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Comparison of cyclists' and motorists' utilitarian physical activity at an urban university

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Abstract

Objective. Preliminary comparison of cyclists and motorists on: (1) distance lived from campus and, (2) the impact of transportation mode on physical activity.

Methods. A purposive sample of students ($n=50$; cyclists = 26, motorists = 24) living <5 miles from Arizona State University campus wore an accelerometer and completed a travel log for two on-campus days during fall 2005–spring 2006. Residence distance to campus was calculated by geocoded addresses ($n=45$; cyclists = 23 vs. motorists = 22). Final outcome variables were: distance lived from campus, accelerometer time moderate-to-vigorous physical activity, steps/day, total time moderate-to-vigorous physical activity (logged minutes cycling + accelerometer-derived moderate-to-vigorous physical activity), and minutes total active commuting (logged walking + cycling).

Results. Groups were significantly different for: distance lived from campus (cyclists = 0.6 ± 0.6 vs. motorists = 2.0 ± 1.1 miles; $p<0.000$); steps/day (cyclists = 11,051 ± 4295 vs. motorists = 9174 ± 3319; $p=0.046$); total time moderate-to-vigorous physical activity (cyclists = 85.7 ± 37.0 vs. motorists = 50.3 ± 23.8 minutes; $p<0.001$); minutes in motorized transport (cyclists = 24.9 ± 27.5 vs. motorists = 61.6 ± 32.9; $p<0.001$); and total active transport (cyclists = 59.4 ± 32.4 vs. motorists = 29.5 ± 20.0; $p<0.001$).

Conclusion. Among students living within 5 miles of campus, cyclists lived relatively closer to campus, accumulated more minutes of physical activity, and spent more time in active transportation than students who used motorized means.

Keywords: Physical activity; Transportation; Accelerometry; Cycling; Utilitarian activity; College students

Introduction

Thirty minutes of at least moderate intensity physical activity most days of the week is recommended for health benefits (Pate et al., 1995). Regardless, a recent meta-analysis reported that 40–50% of college students are physically inactive (Keating et al., 2005). Another study reported only 30.6% of college students met the 30 min, 5 days/week recommendation (Buckworth and Nigg, 2004). Active modes of transportation such as cycling represent potential means by which college students can meet activity recommendations. Specifically, university campuses have a unique environmental design that often discourages motorized transportation by relegating parking to the periphery and cultivating a dense network of destinations that are easily navigable bicycle (Balsas, 2003).

Urban designers have described bikeable neighborhoods as those characterized by a high population density, mixture of land use, high connectivity, and design features such as continuous sidewalks and bicycle lanes (Saelens et al., 2003). Additionally, different elements influence transportation-related activity more than recreation. Having destinations and public transit close to home (e.g., 400 m) (Hoehner et al., 2005) and a high degree of walkability or bikeability (Craig et al., 2002) were strongly associated with active transportation.

The increased prevalence of active transportation on and around campus, specifically cycling, and the distinct physical environment make the university a natural laboratory for understanding built environmental impacts on cycling and its contribution to overall physical activity. To prepare for such research, the purpose of this preliminary study was to use a number of different measurement approaches to compare cyclists and motorists on: (1) distance lived from campus (among those

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living <5 miles of campus) and (2) the contribution of transportation-related cycling to physical activity.

Methods

Participants

During the fall of 2005 and spring of 2006, participants ($n=50$; 52% females and 48% males) were purposely recruited from an online transportation survey of students at Arizona State University who lived off-campus but within a reasonable cycling distance (i.e., 5 miles) (Tolley, 1996). Ethics approval was obtained and all participants signed an informed consent.

Measurements

Participants were instructed to wear an accelerometer and complete a travel log for two non-raining days on which they planned to be on campus (FHWA, 1997). Participants provided their home address for the purpose of determining how far they lived from campus. Travel logs were used to determine number of minutes for each trip mode (motorized, bicycle, and walking). For example, if a person took four trips by bicycle for 10 min each, four trips by walking for 2 min each, and two trips by automobile for 30 min each he/she would spend 40 min in bicycle transportation, 8 min in walking transportation, 60 min in motorized transportation, and 48 min in a combined active transportation variable.

Participants wore a dual-mode uni-axial MTI Actigraph accelerometer (model 7164; ActiGraph, Fort Walton Beach, FL) to detect physical activity (steps and intensity). Accelerometers are calibrated to record ambulatory activity (i.e., hip movement) and therefore do not accurately detect cycling. However, cycling is easily recorded on a travel log since it requires volition to get on a bicycle and trips are often purposeful (FHWA, 1997).

Data treatment and statistical analysis

Addresses were geocoded, using ARCView 9.0 Geographic Information Systems software to determine distance lived from campus using an official campus map. Distance between residence and campus perimeter was measured in crow-fly network (i.e., straight line between residence and campus perimeter) within the software. This approach was selected rather than a street network approach (following the streets) since cyclists may not follow streets and/or use unmarked bicycle paths/trail.

Table 1
Physical activity variables by transportation mode (motorists vs. cyclists)

Variable	Instrument	Motorist-days ($n=35$) Mean (*SD*) (range) *median*	Cyclist-days ($n=34$) Mean (*SD*) (range) *median*
Time worn (hours)	Accelerometer	13.6 (*2.6*) (8–19) *14.0*	14.7 (*3.0*) (9–19) *15.0*
Accelerometer time in moderate-to-vigorous physical activity (minutes)	Accelerometer	47.8 (*25.0*) (11–116) *42.0*	40.0 (*23.8*) (5–85) *40.0*
Total time in total moderate-to-vigorous physical activity (minutes) [a]	Accelerometer +log	50.3 (*23.8*) (18–116) *46.0*	85.7 (*37.0*) (32–209) *81.0*
Steps/day[a]	Accelerometer	9174 (*3319*) (3357–16,821) *8758*	11,051 (*4295*) (5493–20,847) *10,533*

Data were collected during fall 2005 and spring 2006 at Arizona State University.
[a] Significant difference ($p<0.05$), 2-tailed independent t-test.

