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Energy expenditure on recreational visits to different natural environments

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ABSTRACT

Physical inactivity poses a significant challenge to physical and mental health. Environmental approaches to tackle physical inactivity have identified natural environments as potentially important public health resources. Despite this, little is known about characteristics of the activity involved when individuals visit different types of natural environment.

Using Natural England's Monitor of Engagement with the Natural Environment Survey, we examined 71,603 English respondents' recreational visits to natural environments in the past week. Specifically, we examined the intensity of the activities they undertook on the visits (METs), the duration of their visit, and the associated total energy expenditure (MET minutes).

Visits to countryside and urban greenspace environments were associated with more intense activities than visits to coastal environments. However, visits to coastal environments were associated with the most energy expenditure overall due to their relatively long duration. Results differed by the urbanity or rurality of the respondent's residence and also how far respondents travelled to their destination.

Knowledge of what types of natural environment afford the highest volumes and intensities of physical activity could inform landscape architecture and exercise prescriptions. Isolating activity-supporting characteristics of natural environments that can be translated into urban design is important in providing physical activity opportunities for those less able to access expansive environments.

1. Introduction

Despite widespread evidence that physical activity (PA) can reduce the risk of coronary heart disease, cancers, diabetes, and obesity (The National Institute for Health and Care Excellence, 2008), and enhance mental well-being (Downward and Dawson, 2015; Ekkekakis, 2015), physical inactivity is one of the leading risk factors for death worldwide (World Health Organization, 2009). Economically, inactivity is estimated to cost the UK National Health Service almost £1 billion each year (Scarborough et al., 2011). The scale of the issue warrants ecological approaches concerning environmental supports for PA (Hunter et al., 2015). Natural environments have been identified as having much potential for promoting and eliciting recreational PA (Hartig et al., 2014; Ward Thompson, 2013).

One way this has been investigated is through examining access to natural environments and corresponding PA levels. Lachowycz and Jones (2014) found that people living in greener areas of England report more days per week of walking for at least 30 min. Conversely, residents from an English city demonstrated no relationship between living distance from a park and whether or not they did five or more sessions of walking or aerobic PA in the last week (Panter and Jones, 2008). As Hillsdon et al. (2006) note, inconsistency in such studies is rife and this may be because studies can often only account for the presence and proximity of greenspace, and not whether it is actually visited. However, some cross-sectional studies do address this omission. For example, Coombes et al. (2010) found a positive association between visiting greenspace at least once in the last week and the likelihood of achieving recommended PA guidelines. Nonetheless, from this type of evidence, it is still not possible to discern whether health-enhancing

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PA is performed in greenspace. This needs to be established if natural environments are to be considered public health resources as opposed to a preferred visit destination of more active people.

Studies now examine PA in situ using global positioning systems and are often conducted with children (e.g. Wheeler et al., 2010). However, one study observing parent–child pairs found that both the parent and child spent around 20% of their time jointly engaged in moderate-to-vigorous PA (MVPA; ≥3 METs for adults, ≥4 METs for children) in open spaces such as parks, gardens and beaches (Dunton et al., 2013). Additionally, in a sample of American adults, only 8.2% of all moderate and 9.4% of all vigorous activity took place in parks (Evenson et al., 2013). Whilst the former study shows that diverse natural environments can promote MVPA, it cannot determine what environments are associated with what activities. The latter study shows modest associations, but only examines one type of environment (parks). Public health policymakers interested in environmental supports for PA may need to know which types of environment are most beneficial for supporting physical activity (Lee and Maheswaran, 2011) but the above literature is not able to inform on this. Some studies suggest that more expansive environments such as forests (Mitchell, 2013) and coasts (White et al., 2014) are used specifically for physical activity, but the type and duration of this activity is still unknown.

