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Objective versus subjective measures of the built environment, which are most effective in capturing associations with walking?

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ABSTRACT

This study compared the strength of association of objective and subjective measures of environment with walking sufficiently for health. It used an existing model, which employed only objective environmental measures and adjusted for socio-demographic covariates, to estimate the influence of the built environment on walking. The original model was re-run with new, subjectively measured variables. The results showed that objective measures of the built environment had stronger associations with walking than subjective measures. Future studies of the environmental influences on physical activity should include objective measures of the built environment.

1. Introduction

Walking is increasingly considered an effective and popular means of enhancing levels of physical activity for the majority of the population (Simpson et al., 2003). Research has shown that active life styles are influenced not only by who people are, but also by where they live and work. The determinants of walking, and especially the determinants associated with amounts of walking that contribute to health—at least 30 min on most days of the week (United States Department of Health and Human Services, 1996)—are many. Typically, analyses of these determinants rely on social ecologic approaches, which consider several levels of influence, ranging from intrapersonal factors; interpersonal processes; institutional, community, and environmental factors; to public policy (McLeroy et al., 1988; Sallis and Owen, 2002).

Studies that examined associations between attributes of the built environment and levels of physical activity measured environmental variables subjectively, objectively, or in combination. Generally, subjective measures were self-reported perceptions of environment obtained from survey questionnaires (Wilbur et al., 2003; Humpel et al., 2004b). Objective measures came from data collected in the field (Hoehner et al., 2005; de Vries et al., 2007) or from existing land use data bases available in GIS (Lee and Moudon, 2006). The majority of the studies showed that a number of built environment attributes, measured both objectively and subjectively, were related to levels of physical activity, including walking (Handy et al., 2002; Saelens et al., 2003b; Lee and Moudon, 2004; McCormack et al., 2004). A meta-analysis study also concluded that the perceived environment had a modest, yet significant association with physical activity (Duncan et al., 2005). In spite of the methodological importance given to measurement type (Saelens et al., 2003b), research conducted to date has provided little guidance regarding the relative effectiveness of subjectively or objectively measured attributes of the built environment in estimating its influence on physical activity, and on walking in particular.

1.1. Aims

This study compared the strength of association of objective and subjective measures of environment used either separately or jointly, with walking sufficiently for health.

1.2. Previous studies

We reviewed the literature on neighborhood built environment and levels of physical activity in order to summarize the environmental attributes used in previous studies and to compare systematically how these attributes were measured. We

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identified 47 studies published between 2002 and October 2008, which met three selection criteria: they used the neighborhood as the coarsest geographic unit of analysis; they considered attributes of the built environment inclusively of residential, commercial, and recreational activity; and one or more built environment variables were significantly related to physical activity. Twenty-four studies published until 2004 were identified from five literature reviews published between 2002 and 2005 (Humpel et al., 2002; Lee and Moudon, 2004; McCormack et al., 2004; Owen et al., 2004; Duncan et al., 2005). Nine additional studies published from 2005 through May 2006 came from a 2008 review of built environment correlates of walking (Saelens and Handy, 2008). Finally, we found 14 additional studies by searching PubMed and TRIS (Transportation Research Information Services) electronic databases, which were published since 2005 and until October 2008 (King et al., 2005; Weir et al., 2006; Berke et al., 2007; Cerin et al., 2007; Evenson et al., 2007; Granner et al., 2007; McGinn et al., 2007; Moudon et al., 2007; Owen et al., 2007; Scott et al., 2007; Tilt et al., 2007; Frank et al., 2008; McCormack et al., 2008; Rodriguez et al., 2008). Search terms employed were walking, physical activity, active travel, active transport, environment, and built environment.

Eighteen of the 47 studies reviewed used subjective measures of the built environment, 11 used objective measures, and 18 used both types of measures (Table 1). The Behavior Model of Environment (BME) proposed by Moudon and Lee (2003) served to classify the environmental variables that were found to be significantly related to levels of physical activity and walking (Table 2). The BME characterized the built environment into three components associated with people walking and being active: (1) the origins (O) and destinations (D) of the walk trips; (2) the routes (R) taken; and (3) the characteristics of the areas (A) where physical activity took place. Columns A and B in Table 2 classify the measures according to the components of the BME and to the common names given to built environment attributes. Columns C and E list the built environment variables used in the studies. Columns D and F list the individual studies that employed the measures. Overall, the variables covered all components of the BME. The studies isolated 19 subjectively and 22 objectively measured environmental variables that were significant.

