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Urban Trails and Physical Activity
A Natural Experiment

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Background: The built environment in which a person lives and works is thought to have a strong influence on his or her level of physical activity. However, this belief is largely based on cross-sectional studies underlining the need for prospective studies using natural experiments.

Design: This study adopted a quasi-experimental research design with multiple control neighborhoods and was conducted between 2005 and 2007. Data were analyzed in 2008.

Setting/participants: The subjects were children, adolescents, and adults in free-living conditions within one experimental and two control neighborhoods.

Intervention: An urban greenway/trail was retrofitted in a neighborhood that lacked connectivity of the residential pedestrian infrastructure to nonresidential destinations.

Main outcome measures: The main outcomes were 2-hour counts of directly observed physical activity in the general neighborhood and, at the school level, active transport to school.

Results: At the neighborhood level, the 2-hour counts of physical activity significantly increased between 2005 and 2007 (p=0.000) in the intervention neighborhood, with a median increase of 8.0 counts. The control neighborhoods had a significant decrease in counts (p=0.000). The pre- and post-intervention changes between experimental and control neighborhoods were significantly different for total physical activity (p=0.001); walking (p=0.001); and cycling (p=0.038). There was no noted change over time for active transport to school in either the intervention or control neighborhoods.

Conclusions: Changes to the pedestrian connectivity of the built environment infrastructure may lead to greater levels of physical activity. However, this positive effect was limited to physical activity at the neighborhood level and not to active transport to school.
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Introduction

The built environment is thought to have a strong role in facilitating or hindering physical activity across multiple domains, including transportation and leisure-time physical activity. This belief is based largely on cross-sectional research that is limited by its inability to demonstrate causal relationships.[1,2] As such, "natural experiments" using quasi-experimental research designs have been identified as the top research priority in detecting causality between the built environment and physical activity.[1,3]

In 2004, an opportunity to conduct a natural experiment presented itself in Knoxville TN to examine the impact of one aspect of the built environment, neighborhood connectivity, on physical activity. The specific intervention involved retrofitting a neighborhood with an urban greenway/trail to connect the pedestrian infrastructure with nearby retail establishments and schools. Construction of trails that encourage walking and other forms of physical activity has been shown to be associated with increased physical activity among sedentary individuals and with maintenance of physical activity among the currently active.[4–6]

A 6-month period between the announcement of the greenway/trail project and construction allowed investigators to implement a quasi-experimental research design with baseline (2005) and post-intervention (2007) assessments. Direct observation of physical activity was

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used to examine whether improvements in the built environment causes increases in physical activity, in both neighborhood and school settings, in the intervention and control neighborhoods. Direct observation of physical activity in public places provides contextually rich data and has been successfully used in built environment studies.[7–12]

Methods

The study utilized a quasi-experimental multiple-control neighborhood research design to explore causal relationships between the built environment and physical activity.[13] Specifically, the methodology was designed to detect changes in directly observed physical activity at the neighborhood level after exposure to an improved pedestrian infrastructure that enhanced connectivity to retail and school destinations. The research design was planned around the start of greenway/trail construction (May 2005) in the intervention neighborhood. Pre-intervention assessment of directly observed physical activity occurred in March 2005, with follow-up observation in March 2007. The construction of the greenway/trail ended in December 2005, allowing a 14-month exposure before the post-intervention assessment.

Intervention and Control Neighborhoods

The Knoxville–Knox County Metropolitan Planning Commission first identified the intervention neighborhood in 1995 as a "special planning opportunity area" for retrofitting existing physical assets of the built environment to achieve a "true urban village form."[14] The neighborhood was well established, characterized by a mix of residential and commercial uses, including apartments, condominiums, single-family homes, privately owned stores, large franchises, specialty shops, restaurants, three public schools, churches, and a post office. Because of the unfriendliness of the pedestrian environment, the planning committee recommended retrofitting the neighborhood with an urban greenway/trail, with the intent to provide pedestrian-friendly links among residences, businesses, schools, and other public spaces. Construction of the 8-foot-wide and 2.9-mile-long asphalt greenway cost $2.1 million.[15,16]

At baseline, the intervention neighborhood was characterized by a population density of 2590 people per square mile; 2207 occupied housing units; 17.7% minority ethnicity; 10.9% elderly (aged ≥65 years); 32.2% living in poverty; and with 9.6% of intersections connected by three or more street segments.[17] Investigators identified five candidate neighborhoods that matched the intervention neighborhood along socioeconomic dimensions, and two control neighborhoods were selected. Table 1 provides data on socioeconomic measures in these neighborhoods.