Table 2
Time (minutes) spent in each mode of transportation by group (cyclists vs. motorists)

	Motorist-days ($n=35$) Mean (*SD*) (range) *median*	Cyclist-days ($n=34$) Mean (*SD*) (range) *median*
Motorized transportation	61.6 (*32.9*)[a] (12–137) *60.0*	24.9 (*27.5*)[a] (0–105) *18.5*
Bicycle transportation	2.5 (*7.3*)[a] (0–31) *0.0*	45.7 (*30.3*)[a] (12–159) *42.0*
Walking transportation	27.1 (*21.1*)[a] (0–72) *30.0*	13.8 (*13.0*)[a] (0–46) *14.5*
Combined active transportation (bicycling + walking)	29.5 (*20.0*)[a] (0–72) *32.0*	59.4 (*32.4*)[a] (12–173) *48.0*

Data were collected during fall 2005 and spring 2006 at Arizona State University.
[a] Significant difference $p<0.007$ Mann–Whitney U-test.

Days of travel log recording and physical activity monitoring were amalgamated or combined into one single variable (Tudor-Locke et al., 2005) since the day was determined *a priori* to be the unit of analysis rather than the individual. Days were excluded due to: (1) less than 8 h of wear ($n=6$ days) or non-wear ($n=5$ days); (2) equipment malfunction ($n=13$ days) or loss ($n=2$ days); (3) no indication of travel to campus ($n=3$); and (5) cyclists recording 0 min of cycling transportation ($n=2$). After data cleaning, the final sample size was 69 days representing 34 cyclist-days and 35 motorist-days.

Results

Forty-five addresses were successfully geocoded ($n=22$ motorists, $n=23$ cyclists) The majority (91%) of surveyed cyclists lived within a one-mile radius of campus. Median (25th, 75th percentiles) distance in miles that cyclists and motorists lived from campus were 0.4 (0.3, 1.2) and 2.0 (1.1, 2.7), respectively ($z=-4.519$, $p<0.000$).

Age for cyclists and motorists were 21.3 (2.3 SD) and 21.7 (4.0 SD) years (ns), respectively. See Table 1 for accelerometer time worn (hours), accelerometer time moderate-to-vigorous physical activity (minutes), total time moderate-to-vigorous physical activity (i.e., accelerometer + diary bicycle) (minutes), and steps/day for cyclists-days and motorists-days. Steps/day ($t(67)=-2.035$, $p=0.046$) and total time moderate-to-vigorous physical activity ($t(67)=-4.733$, $p<0.001$) were significantly different between commuting modes. See Table 2 for minutes/mode. Cyclist-days and motorist-days indicated approximately 59 and 30 min/day in active transportation, respectively. Groups were different for minutes in motorized ($z=-4.662$, $p<0.001$); bicycle ($z=-7.188$, $p<0.001$); walking ($z=-2.692$, $p=0.007$); and total active transportation ($z=-4.209$ $p<0.001$).

Discussion

The examination of transportation-related cycling activity in this study helps understand its potential contributions to overall physical activity. Using novel and objective measures such as

Geographic Information Systems and accelerometers strengthens the findings observed between environmental determinants and behaviors such as bicycle commuting. Tolley (1996) reported that a reasonable cycling distance is 5 miles or 30 min. However for this preliminary sample, the median distance lived by cyclists was 0.6 miles (maximum 3.0 miles), which is significantly less than motorists who lived 2.0 miles from campus, yet well within considered reasonable cycling distance. Previous studies have also reported that female students are less likely to cycle for transportation (Winters et al., 2007), although no difference was noted in cycling behaviors in the current study between sexes (34.2% of males and 35.6% of females cycled). This preliminary sample may not be representative of other campuses or populations but served the stated objectives to use novel measurement approaches for comparative purposes.

Both preferred transportation modes studied showed similar steps/day (9900–11,500 steps/day) to other studies examining university students (Behrens and Dinger, 2005). When the combined variable of total moderate-to-vigorous physical activity (which included moderate-to-vigorous physical activity and minutes of bicycle transportation) was considered, cyclist-days indicated significantly more minutes (approximately 35) of daily physical activity. Both modes, on average (89% motorists, 100% cyclists), were meeting minimum physical activity recommendations of 30 min/day. Previous studies have reported that 30.6% (Buckworth and Nigg, 2004) of college students meet minimal recommendations. These findings are based on self-report of engagement in purposeful physical activity (e.g., sports and exercise) and overlook potential contributions of transportation-related activity, the focus of the current study.

Study limitations

This study is cross-sectional and inferences about causality cannot be determined. A relatively small sample size that was not randomly recruited decreases generalizability to the rest of the student population or other universities.

Conclusions

Cyclists accumulated more minutes of total moderate-to-vigorous physical activity (35 min/day) and more minutes of logged active transportation (30 min/day) than motorists. In cyclists, cycling for transportation represents 47% of total daily physical activity. One hundred percent and eighty-nine percent of cyclists and motorists achieved public health recommendations on days monitored. Active transportation such as cycling is a plausible strategy to increase levels of physical activity in university students and should be encouraged as a means of meeting public health recommendations.

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