



Original article

Does time spent on visits to green space mediate the associations between the level of residential greenness and mental health?



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ABSTRACT

Objective: The objective of the current study was to explore whether time spent visiting green space near home acts as a mediator in the association between level of residential greenness and perceived mental health.

Methods: Questionnaire data and satellite data of residential greenness were gathered in four European cities (total n = 3748): Barcelona (SP), Doetinchem (NL), Kaunas (LT) and Stoke-on-Trent (UK).

Results: Mediation analyses showed that time spent visiting green space near home was a weak, but statistically significant, mediator in the pooled data and in the Dutch sample only.

Conclusions: The findings provide little support for the hypothesis that purposeful visits are a mediator linking indirectly greenness with mental health. More research is needed to explore other mediators related to different exposure pathways, such as visual exposure, and alternative mechanisms, such as (perceived) safety.

1. Introduction

Many epidemiological studies have shown that exposure to greenness in the immediate residential environment is positively associated with mental health (Gascon et al., 2015; James et al., 2015; van den Berg et al., 2015). Several mechanisms have been proposed that might explain this association. Residential greenness or green space with natural elements, such as trees, forests and urban parks, might offer opportunities for psychological restoration (Kaplan, 1995; Ulrich et al., 1991). Many experimental studies have indicated that exposure to natural or green environments, as opposed to built environments,

positively affects mood and helps people to recover from stress and mental fatigue (Bowler et al., 2010; Bratman et al., 2012; Health Council of the Netherlands, 2004). Furthermore, two indirect pathways have been suggested through which green space might confer health benefits, i.e. through providing suitable spaces for leisure activities and for meeting people, thereby, promoting physical activity and social contacts (Dadvand et al., 2016; de Vries et al., 2013; Hartig et al., 2014; Maas et al., 2009a,b). A growing number of epidemiological studies have investigated these indirect pathways, including several studies on mediation see for reviews e.g. (Hartig et al., 2014; James et al., 2015). However, the evidence supporting this is still inconclusive (Hartig et al.

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2014). One reason might be that a variety of measures of level of residential greenness have been used and none of them do capture actual use of green space, which might be a better indicator of exposure to or contact with greenness than the level of greenness per se.

Several researchers have suggested that intentional visits or visits on purpose to green space in the residential environment play an important role in explaining health benefits of green space (Bedimo-Rung et al., 2005; Hartig et al., 2014; Lachowycz and Jones 2013). However, some studies have provided indications for exposure to greenness which is not related to visits on purpose. The finding that streetscape greenery, i.e. small green spaces such as gardens and street trees visible from the home, was more strongly associated with mental health than nearby green spaces, suggests a direct pathway of exposure, for example through visual exposure from windows at home (van Dillen et al., 2011). Another study found that mental health benefits were associated with surrounding greenness in a circular buffer of 300 m around the residence, but not with presence of one or more green areas, such as urban parks and forests, in the same buffer (Triguero-Mas et al., 2015). This finding supports the possibility of a direct pathway of exposure, besides that of purposeful visits to green spaces. A possible explanation is that visual exposure to greenness from, for example, windows at home or during commuting or other ways of unintentional use of green space may provide (micro-)restorative experiences (Hartig et al., 2014; Kaplan, 1995). Overall, there could be important differences between greenness indicators, which links to different way of exposure to or contact with greenness. Especially, the importance of indirect pathways of exposure is not yet clear: do people have to visit green space on purpose for obtaining mental health benefits from greenness in their immediate residential environment? The aim of the present study was to explore whether time spent visiting green space near home mediates the greenness – mental health association.

1.1. Time spent on visiting green space

Few studies have focussed on the association between the frequency and duration of visits to green space and mental health. These studies have reported that visiting green space more frequently and spending more time in green space was associated with lower perceived stress levels (Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007; Stigsdotter et al., 2010) and better mental health and vitality (van den Berg et al., 2016). A Danish study found that the number of visits to green space decreased with greater distance and that the number of visits partly explained the negative association between distance to green space and stress levels (Nielsen and Hansen, 2007), suggesting that purposeful visits to green space near home might be an important exposure pathway. To date, there is evidence linking self-reported distance to green space with visit frequency, and visit frequency and time spent in green space with better mental health. No studies have investigated whether time spent visiting green space near home, i.e. in the immediate residential environment, mediates the association between level of residential greenness, objectively measured by the Normalized Difference Vegetation Index (NDVI), and mental health.

