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Associations of Leisure-Time Sitting in Cars with Neighborhood Walkability

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Abstract

Background. Too much sitting, including time spent sitting in cars, is associated with poor health outcomes. Identifying the built-environment attributes that may reduce vehicular sitting time can inform future initiatives linking the public health, urban design, and transportation sectors.

Methods. Data collected in 2003-2004 from adult residents (n=2521) of Adelaide, Australia were used. Logistic regression analyses examined associations of prolonged time spent sitting in cars during leisure time (30 min/day or more) with neighborhood walkability and its components (dwelling density; intersection density; land use mix; net retail area ratio).

Results. Lower overall walkability was significantly associated with a higher odds (OR=1.43, 95%CI: 1.21-1.70) of spending prolonged time in cars. For analyses with walkability components, lower net retail area ratio, lower residential density, and lower intersection density were significantly associated with prolonged sitting in cars.

Conclusion. This study found that residents of high walkable neighborhoods tended to spend less time sitting in cars. In particular, higher net retail area ratio, an indicator of tightly-spaced commercial areas, was strongly associated with less time in cars. Policy and planning initiatives to reduce car use require further evidence, particularly on the influence of neighborhood retail areas.

Introduction

Prolonged sitting time has been found to be associated with poor health outcomes, independent of leisure-time physical activity.¹⁻³ Both increasing physical activity and reducing sedentary behavior are important strategies for chronic disease prevention.⁴

Research has shown consistently time spent sitting while driving or riding in a car to be adversely associated with cardio-metabolic health outcomes. For instance, a large-scale cohort study conducted in the USA found that those who reported more than 10 hours/week riding in a car had 50% greater cardio-vascular mortality than those who reported less than 4 hours/week.⁵ Another US study reported that each additional hour per day spent in a car was associated with a 6% greater likelihood of obesity.⁶ A longitudinal study in Australia found that daily car commuters tended to gain more weight over 4 years than those who did not use a car.⁷ A study in Texas used road distance to work as a proxy measure of time spent in cars for commuting, and reported longer distance to be associated with higher BMI and waist circumference.⁸ Thus, prolonged use of a car, which is common among adults,⁹ can have detrimental effects on health.

In order to reduce sitting time in cars through policy and planning initiatives, it is important to identify environmental correlates of car use.¹⁰ Studies in the USA have shown overall neighborhood walkability (a composite measure consisting of residential density, intersection density, land use mix, and net retail area ratio) to be negatively associated with time spent in cars.^{11, 12} However, studies have reported mixed findings for specific walkability components: while residential density was consistently associated with car use,^{6, 13, 14} the roles of land use mix and intersection density in car use are not yet clear.^{6, 14} In addition, to our knowledge, no study

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has examined the impact of net retail area ratio on time spent in cars. Furthermore, the existing studies have examined associations of neighborhood walkability with general car use, which may occur largely outside one's neighborhood (e.g., commuting). We examined associations of neighborhood walkability and its components, which is more likely to take place in or near neighborhoods, with prolonged time spent sitting in cars during leisure, among adult residents of Adelaide, Australia.

Methods

Participants and procedures

This study used cross-sectional survey data from the Physical Activity in Localities and Community (PLACE) study conducted in Adelaide (population: 1.1 million). Detailed methods of data collection have been published elsewhere.¹⁵ Residential addresses were randomly selected from 154 Census Collection Districts (CCD, a geographical unit comprising of about 250 households) in the Adelaide Statistical Division. These CCDs were chosen from the neighborhoods of top and bottom quartiles in walkability, in order to have a large variability in environmental attributes.

An invitation to participate in the study was sent to the residential addresses identified, and a self-administered survey was sent to those who were eligible (20–65 years) and agreed to participate. The total number of responses was 2650. The overall response rate, as a proportion of all the households initially identified, was 11.5%. The Behavioural and Social Sciences Ethics Committee of the University of Queensland approved the study.

