Transit and Health: Mode of Transport, Employer-Sponsored Public Transit Pass Programs, and Physical Activity

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ABSTRACT

Increased provision of transit service and policy incentives that favor transit use can support a physically active lifestyle. We used the SMARTRAQ travel survey in metropolitan Atlanta, Georgia (in 2001–2002) to assess whether transit and car trips were associated with meeting the recommended levels of physical activity by using walking as a means of transportation. Additionally, we assessed associations between walking and using an employer-sponsored public transit pass. We controlled for demographics, neighborhood density, presence of services near workplaces, distance from home to transit, and car availability in our sample of 4,156 completed surveys. Walking distances from origin to destination were derived by a geographical information system and categorized as: no walking, moderate walking, or meeting recommendation (walking $\geqslant$ 2.4 km (1.5 miles) a day, approximately $\geqslant$ 30 min). In a multinomial logistic regression controlling for other covariates, transit trips were associated with an odds ratio (OR) of 3.87 (confidence interval (CI) 95%, 2.93–5.11) of meeting recommendation. In a multinominal logistical regression controlling for other covariates, transit users were associated with meeting recommendation, OR 2.23 (CI 95%, 1.27–3.90).

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INTRODUCTION

Since the 1996 publication of the US Surgeon General's report on physical activity and health (1), public health specialists and urban planners have become increasingly aware of the health benefits that can be derived from including moderate physical activity in daily

activities (2). Thirty minutes of moderate physical activity a day, 5 days a week, even when performed in short sessions of activity, is enough to provide health benefits such as reductions in obesity levels, coronary heart disease, and hypertension (1). Walking for transportation can be an important source of physical activity for otherwise non-active individuals (3).

Mounting evidence reveals a significant association between walking and neighborhood design (i.e., the presence or absence of intersecting streets or sidewalks, and proximity of homes to schools, parks, and shopping) (2–5), although causality has yet to be established (6). To date, little research has assessed the relationships between transit use and walking (7,8), the importance of transit use as a potential confounder of neighborhood walkability (i.e., how friendly the built environment is for people to live in and conduct daily activities) (9), and the impact of transportation incentive programs or Travel Demand Management on walking for transportation (6). Because transit trips (e.g., by bus or train) often involve walking, transit users may be more likely to meet the recommended levels of physical activity regardless of their neighborhood of residence. Moreover, it is likely that the provision of good quality transit service is a necessary condition to reduce high levels of car ownership, which discourages active transportation (e.g., walking or bicycling). Once someone has a car, the habit of driving may reduce the frequency of transit and non-motorized trips (10,11). The current study evaluates transit use and employer-sponsored public transit passes and their relationship to achieving recommended levels of physical activity through walking for transportation.

REVIEW OF THE EVIDENCE

Transit users are also walkers by definition, because buses and trains seldom offer door-to-door service. Since a car is rarely available at the end of a transit trip, the likelihood of walking between two intermediary destinations is potentially high. In metropolitan Atlanta for example, walking and cycling account for 70% of trips to and 76% of trips from Metropolitan Atlanta Rapid Transit Authority transit stations (12). Cervero (13) found that rail stations surrounded by higher residential densities and a mixture of land uses (e.g., commercial, residential, and office space) had a higher proportion of

walk access trips than did rail stations in suburban, low-density environments. Using the US National Household Travel Survey to assess the relationship between walking and transit use at the national level, another study found that 29% of transit users achieved ⩾30 min of physical activity a day solely by walking to and from transit (8). Lower-income individuals, minorities, rail users, and people living in higher-density areas were more likely to reach the physical activity target. Empirical relationships are found between walking as a means of transportation and the number of destinations (shops, restaurants) and presence of public transit within 400 m (1/4 mile) of home (14), but research designs rarely differentiate transit users from other individuals. Although walking to transit is likely to contribute to an active lifestyle, more evidence is needed on how transit use affects total transportation-related walking.

The current study's novelty is to assess the relationship between trips per motorized modes of transportation used and the outcome of meeting recommended levels of physical activity (1), while controlling for neighborhood built environment and sociodemographics. Furthermore, no study to date has established an association between employer-sponsored transit pass programs and walking.