1.1. Present study

The present study addresses limitations with the above literature using the Monitor of Engagement with the Natural Environment Survey (MENE; Natural England, 2015); a dataset concerning recreational visits to natural environments. Using this, it is possible to determine the type and quantity of PA conducted in different environments using estimates of energy cost (METs) and duration, the absence of which has formed an important limitation previously (Mitchell, 2013). The central research question for this study was what types of natural environment are associated with recreational visits involving higher intensity activities, longer visit durations, and higher energy expenditure? Considering that relationships between greenspace and health are moderated by urbanity (Mitchell and Popham, 2007), a subsidiary question was how do the relationships between environments and energy expenditure differ between individuals from rural and urban areas? Lastly, considering recent research suggesting that coastal residents directly use the coastline in order to achieve higher levels of PA (White et al., 2014), the final research question was how does the relationship between environments and energy expenditure vary with the distance travelled to the destination?

2. Methodology

2.1. Sample

MENE is an ongoing survey using a cross-sectional, representative sample of English adults (aged 16 and over) that concerns recreational visits to natural environments (Natural England, 2015). Data is collected throughout the year via in-home interviews with a weekly quota sampling method and respondents report details concerning their visits to natural environments in the last week. All responses were recorded using a Computer Assisted Personal Interviewing (CAPI) device. Once respondents had provided brief details of all visits made in the last week, the CAPI device randomly selected one visit for the interviewer to ask more detailed questions about. The aim of random selection at the point of interview was to reduce potential biases such as recency effects for recall. The data used in the current paper concern this randomly selected visit. Individual-level variables such as self-reported PA, age and gender are also surveyed. Several inclusion criteria existed for this study (consult Supplementary Table A for details). Data from 2009 to 2014 were used and the overall sample size was 71,603.

2.2. Outcomes

2.2.1. Activity intensity

The first outcome variable was the *intensity* of the activity reported. Every respondent chooses an activity that they did on their visit from a predefined list. MET rates were ascribed to each activity. One MET is equivalent to a standard resting metabolic rate (RMR) of 3.5 ml O_2 kg^{-1} min^{-1} (3.5 mL of oxygen consumption per kilogram of body weight of the individual per minute engaged in the activity). METs are then a ratio of the work metabolic rate to this standard RMR. MET scores were derived from the compendium of physical activities (Ainsworth et al., 2011) and have been used frequently in cross-sectional analyses of recreational PA (e.g. Yu et al., 2011). Where multiple activities in the compendium could relate to the activity in the survey, an average MET score was used. For example the activity 'walking with a dog' is 3.0 METs and derived from one activity in the compendium (walking the dog), whereas the activity 'beach, sunbathing or paddling' is 1.9 METs and averaged across two activities in the compendium (lying quietly, doing nothing; water walking, light effort, slow pace).

2.2.2. Duration of visit

The survey records the duration of all visits using the following question:

> *"How long did this visit last altogether –that is from the time you left to when you returned?"*

It is clear that respondents could interpret this question in different ways. Firstly, they could report, as asked, the duration of their entire visit including travel to and from their start point. It could be that the respondents only travelled one-way before moving elsewhere. However, we argue that most respondents interpreted this question as the amount of time spent *in* the natural environment, excluding *all* travel time. This is because in many cases, respondent's reported travel distance and visit duration are incompatible (e.g. travelling 80–100 miles, but only reporting a duration of an hour). Nevertheless, as different interpretations are possible, we separate the findings into different models: Model 1 assumes the respondents reported duration as intended, potentially including travel time. Model 2 subtracts an estimate of the duration spent travelling to and from the destination and omits respondents who report incompatible travel times and durations. Model 3 subtracts a one-way estimate of travel time, again omitting respondents with incompatible travel times and durations. Additionally, a model is presented whereby only respondents who walked to their destination within 5 miles of their start point, and who undertook walking (or walking with a dog) as their chosen activity, were included. As well as representing the most common visit, it would not be of concern that duration included travel time, as this also represents time being physically active. In this sense, it acts as a robustness check and is henceforth referred to as the "walkers only" model. For further details as to how these models were constructed, consult Supplementary Table B.

2.2.3. Energy expenditure

The final outcome variable concerned total energy expenditure. Following earlier work (e.g. Rind and Jones, 2011), MET minutes were calculated by multiplying the MET rate by the duration of the visit (using all models detailed above).