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Measures

The outcome variable was self-reported time spent driving or riding in a car during leisure time within the past seven days. This was calculated by multiplying the number of days participants drove or rode in a car by the average amount of time spent doing so per day. The test-retest reliability (ICC=0.85) and convergent validity (correlation with a 3-day activity log=0.4, $p<0.01$) for the item were high.¹⁶ Since the distribution of this variable was skewed, it was dichotomized using the median (30 min/day). Leisure-time car use may involve non-occupational activities such as shopping, errands, and recreation.

The independent variables were overall neighborhood walkability and its four components.^{17, 18} Residential density was the ratio of the number of dwelling units to the land area for residential use. Intersection density was the ratio of the number of intersections (3-way or more) to the land area. Land use mix was an entropy index describing the heterogeneity of land uses (residential, commercial, recreational, industrial, and other) across a CCD. Net retail area ratio was the ratio of the retail floor space to the retail parcel area. Overall neighborhood walkability (high or low) was determined using the sum of decile score for each of the four walkability components. Each walkability component was categorized into tertiles.

Participants reported their age, gender, educational attainment, work status, marital status, having children in the household, annual household income, and car ownership. Socio-economic status (SES) of each CCD was also identified using its median household weekly income, and all CCDs were dichotomized into a lower or higher SES category using the median.

Data analysis

Multilevel logistic regression, using CCD as the area-level unit of analysis, examined associations of neighborhood walkability and its components with longer time (30 min/day or more) spent in cars during leisure time, adjusting for socio-demographic variables, which may confound the relationships between walkability and prolonged time in cars. Two regression models were tested: one model examined overall walkability, while the other examined four walkability components (entered simultaneously), with both models adjusting for the socio-demographic variables described above. Stata 11.0 (Stata Corp, College Station, Texas) was used for analysis.

Results

After excluding those who did not report time spent in cars, 2521 participants were retained for analysis. Table 1 shows the characteristics of the whole sample and for the two groups stratified by the outcome variable.

INSERT TABLE 1 ABOUT HERE

Table 2 shows the results of the multilevel logistic regression models, after adjusting for the socio-demographic variables. The models did not adjust for area-level SES as it was not related to longer sitting in univariate analysis. It was found that participants who lived in low walkable neighborhoods were about 1.4 times more likely to spend longer time (30 min/day or more) in cars during leisure time, compared to those living in high walkable neighborhoods. In the model

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examining walkability components, participants living in neighborhoods with lower residential density, lower intersection density, or lower net retail area ratio had a significantly higher odds of spending prolonged time in cars, compared to those living in neighborhoods of the top tertile in these attributes. Net retail area ratio was most strongly associated with longer sitting time in cars, but land use mix was not associated with the outcome variable.

INSERT TABLE 2 ABOUT HERE

Discussion

This study found that residents of low-walkable areas tended to spend more leisure time sitting in cars, which is consistent with previous studies.^{11, 12} The finding is also consistent with transportation research that has shown longer car driving in more sprawled areas.¹⁹ Low-walkable areas, which are typically characterized by low availability of local destinations, might compel residents to drive more.

In analysis examining specific walkability components, it was found that residential density, intersection density, and net retail area ratio had a significant negative association with time spent in cars during leisure time, while land use mix showed no significant association. Our findings mostly concur with previous studies,^{6, 13, 14} with the exception of land use mix, which was found to be unrelated to prolonged driving time in this study. Higher land use mix could be achieved without commercial land areas in our study. As lack of commercial destinations in local areas may lead to greater car use, future studies need to use a land use mix measure with relevant