We used the ecological model of active living to assess disaggregate relationships between individual demographic, household, environmental, and policy factors on a healthy behavior outcome (15). Trips taken per each mode of transportation were considered an expression of individuals' transportation choices and constraints. Because motorized trips begin and end with a walking trip, however short, we hypothesized that the likelihood of meeting recommended levels of physical activity solely by walking for transportation would be greater for transit users than for car drivers or passengers. Our reasoning was that transit riders are more likely to walk to and from transit, to take mid-day walk trips from work (16), and to access other nearby destinations during a tour (a chain, or sequence of trips that usually begins and ends at home) (6).

We also tested the relationship between employer-sponsored public transit passes and walking. Transit use and walking may be affected by policies that modify the relative costs of travel behaviors (6). In the United States, the Transportation Equity Act for the 21st Century promotes Travel Demand Management programs, such as

employer-sponsored transit passes, to reduce auto use and greenhouse gas emissions and to provide access to employment (17). Researchers have evaluated a number of employer-based programs or interventions that may support healthy behavior (18), and interventions to promote walking to work have been the target of previous studies (3). We hypothesized that if owning a transit pass is associated with greater transit use (19), employer-sponsored transit pass programs might also be associated with meeting physical activity recommendations for walking. These findings could give credence to the idea that transportation policies that favor transit use may produce indirect health benefits through increased walking.

METHODS

The study used a cross-sectional design in which self-reported transit and car trips, employer-sponsored transit passes, and the availability of transit service were used as independent predictors of three categories of walking. Sociodemographic factors and urban form were used as control variables. The study used Strategies for Metropolitan Atlanta's Regional Transportation and Air Quality (SMARTRAQ) data (20), a computer-assisted telephone interview of 18,326 individuals that recorded 2-day travel diaries in metropolitan Atlanta, Georgia, in 2001 and 2002. The overall response rate was 30.4% (4,5,20). Recruitment was stratified based on income, household size, and the net residential density of neighborhoods to produce a statistically representative sample of households living in distinctly different built environments. Density was highly correlated with other urban form measures in the Atlanta region, such as mixed use and street network connectivity (5). In addition, extra effort was placed on the recruitment of lower-income participants who are often harder to reach and to recruit into travel surveys (20). A random sub-sample of employed respondents was asked additional questions about employer-sponsored transportation programs. Our analysis focused on these 4,156 employed individuals, aged between 16 and 70 years, with no reported disabilities.

Dependent Variable

The dependent variable was based on the mean value of the total distance walked per day for transportation purposes as measured

over two consecutive days (with a maximum of one weekend day). Distance walked was measured by summing the shortest path distance on the street network between origin and destination for each non-leisure walk trip (geographic information system (GIS)-based measure). For trips involving walking and transit, the walking distance was calculated from home address to transit network access point and from transit egress point (exit) to destination address. When addresses were not available, nearest cross street or major landmarks were used to calculate distances (20). Hence, the walking distance measure did not include any walking indoors or on trails outside of the street network. Converted to distance, 30 min of walking represents the equivalent of walking approximately 1.5 miles (2.4 km) at a brisk pace of 3 miles per hour (5 km per hour) (1). We categorized mean walking distance into one of the three categories: no walking (no measured walking on the street network), moderate levels of walking (having recorded a mean walk distance of < 2.4 km), and sufficient walking to meet the Surgeon's General physical activity recommendation ($\geqslant 2.4$ km per day, referred to as *meeting recommendation*) (1). A multinomial logistic regression was used to assess the individual role of independent correlates and controls on the likelihood of meeting the physical activity recommendation or of being a moderate walker, using the non-walkers as a reference category. We also estimated the same model with moderate walking as a reference category, and meeting recommended activity levels as the outcome.

Note: The dependent variable suggests the use of an ordered regression. We chose to use the multinomial logistic model because we found evidence of a non-linear relationship between trips as driver and walking categories (See Table 3 and discussion). The results presented in this multinomial logistic analysis are otherwise similar to those found using an ordered regression model, but produce a stronger model fit.

Independent Variables: Correlates

Travel diary data provided the number of *trips per motorized mode* of transportation per day over the 2-day period for each individual. Mean number of trips per day as car driver, car passenger, and transit passenger were introduced as indicators of travel preference and constraints.

