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Associations of neighborhood environmental attributes with adults' objectively-assessed sedentary time: IPEN adult multi-country study

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ABSTRACT

Neighborhood environmental attributes have been found to be associated with residents' time spent walking and in physical activity, in studies from single countries and in multiple-country investigations. There are, however, mixed findings on such environmental relationships with sedentary (sitting) time, which primarily have used evidence derived from single-country investigations with self-reported behavioral outcome measures. We examined potential relationships of neighborhood environmental attributes with objectively-assessed sedentary time using data from 5712 adults recruited from higher and lower socio-economic status neighborhoods in 12 sites in 10 countries, between 2002 and 2011. Ten perceived neighborhood attributes, derived from an internationally-validated scale, were assessed by questionnaire. Sedentary time was derived from hip-worn accelerometer data. Associations of individual environmental attributes and a composite environmental index with sedentary time were estimated using generalized additive mixed models. In fully adjusted models, higher street connectivity was significantly related to lower sedentary time. Residential density, pedestrian infrastructure and safety, and lack of barriers to walking were related to higher sedentary time. Aesthetics and safety from crime were related to less sedentary time in women only. The predicted difference in sedentary time between those with the minimum versus maximum composite environmental index values was 71 min/day. Overall, certain built environment attributes, including street connectivity, land use mix and aesthetics were found to be related to sedentary behavior in both expected and unexpected directions. Further research using context-specific measures of sedentary time is required to improve understanding of the potential role of built environment characteristics as influences on adults' sedentary behavior.

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1. Introduction

High volumes of sedentary (sitting) time can be associated – after accounting for moderate-to-vigorous activity – with premature mortality and other health problems (Chau et al., 2013; Biswas et al., 2015). Adults can spend a majority of their waking hours sitting (Healy et al., 2007; Matthews et al., 2008). Recent evidence indicates that the greatest risk of mortality from sitting time is among adults who are in the top sedentary quartile but who are also physically inactive (Ekelund et al., 2016).

If broad-based changes in sedentary time are to be pursued, environmental and policy initiatives will be required (Sallis et al., 2016; Giles-Corti et al., 2015). Similar to associations observed between aspects of the built environment and physical activity (Sallis et al., 2016), sedentary behavior may be influenced by surrounding environmental conditions. It is possible, for example, that neighborhood environments that are unsafe, or have low walkability, may lead to less leisure-time physical activity and thus more time spent in TV viewing and other sedentary indoor engagements. For example, aesthetics have been found to be associated with lower levels of sedentary time (Van Dyck et al., 2012), while higher levels of perceived safety and the presence of street lighting have been associated with lower levels of TV viewing among Belgian (Van Cauwenberg et al., 2014) and Hong Kong older adults (Barnett et al., 2015). Evidence for associations with walkability characteristics is more mixed. Some studies have found walkability features, including residential density, to be associated with higher levels of sedentary time (Van Dyck et al., 2012; Van Dyck et al., 2010), while others have observed associations with lower levels of TV viewing time among women (Sugiyama et al., 2007).

Some of these associations may be gender-specific — two studies have found neighborhood aesthetics (Strong et al., 2013) and perceptions of safety concerns (Van Dyck et al., 2012; Strong et al., 2013) to be associated with higher levels of TV viewing and overall sitting time among women only. Similarly, research from Australia has found that residential density and access to transit stops were associated with less sitting time, but only for women (Foster et al., 2015).

While there is some evidence suggesting potential associations between perceptions of the built environment and sitting time, a recent review concluded that the pattern of associations within the published studies was modest and inconsistent (Koohsari et al., 2015). In addition, some more recent studies assessing associations between objective measures of the environment and sedentary time have failed to identify significant associations (Compernolle et al., 2017; van Nassau et al., 2015; Hinckson et al., 2017). The inconsistent relationships between environmental attributes and sedentary behavior may be because such relationships are less direct and strong than are those for physical activity. It is also possible that non-significant or weak associations reported in single-country studies may be due partly to limited variation in environmental attributes. With the exception of two multi-country studies (Van Dyck et al., 2012; Compernolle et al., 2017), the evidence on perceived environmental correlates of sedentary behaviors arises from single countries. Studies involving multiple countries can fill this gap by providing broader environmental variance (Cerin et al., 2013). Previous literature has also often employed self-report measures of sedentary time (Koohsari et al., 2015), which often have poor accuracy and precision (Chastin et al., 2018). Research employing objective measures of sedentary time potentially can provide more robust evidence on environmental correlates (Owen, 2012).