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land uses to capture the impact of land use diversity on car use.²⁰ Our finding on intersection density also disagrees with Guo et al.¹⁴, which found no significant association between block size and number of car trips. Further research on the role of intersection density in residents' car travel is warranted. A novel finding of this study is the strong relevance of net retail area ratio to adults' car use. In neighborhoods with higher net retail area ratio, retail buildings may be more densely packed as they have less space (typically for parking) around them. This may make commercial destinations easily accessible via walking and discourage car use. Future research should examine attributes of neighborhood retail areas associated with car use, including the availability of parking spaces that may be associated with residents' car use.²¹

There are some limitations to our findings. First, the cross-sectional design makes it difficult to ascertain causal relationships. Longitudinal studies examining the impact of moving to high/low walkable areas can provide insight into causality. Second, despite our measure demonstrating strong reliability and validity, the use of self-reported time spent in cars may have involved error and bias. Future studies could assess time spent in cars objectively, using technologies such as global positioning systems.²² Studies could also examine whether mismatch between objective and perceived walkability (e.g., perceiving high walkable areas as low), which has been shown to be related to physical inactivity and weight gain,²³ is associated with time spent in cars. In light of the finding on net retail area ratio, the availability of parking spaces may be a plausible factor associated with residents' car use.²¹ Access to public transport and self-selection of neighborhoods are other potentially-relevant elements that were not specifically examined in this study. Lack of these potentially confounding variables is another limitation of the study.

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In summary, our study, in conjunction with previous research, suggests that high-density neighborhoods with tightly-spaced commercial areas may be conducive to less time spent in cars during leisure time. Decreasing dependency on automobiles is one of the high-priority issues in contemporary society. Considering that urban populations are expanding rapidly worldwide,²⁴ it is important to find ways to develop urban forms that help reduce dependency on private motor vehicles. An integrated, coordinated effort between public health, transport planning, and urban design sectors will be needed to achieve this goal.

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Tables

Table 1. Attributes of study participants with lower and higher levels of leisure-time sitting in cars (Adelaide, Australia, 2003-2004)

	Total (n= 2521)	Time spent in cars during leisure time		<i>p</i> ¹
		less than 30 min/day (n=1362)	30 min/day or more (n=1159)	
Age, mean (SD)	44.4 (12.3)	44.1 (12.5)	44.7 (12.1)	0.11
Gender				0.10
% women	64	65	62	
Education				0.07
% with tertiary	46	47	44	
Work status				<0.001
% working	64	60	68	
Marital status				0.03
% couple	55	53	58	
Having children in the household				<0.001
% yes	30	28	34	
Annual household income				0.01
% with \$41600 or more	48	45	50	
Car ownership				<0.001
% with no car	10	16	4	
% with 1 car	40	41	38	
% with 2 cars or more	50	43	58	
Walkability				<0.001
% living in high walkable areas	49	56	40	
SES				0.27
% living in high SES areas	53%	54%	52%	

¹ difference between the groups stratified by time spent in cars

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Table 2. Adjusted odds ratios (95% CI) of spending 30 min/day or more in cars during leisure time by overall walkability and walkability components (Adelaide, Australia, 2003-2004)

	Model for overall walkability OR (95%CI)	Model for walkability components OR (95%CI)
Walkability		
High	1	
Low	1.43 (1.21-1.70) ***	
Residential density		
Top tertile		1
Middle tertile		1.24 (1.02-1.50)*
Bottom tertile		1.35 (1.10-1.67)*
Intersection density		
Top tertile		1
Middle tertile		1.17 (0.95-1.43)
Bottom tertile		1.45 (1.18-1.79)*
Land use mix		
Top tertile		1
Middle tertile		1.15 (0.93-1.43)
Bottom tertile		1.10 (0.89-1.35)
Net retail area ratio		
Top tertile		1
Middle tertile		1.44 (1.17-1.77)*
Bottom tertile		1.63 (1.32-2.01)***

The models corrected for clustering at the CCD level and adjusted for age, gender, education, marital status, having child, income, work status, and car ownership. In the model for walkability components, all the components were mutually adjusted.

* p<0.05, *** p<0.001