Availability and use of *employer-sponsored transit passes* was introduced as a categorical variable. We expected that the use of an employer-sponsored public transit pass would be positively associated with meeting the physical activity recommendation for walking. The survey items asked if the person received and used "free or subsidized" transit passes. We therefore cannot separate different levels of subsidy. However, in Atlanta, the Transcard program in place at the time of the survey provided up to US$100 in subsidy per month (21).

Distance to nearest transit stop or station was a measure of transit service access (only for those using transit), and was calculated using the shortest network distance between the nearest transit stop and the center of a 200-m grid (0.12 miles) within which a transit user's residence was located. The 200-m grid surface was developed for the 13-county Atlanta region as part of the SMARTRAQ project (20). Shorter distances to transit make transit use a more attractive option, as it can reduce relative and overall travel time to get to a destination using transit. Less than 450 m (0.28 miles) is the typical threshold used by transit providers to estimate transit service catchments, although rail users may accept walking greater distances (22). We included dichotomous variables of whether transit users lived within 450 m and between 450 and 1,000 m (1 km, 0.6 miles) of a transit stop. We expected an association between greater distance to transit and more walking for transit users. A detailed method for the creation of land use measures has been published previously (23).

Car availability was the number of vehicles in a household divided by the number of licensed drivers, for every respondent with a driver's license. Values ranged from 0 to 1, and fractions represented shared vehicles and thus limited availability (e.g., 1 vehicle for 4 drivers = 0.25). For individuals with values >1 (more cars than drivers), a value of 1, indicating full availability, was imputed to ease interpretation. Individuals with no driver's license, and licensed drivers in households with no cars, received a value of 0.

Control Variables

The travel survey included sociodemographics for each respondent. The measures included a continuous variable for age and a dichotomous variable for ethnicity (white or other). The annual

income was measured at the household level and grouped into three categories (US$0–29,999; $30,000–$59,999; and ⩾$60,000).

We describe the *neighborhood environment* of residence using net residential density, which has been associated with mode choice and walking behavior (2–6,24). Net residential density was the number of households per acre of residential land within the home census block group (25). Net residential density was grouped into five categories (0–1.999, 2–3.999, 4–5.999, 6–7.999, ⩾8) (20). Based on findings in previous studies, we expected that higher density in the neighborhood of residence would be linked to more walking.

A dichotomous variable captured the self-reported presence or absence of retail stores within a 10-min walk from work. The presence of such destinations could intervene in the relationship between employer-sponsored transit pass incentives and walking.

Significance is reported at the 95% level and coefficients are expressed in terms of the adjusted odds ratios (OR) of being in the given category of walker. Survey weights were applied.

RESULTS

Our sample ($N = 4,156$) contained 22.7% of all SMARTRAQ survey respondents. The descriptive statistics for our sample are presented in Table 1. In our sample, 2.6% met the physical activity recommendation solely by walking for transportation, 8.3% recorded some walking, and 89.2% recorded no walk trips. These results are lower than typical self-reported levels for moderate physical activity but they compare favorably to the low walk trip rates in the Atlanta region (20). This is because we measured only moderate physical activity related to transportation on the street network, whereas overall physical activity captures many other kinds of activity that are not transportation-related. We found that 5.4% of the sample used transit, reflecting the low mode share of transit (among all possible modes of transportation) in the Atlanta region. Approximately 19% of individuals were in areas with a net residential density level of ⩾6 dwelling units per acre. About 65% of individuals lived in single-use low-density residential areas on lots that were ⩾1/4 acre (⩾0.1 hectare). We found that 8.7% of our sample had and used an employer-sponsored transit pass, and 11.1% were eligible for such a program but did not use it. Only 1.3% of

Table 1: Characteristics of subset of SMARTRAQ respondents (*N*=4,156), Metro Atlanta, 2001–2002