The primary aim of the present study was to identify potential associations of perceived neighborhood environmental attributes with accelerometer-derived overall sedentary time across 10 countries. To assess variation between countries, we examined overall and site-specific associations. Gender-specific associations were also assessed based on previous research suggesting possible gender differences (Sugiyama et al., 2007; Strong et al., 2013; Foster et al., 2015). In light of some inconsistent associations between environmental attributes and sitting time in previous studies (Koohsari et al., 2015), we hypothesised that positive perceptions of neighborhood environmental attributes supporting physical would be negatively associated with sedentary time.

2. Methods

2.1. Study design

The IPEN (International Physical Activity and the Environment Network) Adult study is an observational, epidemiologic, multi-country, cross-sectional study, including 17 city-regions (hereafter, 'sites') located within 12 countries worldwide: Australia (Adelaide), Belgium (Ghent), Brazil (Curitiba), Colombia (Bogota), Czech Republic (Olomouc, Hradec Kralove), Denmark (Aarhus), China (Hong Kong), Mexico (Cuernavaca), New Zealand (North Shore, Waitakere, Wellington, Christchurch), Spain (Pamplona), the United Kingdom (Stoke-on-Trent) and the United States (Seattle, Baltimore). For the present analyses, data were included from 12 sites in 10 countries (excluding Australia and New Zealand) that used ActiGraph accelerometers.

Study participants were recruited from neighborhoods chosen to maximize variance in neighborhood walkability and income. For selection of neighborhoods, all countries but one (Spain) used a neighborhood walkability index that was measured objectively with Geographic Information Systems (GIS) data at the smallest administrative unit available. The neighborhood-selection techniques employed in each country can be found elsewhere (Kerr et al., 2013). For every administrative unit across study sites, the walkability index was derived as a function of at least two of the following variables: net residential density, land use mix and intersection density. In four countries, retail floor area ratio was also included in the index as a proxy for pedestrian-oriented design. The walkability index is described in more detail elsewhere (Cerin et al., 2008; Frank et al., 2010). In each country, administrative units were ranked based on the walkability index and household-level income data from the census; the selection procedure resulted in an equal number of neighborhoods among four pre-specified types (quadrants), stratified as follows: high-walkable/high-income, high-walkable/low-income, low-walkable/high-income, and low-walkable/low-income.

2.2. Participant recruitment

IPEN used a systematic strategy to recruit participants. Random samples of adults (aged between 18 and 66 years) living in the selected neighborhoods were contacted and invited to wear an accelerometer for objective physical activity assessment. Three countries recruited and conducted data collection by phone and mail/online surveys and six countries visited participants in person to deliver study materials. In Hong Kong, intercept interviews were conducted in residential areas where individual addresses were not available (e.g., high-rise apartments). Study dates ranged from 2002 to 2011. Further details on the participant recruitment techniques and response rates across countries can be found elsewhere (Kerr et al., 2013).

Of the 9065 potential participants, 3100 were not part of the accelerometer subsample per country or had missing accelerometer data and 253 had less than four valid (at least 10 wearing hours) days of data, yielding a final sample of 5712. Compared to potential participants who were excluded, those with valid accelerometer data were more likely to be older ($p < .001$), married or in a de facto relationship ($p < .001$), employed ($p = .014$), and living in neighborhoods perceived to have higher levels of safety from crime ($p = .037$). The sociodemographic characteristics of the sample with valid accelerometer data, by study site, are presented in Table 1.