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How do type and size of natural environments relate to physical activity behavior?

F.M. Jansen[a,*], D.F. Ettema[a], C.B.M. Kamphuis[a], F.H. Pierik[b], M.J. Dijst[a]

[a] Department of Human Geography and Spatial Planning, Faculty of Geosciences, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands
[b] Department of Sustainable Urban Mobility and Safety, TNO, P.O. Box 80015, 3508 TA Utrecht, the Netherlands

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ABSTRACT

Natural environments (NE) are promoted as places that support physical activity (PA), but evidence on PA distribution across various types and sizes of NE is lacking. Accelerometers and GPS-devices measured PA of Dutch general population adults aged 45–65 years (N=279). Five NE types were distinguished: 'parks', 'recreational area', 'agricultural green', 'forest & moorland', and 'blue space', and four categories of size: 0–3, 3–7, 7–27, and ≥27 ha. Modality (i.e. spatially concentrated PA, walking, jogging, and cycling) and intensity (i.e. sedentary behavior, LPA, and MVPA) of PA varied significantly between NE types. Compared to parks, less sedentary behavior and walking but more spatially concentrated PA was observed in recreational areas and green space. Cycling levels were found to be significantly lower in recreational areas and forest & moorland, but higher in blue space as compared to parks. Larger sized NE (≥7 ha) were associated with higher levels of MVPA, walking, jogging and cycling. Insight in which environments (according to type and size) facilitate PA, contributes to the development of tailored PA promoting interventions with ensuing implications for public health.

1. Introduction

Physical inactivity is seen as a major global public health problem (Kohl et al., 2012) and policy makers, health professionals and urban planners seek for opportunities to increase levels of physical activity (PA). A growing body of evidence indicates that PA levels can be related to environmental factors such as street design, land use mix, street connectivity, access to facilities (e.g. shops) and population density (Lee et al., 2015; McCormack and Shiell, 2011; Van Holle et al., 2012). In particular natural environments (NE) such as city parks, beaches, or grasslands, have been found to be frequently used for a variety of PA behaviors (Lee et al., 2015). Due to the opportunities such environments provide for PA, and their potential to promote also other aspects of health and well-being, NE have become of increasing interest in land-use planning aimed at promoting PA, and the relationship between NE and PA is increasingly studied (Lee et al., 2015). However, previous studies suffer from various shortcomings.

Where most studies have examined whether associations exist between (access to) NE and PA (e.g. Cohen et al., 2007; Evenson et al., 2013; Veitch et al., 2013; White et al., 2014; Witten et al., 2008), only limited research has examined what different types and intensities of PA are actually performed in such natural spaces (Elliott et al., 2015). As different environments facilitate different behaviors, researchers suggest that type of NE (e.g. forest, parks, moorland) may be an important moderator in the relationship between NE and PA (Thompson Coon et al., 2011). Since NE fulfil a wide range of roles (Elliott et al., 2015; Koohsari et al., 2015; Lee et al., 2015), i.e. they provide opportunities for social interactions, relaxation, recreation, cultural activities and they facilitate PA behaviors such as walking, cycling, running, and sports (e.g. soccer)Lee et al., 2015) , it is likely that different types of NE are used for different types and intensities of PA. To assess these hypotheses, a detailed examination of specific PA behaviors across various types of NE is necessary. However, the majority of previous studies has focused on green spaces in general, or isolated only one type of NE: mostly parks, or less frequently, coastal areas (e.g. Bancroft et al., 2015; Cohen et al., 2007; Evenson et al. 2013; Han et al., 2013; McCormack et al., 2010; Schipperijn et al., 2013; Shores and West, 2010; Stewart et al., 2016; Veitch et al., 2013; White et al., 2014).

Besides typology, it is assumed that the size of NE may also be related to how these environments are used for PA (Lee et al., 2015; Peschardt, Schipperijn en Stigsdotter 2012). For example, small inner-

* Corresponding authorUtrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands.
E-mail addresses: f.m.jansen@uu.nl (F.M. Jansen), d.f.ettema@uu.nl (D.F. Ettema), c.b.m.kamphuis@uu.nl (C.B.M. Kamphuis), frank.pierik@tno.nl (F.H. Pierik), m.j.dijst@uu.nl (M.J. Dijst).

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city public green spaces seem to be used for social activities and relaxation more often than for PA (Peschardt et al., 2012), whereas larger NE may be settings in which people engage in PA more often. However, evidence is largely missing and it is a first step is to describe how NE of various sizes are used for different PA behaviors. Insight in this is necessary to allow urban planners to make informed decisions about the PA behavior they wish to facilitate when designing the environment (Elliott et al., 2015).

A methodological limitation of previous studies on PA and NE, is the use of self-report measures to determine levels of PA and concurrent locations. The availability of newer technologies and measurement methods (i.e. accelerometer and GPS) provides more options to accurately assess context specific PA behavior (Bancroft et al., 2015; Koohsari et al. 2015) and improves the quality of such studies (Bancroft et al. 2015; Schipperijn et al., 2013). Some studies that used accelerometers and GPS-devices compared PA locations and included various types of NE, such as overall green space, parks, green verges, gardens and beaches Coombes et al., 2013; Lachowycz et al., 2012). These studies were however conducted among children, whereas there is a lack of evidence for adults (Stewart et al., 2016).

This study adds to current literature by using accelerometers and GPS-devices to investigate different PA intensities and modalities in various NE with different sizes, among an adult population (45–65 years). This study aims to provide insight in the different PA behaviors according to modality (i.e. spatially concentrated PA, walking & jogging, and cycling) and intensity (i.e. sedentary behavior, light PA and moderate-to-vigorous PA) that occur in different NE (i.e. according to typology and size), and to examine the associations of size and type of NE, with PA intensity and PA modality.