Variable description	*Used in analysis (4,156)*			*Not in analysis (14,170)*		
	n	*Mean*	*%*	*Std. dev.*	*Mean*	*%*	*Std. dev.*
Mode selection and trips							
Mean number of public transit trips per day		0.09		0.46	0.059		0.377
Mean number of trips as driver per day		3.54		2.12	1.83		2.28
Mean number of trips as passenger per day		0.26		0.73	0.731		1.25
Car availability		0.96		0.16	0.622		0.466
Sociodemographics							
Age		42.97		11.12	36.61		23.068
White (1=yes)			71.0			67.6	
Income							
<$30,000	561		13.5			19.4	
$30,000–$60,000 (ref.)	1,563		37.6			32.1	
>$60, 000	2,032		48.8			48.5	
Gender							
Male	2,082		50.1			48.0	
Female	2,074		49.9			51.8	
Employer-sponsored transit pass							
Has access and uses	363		8.7			2.9	
Has access but does not use	460		11.1			3.1	
Do not have access (ref.)	3,333		80.2			94.0	
*Net residential density (*res. units/net res. acre*)*							
0–2	1,568		37.8			44.3	
2–4	1,133		27.3			28.7	
4–6	657		15.8			13.7	
6–8	308		7.4			4.8	
8+	490		11.8			8.5	

Table 1: *(Continued)*

Variable description	*Used in analysis (4,156)*			*Not in analysis (14,170)*		
	n	*Mean*	*%*	*Std. dev.*	*Mean*	*%*	*Std. dev.*
Services near employment							
Retail stores within 10-min walk from work			42.0			22.7	
Transit service: distance to nearest transit stop							
Within 450 m for users			2.0			1.4	
From 450 m to 1 km for users			2.0			1.1	
*Three categories of walking**							
Non-walker	3,707		89.2			92.2	
Walk up to 2.4 km – moderate walker	343		8.3			6.2	
Walk 2.4 km or more – PA recommendation met	106		2.6			1.6	
Total	4,156		100			100.0	

*Distances are in km per day.

sampled individuals had no car, and 92.7% had a car they did not share with anyone. Nearly 6% shared a car with other household members, resulting in a situation of restricted car availability. The sample used, on average, was older, wealthier, lived in denser areas, traveled more frequently, and had greater access to a sponsored transit pass than those not included in study.

Table 2 shows differences in distance walked and trip rates based on transit use and income groups. A proportionally small group of transit users walked considerably greater distances, and took fewer car trips as drivers and slightly more trips as passengers. Separating users and non-users of transit by income groups further allowed us to see differences in walking and motorized travel indicators. Higher-income individuals, on average, took fewer transit trips when they

Table 2: Distance walked and trips per mode by income groups and transit use, SMARTRAQ (*N*=4,156), Metro Atlanta, 2001–2002

Income	*Transit users*				*Non-users of transit*			
	Less than $30,000	*$30,000–$60,000*	*$60,000 and more*	*Total (5.4%)*	*Less than $30,000*	*$30,000–$60,000*	*$60,000 and more*	*Total (94.6%)*
n (%)	52 (23.2)	92 (41.1)	80 (35.7)	224 (100)	509 (12.9)	1,471 (37.4)	1,952 (49.6)	3,932 (100)
Transit trips	1.81	1.75	1.57	1.70	—	—	—	—
Driver trips	0.71	2.09	2.66	1.97	3.63	3.60	3.73	3.63
Passenger trips	0.52	0.32	0.30	0.36	0.26	0.22	0.30	0.26
At least one walk trip (%)	59.6	60.9	56.3	58.9	11.6	9.0	8.9	9.3
Total distance walked (km per day)	1.54	1.56	2.01	1.72	0.23	0.13	0.16	0.16
No car or no license (%)	51.9	14.1	0.0	17.9	2.2	0.1	0.1	0.4
Shared car (%)	3.8	16.3	7.5	10.3	8.8	7.1	4.0	5.8
Car fully available (%)	44.2	69.6	92.5	71.9	89.0	92.8	95.9	93.8

did use transit, and made more car trips as drivers. Interestingly, higher-income transit users reported walking greater distances than other transit users and non-users of transit.

Table 3 shows the results of the multinomial logistic regression. The first two sets of OR and significance parameter (columns 1–4) estimate each of the walking outcomes, with no walking as a reference category. In the third set (columns 5–6), we estimated the OR of meeting the physical activity recommendation, using moderate walking as a reference group. Additional trips by any mode were found to be associated with greater odds of reporting moderate walking (column 1). However, only additional trips by transit are significantly associated with greater odds of meeting the recommendation (OR = 3.35; 95% confidence interval (CI) = 2.36–4.77) (column 3). Car trips as driver or passenger are not significantly associated with meeting the recommendation.