Several individual and socio-cultural factors may influence time people spent on visiting green space, such as opportunity and motivation, perceptions of green space, perceived quality and safety (Lachowycz and Jones, 2013). Climatic factors may influence the time people spent visiting green space in different seasons. Socio-cultural factors that influence perceptions of green space and attitudes to visit green space, and towards nature in general, might even more important than having green spaces available and easily accessible (Lin et al., 2014). Therefore, it is expected that the importance of time spent on visiting green space as a mediator may differ between cities in European countries with different cultural and climatic contexts.

The present study builds on previous analyses by van den Berg et al. (2016) and is part of the EU-FP7-funded 'Positive Health Effects of the Natural Outdoor Environment in Typical Populations in Different

Regions in Europe (PHENOTYPE) project. The main objective of the present study is to investigate whether time spent on visits to green space near home mediates the association between objectively measured level of residential greenness and mental health, and whether this association differs across cities.

2. Methods

2.1. Study background and data collection

Data for this study were derived from a questionnaire administered as part of the PHENOTYPE project. The study protocol has been described elsewhere (Nieuwenhuijsen et al., 2014). All procedures have been approved by ethical committees of the respective research institutes.

Data were collected from 3947 adult residents from 124 neighbourhoods across four European cities: Barcelona (Spain); Kaunas (Lithuania); Doetinchem (the Netherlands) and Stoke-on-Trent (UK). In Doetinchem, Barcelona and Stoke-on-Trent the questionnaire data were collected with face-to-face interviews, while in Kaunas postal questionnaires were conducted. A summary of the spatial units that were used for area selection can be seen in Supplementary Table 1. The spatial units in Barcelona are much smaller in physical size than the other cities. However, the population density of Barcelona is much higher. Furthermore, Doetinchem is the smallest city, both in size and in study population. Approximately 30 spatial units with sufficient variability in proximity to green space and in socioeconomic status (SES) were selected, in each city. A random sample of 30–35 adults was drawn from the general population aged 18–75 years, in each spatial unit. For further details on the area and population selection collection see van den Berg et al. (2016).

2.2. Questionnaire

Most questions were derived from existing and validated measures, and some were developed for the specific objectives of PHENOTYPE. Where new questions were developed, they were drafted in English and translated (and back translated) into Dutch, Spanish and Lithuanian.

The following subset of questions was used for this study:

Mental health: A subscale from The Medical Outcome Study Short Form (SF-36) general health survey was used to measure perceived mental health (Ware and Sherbourne 1992). The 5-items mental health subscale, also known as MHI-5, assesses nervousness and feelings of depression in the last month. All items were scored on a 6-point scale and sum scores were transformed into a scale from 0 to 100, where a higher score reflects better mental health.

Frequency and duration of visits to green space near home: Visit frequency was measured by asking “how often did you visit in the last 4 weeks on purpose the green/blue environment near home your home (i.e. at less than 15 min by foot/bike). This item was scored on a 5-point scale (never; 1 time or less in past month; 2–3 times in past month; 1–4 times weekly to (almost) daily). Visit duration was assessed by asking “how much time did you spend in green or blue environments near home in the last 4 weeks (per visit)”. This was scored on a 4-point scale (< 1 h, 1–2 h, 3–5 h, 6–10 h). A new variable was constructed to obtain the total hours spent in green space near home in the last 4 weeks. The mid-points for each response category was used for visit frequency and duration and they were then multiplied to provide total hours spent in green space near home in the last 4 weeks (e.g. less than 1 times/month was coded as 0.5 times/month and less than 1 h/month was coded as 0.5 h/month). “Never” and “not applicable” answers for visit frequency were recoded as zero hours in the past month. Because of its skewed distribution, the variable time spent on visits to green space near home was dichotomized around the median (4 h for pooled data, specific median values for the city data, see Table 1). Although the questions included visits to both green and blue space, the analyses only assessed

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