion. They hypothesised that the residual relationship between greenness and mental health might be due to the restorative effects of natural environments, an aspect that was not included in their study. The present study extends the work of Sugiyama et al. (2008); to begin, we include stress as a possible mediator. Moreover, we not only look at physical activity that might be associated with nearby nature, but also at overall physical activity. Finally, we use more objective information on the quantity and quality of greenery in the neighbourhood, rather than the perceptions by residents. Giles-Corti and Donovan (2002) highlight the importance of using objective measures to better understand the relationships between environments and behaviours.

In summary, we hypothesise that residents in neighbourhoods with more and/or higher quality streetscape greenery experience less stress, more social cohesion, and spend more time on (green) physical activity. Our second set of hypotheses is that stress is negatively related to health, and (feelings of) social cohesion and (green) physical activity are positively related to health. Finally, we expect that stress, social cohesion and (green) physical activity will mediate the relationship between quantity and quality of greenery in urban neighbourhoods and health to a significant extent.

Methods

Study population

Four Dutch cities (Utrecht, Rotterdam, Arnhem, Den Bosch) were chosen with comparable levels of urbanity and at least 125,000 inhabitants. Within each city 20 neighbourhoods were selected. Neighbourhoods were defined as administrative units, having 2200 residents on average. The average quantity of public green area (i.e., square metres available per residence within a distance of 500 m) was used to select ten more and ten less green neighbourhoods within each city to ensure variation in the amount of green area. (However, this is not directly relevant for streetscape greenery.) During this selection we tried to exclude neighbourhoods with very peculiar or extreme socioeconomic profiles to keep the sample as homogeneous as possible in this respect. Profiles were assessed based on neighbourhood-level data available at Statistics Netherlands.

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