2. Methods

2.1. Study design, setting, participants

This cross-sectional study was part of the PHASE (Physical Activity in public Space Environments) project (Jansen et al., 2016). Adults aged 45–65 years were recruited from four neighborhoods in Rotterdam (623 652 inhabitants) and Maastricht (122 397 inhabitants), the Netherlands. These four neighborhoods, two in Rotterdam (Oude Noorden and Kralingen-West) and two in Maastricht (West and Zuid-Oost), differed in presence of green space, distance to the city center, and population density, to increase variations in exposure to (natural) environments. Adults' home addresses (N =14889) were randomly selected from the municipal population registers of Rotterdam and Maastricht. An information letter, in which one was asked to participate in the study, was sent to each adult of the selected sample. Those who were willing to participate could register through a website or by telephone (N =516 adults registered). After registration, researchers contacted the participants by phone or e-mail to plan the accelerometer and GPS-logger distribution. Trained staff members distributed the devices and explained monitor wear to participants (N =406) in community centers on weekday evenings. One community center per neighborhood was selected, to ensure short travel distances for participants. Sheets with a summary of monitor wear instructions were provided. Data collection occurred from April 2014 to December 2014. Participants signed informed consent. Analyses included data of 279 participants (175 Maastricht, 104 Rotterdam) after applying criteria for valid data (see below). The study was conducted with approval of the institutional review board of the faculty of Social and Behavioural Sciences of the Utrecht University.

2.2. Measures

The outcome measure was 'PA behavior during NE visits'. To measure PA behavior as well as the locations in which the behaviors occurred, participants were asked to wear an Actigraph GT3X+ accelerometer (Actigraph, Pensacola, Florida) and a BT-Q1000XT GPS-device (QStarz International Co) for seven consecutive days during waking hours. Both devices were attached to an elastic, adjustable belt which participants were asked to wear on the right hip. GPS-devices and accelerometers provided data for every 5 s.

2.2.1. Accelerometer data

Accelerometer data were downloaded using Actilife v6.11.2 (Firmware 2.2.1, Actigraph), and triaxial counts were summed as counts per minute (cpm). Consecutive zero strings of ≥90 min were defined as non-wear episodes, which is similar to other Actigraph accelerometer studies with samples of approximately similar age range (e.g. Berkemeyer et al., 2016; Jefferis et al., 2014). Short interruptions of up to 2 consecutive minutes of 1–100 counts per minute (cpm) were allowed as non-wear time to account for the possibility of accidental monitor movements (e.g. a monitor being disturbed while left on a table) (Jefferis et al., 2014). Vector magnitude cut-points, that were developed for similar age groups, were used to define 4 intensities of PA: sedentary behavior (< 150 cpm), light PA (150–3208 cpm), moderate PA (3208–8564 cpm) and vigorous PA (≥8565 cpm) (Carr and Mahar, 2012; Santos-Lozano et al., 2013). Moderate PA and vigorous PA were summed to moderate-vigorous PA (MVPA). We used the 70/80 rule to define a valid day (Catellier et al., 2005). Therefore, we calculated the time during which ≥70% of participants wore the accelerometer device: 611 min in this study. A day was considered valid if ≥80% of this episode had non-missing counts (488.8 min). If participants had ≥4 of such valid days, their data were included in analyses (Bento et al., 2012).

2.2.2. GPS data

GPS data were downloaded using QStarz QTravel software (v1.45, QStarz International Co). All GPS data-points that were measured on valid days were uploaded in ArcMap 10.2.2 (Esri, Redlands, California). Since only data on land use of the Netherlands was available (available from Dutch Statistics, 2012), data-points lying in other countries were excluded (about 4% of the data). For each data-point it was determined in which type of land use it was located. Only data-points that lay in NE were selected for this study. Based on the land use data we labelled each data-point with the NE type and NE size in which it occurred. Five different types of NE were distinguished: 'parks' (e.g. city parks, children's farm), 'recreational area' (e.g. zoo, playground, picnic places), 'agricultural green' (e.g. grassland, orchard), 'forest & moorland' (e.g. forest, moorland, dunes), and 'blue space' (e.g. lakes, rivers, water in parks, seas). ArcMap was used to calculate the size (i.e. surface) of each NE. SPSS 23.0 was used to calculate quartiles of NE size (i.e. so that each size category had an approximately equal number of visits). The cut points were rounded to: 3 ha, 7 ha, and 27 ha.

Besides, GPS-data were also used to classify PA behavior during NE visits into three categories of modality: 'spatially concentrated PA' (i.e. PA in one place, e.g. gardening), 'walking & jogging', and 'cycling'. A spatially concentrated activity was defined as a cluster of successive data-points that occurred within a range of 150 m or less, a maximum speed of 3 km/h, and a duration of ≥2 min. Spatially concentrated activities may thus include sedentary behavior (e.g. sitting on a bench in a park), but also include (sporting) activities (e.g. volleyball, soccer). Non-spatially concentrated activities were defined as clusters of successive data-points with a minimum length of 100 m, an average speed of ≥3 km/h, and a duration of ≥1 min. If the speed of GPS data-points was < 12 km/h, modality was set to 'walking & jogging', and if the speed of the GPS data-points was ≥12 and < 25 km/h, modality was set to 'cycling'. For each day of each participant, consecutive GPS data-points linked to a NE area of similar size and type were clustered and considered as one NE visit. However, if the time difference between GPS data-points of similar size and type of NE was 5 min or more, these data-points were assigned to separate visits. Then, the