In column 3, car availability presented a strong negative relationship with meeting the physical activity recommendation (OR = 0.13, CI = 0.05–0.33). Being white was positively associated with meeting the physical activity recommendation. Both higher- and lower-income groups had significantly higher OR of meeting the physical activity recommendation than the reference category for income ($30,000–$59,999), suggesting a somewhat bi-modal distribution.

Having and making use of an employer-sponsored transit pass was both positively and significantly associated with meeting the physical activity recommendation (OR = 4.96, CI = 2.8–8.9) but was not significantly associated with being a moderate walker. Having access to, but not using, an employer-sponsored transit pass had a non-significant relationship with being a moderate walker and a significant OR of 2.2 (CI = 1.15–4.3) of meeting the physical activity recommendation. When estimating OR of meeting the physical activity recommendation with moderate walkers as a reference category (column 5), trips as driver (OR = 0.86, CI = 0.76–0.98) and car availability (OR = 0.25, CI = 0.09–0.69) were negatively associated. Public transit trips and having and using an employer-sponsored transit pass (OR = 3.6, CI = 1.83–7.1) remained positive and significant.

Living in a lower density neighborhood was significantly and negatively associated with being a moderate walker and with meeting recommendation after adjusting for other variables in the

Table 3: Multinomial logistic regression of three categories of walkers, SMARTRAQ (N=4,156; weighted), Metro Atlanta, 2001–2002 (km per day)

	Walk up to 2.4 km – Moderate walkers (vs. non-walker)		*Walk 2.4 km or more – PA recommendation met (vs. non-walker)*		*Walk 2.4 km or more – PA recommendation met (vs. moderate walker)*	
	Odds ratio (Column 1)	*Sig. (Column 2)*	*Odds ratio (Column 3)*	*Sig. (Column 4)*	*Odds ratio (Column 5)*	*Sig. (Column 6)*
Intercept		0.000		0.000		0.340
Mode selection and trips						
Mean number of public transit trips per day	2.27	0.000	3.35	0.000	1.48	0.015
Mean number of trips as driver per day	1.19	0.000	1.02	0.704	0.86	0.026
Mean number of trips as passenger per day	1.51	0.000	1.15	0.363	0.76	0.095
Employer-sponsored public transportation program						
Has access and use	1.38	0.170	4.96	0.000	3.60	0.000
Has access but do not use	1.49	0.049	2.24	0.017	1.51	0.267
Do not have access (ref.)	—	—	—	—	—	—

Table 3: *(Continued)*

	Walk up to 2.4 km – Moderate walkers (vs. non-walker)		*Walk 2.4 km or more – PA recommendation met (vs. non-walker)*		*Walk 2.4 km or more – PA recommendation met (vs. moderate walker)*	
	Odds ratio (Column 1)	*Sig. (Column 2)*	*Odds ratio (Column 3)*	*Sig. (Column 4)*	*Odds ratio (Column 5)*	*Sig. (Column 6)*
Sociodemographics						
Income						
<$30,000	1.62	0.014	2.91	0.005	1.79	0.145
$30,000–$60,000 (ref.)	—	—	—	—	—	—
>$60, 000	1.17	0.360	2.29	0.008	1.97	0.043
Car availability	0.50	0.044	0.13	0.000	0.25	0.008
Age	0.99	0.318	0.99	0.407	1.00	0.814
White (1=yes)	1.43	0.022	2.81	0.000	1.97	0.033
Built environment						
Net residential density (res. units/net res. acre)						
0–2	0.14	0.000	0.15	0.000	1.08	0.851
2–4	0.35	0.000	0.26	0.000	0.75	0.472
4–6	0.51	0.003	0.45	0.032	0.88	0.745
6–8	0.37	0.001	0.32	0.044	0.88	0.831
8+	—	—	—	—	—	—