Table 1. Socioeconomic measures comparing experimental and control neighborhoods based on 2000 U.S. Census data (% unless otherwise indicated)

Socioeconomic measure	Experimental neighborhood	Control neighborhoods[a]
Less than high school education	9.3	9.7
Black	6.9	5.4
Unemployed	5.6	4.4
Female	50.2	53.0
Houses with mortgages	63.5	63.0
Median year house built	1950	1967
Median age (years)	30.0	39.5
Median household income ($)	36,563	50,612

[a]For each socioeconomic measure, Table 1 presents the mean value across two control neighborhoods.

Direct Field Observation of Physical Activity

Direct observation of physical activity, at both the neighborhood and school levels, was conducted during the 4th week of March in 2005 (pre-intervention) and 2007 (post-intervention) by trained research assistants. Training consisted of 4 hours of classroom and in-field instruction focusing on identifying valid physical activities, coding schemes, and data-entry procedures. The University of Tennessee IRB approved both the direct observation protocols, and research review board of the Knox County Schools approved the school-level direct observation protocol.

Neighborhood-level direct observation, based on the pedestrian count survey methodology,[11] was conducted for 2 hours each in the morning (7:00–9:00AM); midday (11:00AM–1:00PM); and evening (4:00–6:00PM) on 2 days (Wednesday and Saturday). In each neighborhood, research assistants (in teams of two) were positioned unobtrusively at a location that provided distinct views of physical activity. The locations, days, and times were consistent across study years. Direct observation protocol included contingency plans for inclement weather. However, no weather-related factors impeded neighborhood-level direct observation. Research assistants recorded counts of pedestrians, cyclists, and individuals performing other forms of physical activity (e.g., skateboarding).

School-level direct observation, which followed the protocol developed by Suminski and colleagues,[12] was conducted for 2 days (Tuesday and Thursday) during the hours of 7:00–9:00AM and 2:30–4:00PM in order to best capture active transport to school (ATS). Permission from each respective school principal (Intervention: two elementary and one high school; Control: two elementary and one middle school) was secured in order to identify the best locations for unobtrusive observation. Because of the multiple corridors of possible ATS at each school, one research assistant was positioned at each location, with two to four assistants in total at each school. Research assistants recorded the number of school-aged youth observed in ATS.

Statistical Analysis

The count-level data generated through direct observation in the present study possessed both non-normal distributions and outliers. Therefore, analysis utilized a series of nonparametric tests conducted in SAS, version 9.2. The analysis used Fisher's exact tests to detect statistically meaningful relationships among the counts of physical activity observed (1) in the experimental and control areas during the same year and (2) in the same neighborhood between the pre- and post-intervention periods. The Wilcoxon rank sums test was used to compare changes in physical activity during the study period between the experimental and control areas.

Results

Figure 1 presents the 2-hour physical activity counts observed in the experimental and control neighborhoods. At baseline (2005), there was no significant relationship between the 2-hour total physical activity counts in the experimental and control neighborhoods (p=0.370). Focusing on pedestrian- and cycling-specific physical activity yielded similar findings (p=0.176 for walkers, p=0.060 for cyclists). However, at follow-up (2007), the 2-hour count of total physical activity was significantly (p=0.028) higher in the experimental neighborhood than in the control neighborhoods. This significant difference was also noted among walkers (p=0.002) and cyclists (p=0.036).

In the experimental neighborhood, the 2-hour physical activity counts increased between pre- and post-intervention (p=0.000), with a median increase of 8 counts. If a similar increase was observed throughout the average daylight period of 12 hours per day, then a total daily increase in physical activity of 48 counts would be expected. In contrast, in the control neighborhoods, the 2-hour counts of physical activity between 2005 and 2007 decreased (p=0.000), with a median difference of –1 counts. When these pre- and post-intervention changes in physical activity counts for the experimental neighborhoods were compared to those for the control neighborhoods, the experimental neighborhoods' change in physical activity was found to be significantly different from the control neighborhoods' for pedestrian (p=0.001); cycling (p=0.038); and total physical activity (p=0.001).

The 2-hour observation counts for ATS in the experimental and control schools are presented in Figure 2. For both the pre- and post-intervention periods, ATS was generally higher in the control schools than in the experimental schools. However, this difference was significant in 2007 only (p=0.026). Wilcoxon rank sums test detected no significant difference in the pre–post intervention change in ATS for the experimental compared to the control schools (p=0.2061).