Comparing subjective and objective measures of the environmental attributes used in the 47 studies revealed interesting patterns. About one third of the variables employed had been measured both subjectively and objectively by different studies. The majority of studies used subjective environmental measures, ostensibly because the data could be more economically obtained than those of field-collected objective measures, or because detailed objective land use data in GIS had yet to be commonly accessible. However, it appeared that subjective measures would require or could benefit from checks for within-subject and between-subject agreements (Rivara et al., 1989). For example, variables capturing "accessibility to or convenience of destinations" were found to be significant in 22 studies (Booth et al., 2000; Ball et al., 2001; Rutten et al., 2001; Troped et al., 2001; Giles-Corti and Donovan, 2002a, 2002b; de Bourdeaudhuij et al., 2003; Huston et al., 2003; King et al., 2003, 2005; Troped et al., 2003; Humpel et al., 2004c; Duncan and Mummery, 2005; Li et al., 2005; Handy et al., 2006; Krizek and Johnson, 2006; Cerin et al., 2007; Moudon et al., 2007; Scott et al., 2007; Tilt et al., 2007; McCormack et al., 2008; Rodriguez et al., 2008), 16 of which measured the variable subjectively (see Table 2). We found the definitions of subjective measures of "accessibility to or convenience of destinations" to be inconsistent across studies due to the different study contexts (including geographic locations, measures used for walking, etc.) and the distinct survey questionnaires using different characterizations of walking. These differences not only hindered comparisons across studies, but also lacked instructive information for policy implications. The mechanisms shaping how and why individual perceptions were formed needed to be explicated before environmental change could be conceptualized. In contrast, objective environmental measures had the advantage of facilitating the translation of study results directly into intervention strategies. Furthermore, objective measures could serve as a tangible and measurable counterpart to self-report measures, helping clarify or even corroborate the meaning of the self-report measures, and possibly justifying the value of using both types of measurements. These considerations might have been the impetus behind the noted increase in the number of studies using objective measures of the built environment since 2006 (13 out of 16 studies). Overall, the

Table 1
Summary of studies of physical activity and the built environment by type of measurement and in chronological order.

	Studies including objective measures of built environment only	Studies including subjective measures of built environment only	Studies including both subjective and objective measures of built environment
1	Cervero and Kockelman (1997)[a]	Booth et al. (2000)[a]	Troped et al. (2003)[a]
2	Craig et al. (2002)[a]	King et al. (2000)[a]	Handy and Clifton (2001)[a]
3	Rodriguez and Joo (2004)[a]	Brownson et al. (2001)[a]	Giles-Corti and Donovan (2002b)[a]
4	Giles-Corti et al. (2005)[b]	Rutten et al. (2001)[a]	Giles-Corti and Donovan (2002a)[a]
5	King et al. (2005)[c]	Ball et al. (2001)[a]	Ewing et al. (2003)[a]
6	Frank et al. (2006)[b]	King et al. (2003)[a]	Giles-Corti and Donovan (2003)[a]
7	Krizek and Johnson (2006)[b]	Saelens et al. (2003a)[a]	Troped et al. (2003)[a]
8	Berke et al. (2007)[c]	Ainsworth et al. (2003)[a]	Duncan and Mummery (2005)[b]
9	Owen et al. (2007)[c]	Wilbur et al. (2003)[a]	Hoehner et al. (2005)[b]
10	McCormack et al. (2008)[c]	de Bourdeaudhuij et al. (2003)[a]	Li et al. (2005)[b]
11	Frank et al. (2008)[c]	Huston et al. (2003)[a]	Handy et al. (2006)[b]
12		Addy et al. (2004)[a]	Lee and Moudon (2006)[b]
13		Humpel et al. (2004a)[a]	Cerin et al. (2007)[c]
14		Humpel et al. (2004b)[a]	McGinn et al. (2007)[c]
15		Suminski et al. (2005)[b]	Moudon et al. (2007)[c]
16		Weir et al. (2006)[c]	Scott et al. (2007)[c]
17		Evenson et al. (2007)[c]	Tilt et al. (2007)[c]
18		Granner et al. (2007)[c]	Rodriguez et al. (2008)[c]

[a] Studies published before 2004 identified from 5 literature reviews—24 studies.
[b] Studies published between 2005 and May 2006—9 studies.
[c] Studies published since 2005 and until October 2008—14 studies.