Table 3: *(Continued)*

	Walk up to 2.4 km – Moderate walkers (vs. non-walker)		*Walk 2.4 km or more – PA recommendation met (vs. non-walker)*		*Walk 2.4 km or more – PA recommendation met (vs. moderate walker)*	
	Odds ratio (Column 1)	*Sig. (Column 2)*	*Odds ratio (Column 3)*	*Sig. (Column 4)*	*Odds ratio (Column 5)*	*Sig. (Column 6)*
Services near employment						
Presence of retail stores within 10-min walk	1.49	0.004	2.60	0.000	1.75	0.042
Transit service: distance to nearest transit stop						
Within 450 m for users	1.19	0.685	0.58	0.322	0.49	0.204
From 450 m to 1 km for users	6.54	0.000	1.30	0.642	0.20	0.004

model. Living within 450 m (0.28 miles) of a bus stop or rail station was not associated with walking when only transit users were considered. However, transit users living between 450 and 1,000 m (0.6 miles) of transit were more likely to be moderate walkers than those living farther away from transit.

DISCUSSION

As shown in Table 2, transit users record fewer driver trips and slightly more passenger trips than non-users and also have lower car availability. As income increases, transit users take slightly fewer trips by transit and more by car. Transit users also accumulate greater total walking distance across income groups. Higher-income transit users report the most walking. In Table 3, additional transit trips were found to be a significant predictor of meeting the physical activity recommendation when controlling for sociodemographics, car availability, and urban form characteristics. This suggests that transit users participate in more multimodal trips that involve walking, and often walk greater distances between destinations. Interestingly, however, taking additional car trips (both as drivers and passengers) was also positively associated with being a moderate walker, but not with meeting the physical activity recommendation. Our interpretation is that a person who recorded any motorized trips regardless of the mode is more likely to have walked because, as with transit trips, some car trips may be complemented by walking to access destinations. It is likely, however, that short distance car trips may substitute for walk trips, and could result (as reported here) in shorter walked distances and a reduced likelihood of meeting the recommended levels of physical activity. For car passenger trips, we interpret the unclear trend as a product of interactions of car availability, driver trips, and transit trips. The variety of situations in which car passengers find themselves (e.g., being picked up and driven directly to a destination vs. being driven to a transit stop and getting back home by another mode) requires additional analysis beyond the scope of this study.

Having an employer-sponsored transit pass had a positive relationship with meeting the physical activity recommendation, but not with being a moderate walker. It may be that those who benefit from a sponsored transit pass leave home more frequently

without a car, make shopping and leisure detours between transit and destination, work in locations that are denser and better served by transit, and, as a result, adopt a lifestyle that involves walking considerable distances. Transit routes are more likely to serve central areas of higher residential and employment densities that are more walkable. Employers located in areas well served by transit are more likely to consider offering transit pass programs (26). Sponsored transit pass programs are attractive to both employer and employee because they are tax-free to employees and tax-deductible for the employer. Furthermore, they may reduce demand on parking space for employers and contribute to employee retention (27). We interpret the positive and significant OR of having access to, but not using, an employer-sponsored transit pass as being associated with employment location. When the presence of retail stores within a 10-min walk from the workplace is introduced into the model, the OR of using a pass and meeting the recommendation stays relatively constant, but the OR of not using the available program decreases considerably, giving credence to the importance of the built environment at the place of employment for walking (only final model is shown in Table 3). This is consistent with other findings showing that the presence of shops and services at the place of employment is an important predictor of walking at mid-day (16). It is plausible that the neighborhood environments on the home and work end of commutes affect transit use, and that this relationship is moderated by incentives that encourage transit ridership. More investigation is required to understand the distribution of access to such incentives, the factors that support the use of employer-sponsored transit passes, and how such use may translate into a more active lifestyle.

Motorized modes of transport and trips taken may act as mediators in the relationship between the built environment and walking. Employer-sponsored pass users and other transit users do not all reside in higher-density areas. Some transit users may live in medium-density areas adequately served by transit, but gain access, through a transit trip, to higher-density areas where multiple services are available within short walking distances. These individuals might be reported as frequent walkers living in low-density, disconnected areas, and may have decreased the impact and significance of residential neighborhood effect in previous studies. Inversely, car

users living in a highly walkable area may record little walking if their work destination is not walkable and not accessible by transit. Car users may also live in sprawling neighborhoods but access central locations where they perform walk trips during the day. However, cars afford access to most destinations, including those less conducive to walking. Once a tour is initiated with a car, subsequent car trips may be favored over walk trips. Understanding how these various factors (total travel, mode of transportation used, policy incentives, and characteristics of the built environment both at home and at the workplace) may be associated with walking for transportation is a worthwhile endeavor.