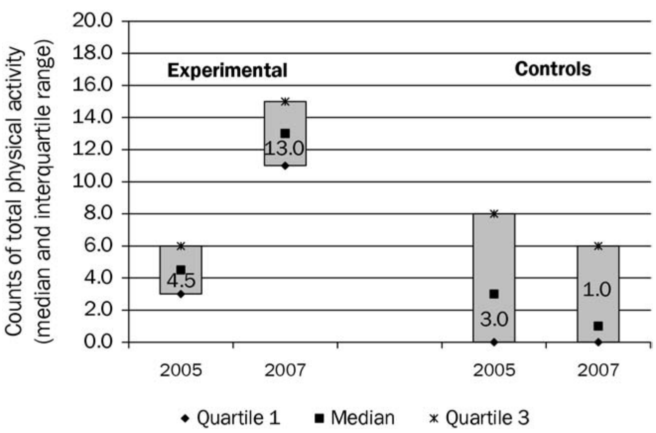

Figure 1. Two-hour counts of total physical activity (walking and cycling) observed in the neighborhood setting: pre-intervention (2005) and post-intervention (2007)

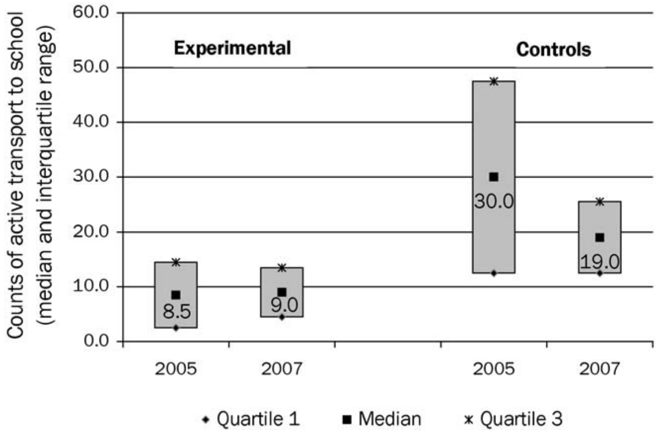

Figure 2. Two-hour counts of active transport to school: pre-intervention (2005) and post-intervention (2007)

Discussion

The current study confirms that enhancing a neighborhood's pedestrian infrastructure increases outdoor physical activity. However, the positive increase detected in the current study was limited to physical activity observed in the general neighborhood and did not extend to the school environment. Previous cross-sectional research on walking and ATS can provide some insight into these findings.

Walking for transport is positively related to neighborhood density, resident proximity to nonresidential destinations, and land use mix.[18,19] It is important to note that in the current study both the experimental and control neighborhoods were judged to have all three of these characteristics. What they failed to have at pre-intervention was street/sidewalk connectivity that would allow safe, direct routes to proximate nonresidential destinations. Street/sidewalk connectivity has not been found to be a factor consistently associated with walking.[19] However, the findings in the present study provide indirect evidence of the importance of pedestrian infrastructure connectivity in promoting physical activity at the neighborhood level.

Our finding that enhanced pedestrian infrastructure connectivity does not increase ATS reinforces current thoughts in the literature. The prevailing belief is that changes in the built environment alone are unlikely to lead to increases in ATS.[20–23] ATS has been found to be associated with multiple factors related to the parents and the school.[20,22,24,25] Many now believe that improvements in the built environment need to be reinforced with parental education to address safety concerns and perceived barriers.[22,25] In order to maintain the integrity of the current research design, the study neighborhoods were not exposed to any social marketing or awareness campaigns during the course of the study.

The present study did not permit an investigation of the types of users represented in the increased physical activity counts observed in the experimental neighborhood. However, since the greatest increase in greenway/trail users was observed among walkers, it is likely that the increased physical activity occurred among new users that lived within the neighborhood. It is possible, however, that some of the greenway/trail users in the present study, especially those observed cycling, originated from outside the neighborhood, perhaps from neighborhoods close to the experimental neighborhood.[10]

A key strength of the current study is the quasi-experimental research design that used multiple control neighborhoods.[26] However, as with any community-based research, there are limitations that need to be considered when interpreting the results. First, the use of direct observation to document physical activity does not allow a distinction to be drawn between transport and leisure-time physical activity.[20] In addition, a definitive statement about causality requires accurately identified controls. Although the methods used in the current study included appropriate techniques for identifying control neighborhoods, the possibility remains that the experimental and control areas differ along unobservable dimensions.

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