LIMITATIONS

Atlanta has a low transit mode share and therefore our sample consisted of few transit users and few individuals with access to an employer-sponsored transit pass. Atlanta is also the US's "poster child" for suburban sprawl, with most people living in low-density environments where little to no transit service is provided. This factor was somewhat mitigated in this study by oversampling people in more walkable environments in the Atlanta region. Other US cities may have increased capacity to support sponsored passes through a transit system that reaches more regional destinations and has greater service quality, and through greater employer adherence to the sponsored transit pass program and greater employee use of the passes. In such instances, we would expect more workers to use a transit pass, and we expect a similar association with physical activity levels.

A small proportion of participants met the recommended level of physical activity through walking for transportation on local streets. We employed an objective GIS-based measure of walking distance on local streets, but, as with recorded or reported time spent walking, we have no measure of the speed or intensity of walking. We did not account for any walking performed in other places, such as in parking lots or indoor malls, as well as any other form of physical activity. Being a non-walker in this study therefore does not imply having no physical activity at all. Furthermore, short walking distances (to transit, to car) are more likely to be misreported. As physical activity through transit use is likely to be accrued in short

sessions, research on transit use and walking will gain greatly from increased certainty as to the contribution of short sessions of activity to overall physical activity (1). Although standard within the transportation industry, the 2-day travel diary upon which this study is based may not always reflect more habitual underlying travel patterns of our participants.

As with most studies to date, our cross-sectional design prevents us from drawing clear conclusions on a causal link between transit use, transit incentives, and increased walking as a means of transportation. Longitudinal studies capturing shifts in mode following infrastructure development or changes in policy incentives could provide more elaborate evidence.

Finally, the SMARTRAQ survey upon which this study is based has the benefit of a large population, detailed travel and land use information, perceived presence of services at the workplace location, Travel Demand Management measures, and particular attention to walking; however, several variables of potential interest were not included in the study because of a skewed sample distribution (small categories of the behaviors of interest). Physical activity is influenced by a number of psychological, psychosocial, and socio-cultural factors (15) that were not addressed here. Additional transit service factors such as frequency of service, service type, capacity, and accessibility to employment centers (22) also have the potential to influence the decision to use transit, and should be considered.

CONCLUSION

We found a positive association between public transit trips and meeting the physical activity recommendation by using walking for transportation. For car trips (as a driver), this relationship was negative. Having and using an employer-sponsored transit pass was also associated with meeting the physical activity recommendation when compared with both non-walkers and moderate walkers. These relationships proved significant after controlling for income, age, ethnicity, and measures of the built environment. Whether these results may be caused by transit users' preference for an active lifestyle, travel constraints, or choice of residential location warrants further analysis. The lower-income group, which had higher transit

use and lower car ownership rates, was positively associated with meeting the physical activity recommendation. This suggests motorized travel restrictions that may induce more walking under poor conditions (e.g., poor sidewalks, or few destinations). Results also support the conclusion that at least some of the variation in walking is a function of the distance to transit service for users.

From a planning perspective, guidance is needed on the most cost-effective methods to foster physically active lifestyles and a shift in travel modes. To reduce car travel, walkable developments must provide an alternative to car use for long-distance regional travel. Along with land use policies and transportation infrastructure, we found that transportation incentives supporting transit use may offer a synergistic means of improving population health through active lifestyles. Changing land use is difficult and will likely not be enough. Making transit incentives more broadly available may increase the proportion of people meeting the physical activity recommendation. Such benefits will likely be appealing to policy makers because they can be achieved within shorter time frames than the longer-term structural changes required to influence travel behavior through the built environment.

The significant and positive relationship between having access to an employer-sponsored transit pass, using the pass, and meeting the physical activity recommendation suggests public health benefits of transit passes and that working in a walkable environment is associated with health-promoting behaviors. The very location of an employer may in itself provide considerable incentives for walking – and may encourage lower levels of vehicle ownership and use if transit service between home and work is a viable alternative.

Increased attention to the moderating role of public transit use in the relationship between the built environment and walking is needed. Future studies seeking to understand the relationships between transit use and physical activity will benefit from more information on the quality of public transit service, incentive to use transit, and features of the built environment at destinations.

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