Associations among Active Transportation, Physical Activity, and Weight Status in Young Adults

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Abstract

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Objective: To describe prevalence of active, public, and car transit by overweight status and amount of leisure-time physical activity in a nationally representative cohort of ethnically diverse young adults.

Research Methods and Procedures: Questionnaire data on patterns of transportation were collected from U.S. adolescents enrolled in Wave III (2001) of the National Longitudinal Study of Adolescent Health (N = 10,771). Measured height and weight data were used to calculate BMI and classify adults by overweight status (BMI $\geq$ 25). Self-reported physical activity data were used to classify adults into those who achieved $\geq$ 5 bouts of weekly moderate-vigorous physical activity and those who did not. Results were stratified by overweight and physical activity status.

Results: The vast majority of young adults used car transit (work, 90.4%; school, 74.7%). A small proportion of young adults used active means of transportation to work (8.1%) and school (26.7%), and fewer used public transportation to work or school (<10%). The proportion of individuals using active transportation was higher among the nonoverweight traveling to work (9.2%) and school (29.7%) and among the more active traveling to work (15.2%) and school (37.0%) relative to the overweight and less active young adults.

Discussion: The vast majority of young adults of all racial/ethnic backgrounds, particularly blacks and Hispanics, did not use active transportation to school and/or work. Active transportation was more common among nonoverweight and more active young adults, of high socioeconomic status, particularly full-time students. Population-level efforts (and environmental supports) to increase non-leisure physical activity, particularly active transportation, are sorely needed as a means of supporting and promoting overall physical activity.

Key words: environment, transportation, ethnicity, non-leisure physical activity, car travel

Introduction

Physical activity is low and inactivity high among U.S. adults (1,2). Inactivity and poor diet are responsible for roughly 400,000 annual deaths and may soon become the leading causes of death in the U.S. (3). The Centers for Disease Control and Prevention (CDC)[1] and the American College of Sports Medicine (CDC/American College of Sports Medicine recommendation) recommend engaging in 30 minutes of moderate physical activity on most, if not all, days of the week (4).

Walking is the most prevalent leisure-time physical activity among young adults (5) and is a major target of public health efforts (5,6). However, transportation research shows that over 75% of all trips less than 1 mile (a clearly walkable distance) are made by automobile (7). In addition, the number of walking trips as a percentage of all trips taken (of any distance) has declined over the years. Walking trips made by adults dropped from 9.3% in 1977 to 7.2% in 1990 and again to 5.4% in 1995 (7). Recent research has focused on built environmental factors that could support active transportation as part of a healthy lifestyle (8).

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[1] Nonstandard abbreviation: CDC, Centers for Disease Control and Prevention; Add Health, The National Longitudinal Study of Adolescent Health.

Despite recent attention to the issue of walkable environments (9), research on the topic of active transportation and its association with obesity and leisure-time physical activity in national, ethnically diverse cohorts is scarce. Active commuting has been found to be positively associated with physical activity in British boys (10) and negatively associated with overweight in Chinese adults (11), type 2 diabetes risk in Finnish adults (12), and colon cancer risk in Chinese adults (13). Further, car ownership has been found to be associated with obesity in Chinese men and women (14). In the U.S., the association between self-reported obesity and use of car transit has been shown in a study of Atlanta adults (15). Yet, there are limited prevalence data on use of active vs. nonactive transit by race/ethnicity in a diverse national U.S. data set. Given the prominent disparities in overall physical activity and substantial variation in neighborhood environment by racial/ethnic composition, it is important to document the national prevalence by race/ethnicity to estimate the scope of the problem and target future health promotion strategies.

The young adult period has been shown to be a period of high risk for obesity incidence and maintenance (16) and declining physical activity (17–19). This is a descriptive study examining the prevalence of active and nonactive transportation across race/ethnic groups in a national sample of young adults. The aim of this study was to document the overall prevalence of active and nonactive transport among young adults and the variation in prevalence by potentially influential covariates (e.g., part- and full-time work and/or school, socioeconomic status, physical activity, and weight status).

Research Methods and Procedures

Survey Design

The study population consisted of >20,000 adolescents enrolled in The National Longitudinal Study of Adolescent Health (Add Health), a longitudinal, nationally representative, school-based study of U.S. adolescents in grades 7 to 12, supplemented with minority special samples and collected under protocols approved by the Institutional Review Board of the University of North Carolina. The survey design and sampling frame have been described elsewhere (20,21). The primary sampling frame included a sample of 80 U.S. high schools and 52 middle schools with unequal probability of selection. Study design included systematic sampling methods and implicit stratification to ensure representation of U.S. schools with respect to region of country, urbanicity, school size, school type, and ethnicity.

Add Health explores the transition between adolescence and young adulthood, with particular emphasis on the influence of adolescent exposures on outcomes at young adulthood. Wave III was conducted in 2001 to 2002, when the respondents were 18 years old and older and included 15,197 eligible original Wave I (1994 to 1995) respondents, measured between August 2001 and April 2002, including 218 pretested in April 2001. The final analysis sample includes 10,771 young adults (49% male, 57% white, 19% black, 16% Hispanic, 8% Asian) with complete transportation, measured height and weight, leisure-time physical activity, and sociodemographic data from Wave III. Ages range from 18 to 28 years ($\bar{x} = 22.5$; 95% confidence interval, 19.6 to 25.1). Exclusions include seriously disabled respondents (used a walking aid) ($n = 191$), women who were currently pregnant at the time of the survey ($n = 313$), and Native Americans ($n = 179$) due to their small sample size.

Using poststratification sampling weights (calculated to account for persons who could not be located or refused to participate), the school as the primary sampling unit and U.S. region as a stratification variable, the Add Health cohort provides a representative sample. In Wave III, 6% of the original Wave I study population refused participation, and an additional 19% could not be located or were unable to participate for other reasons. Probability sampling weights properly adjust sample estimates on an array of demographic and school characteristics, health outcomes, and behaviors, so that loss-to-follow bias is very small (22).

Study variables

Active and Nonactive Transportation. Add Health questionnaires included questions regarding transportation to/from work and school (including also job training or vocational education program). Respondents could answer: car, bus, subway, walking, bicycling, or other. Response categories were not mutually exclusive. Responses were categorized into: car, public (bus, subway), and active (walking, bicycling) transit.

BMI. Height and weight were measured in Wave III during in-home surveys using standardized procedures. A large number of respondents refused height and weight measurements, and 71 weighed in excess of the scale capacity (330 lb). When respondents who refused measurements had self-reported weight or height, we used their self-reported values because they have been shown to correctly classify a large portion of the Add Health sample (23). In the analysis sample, this substitution was done for 371 respondents in Wave III.

Physical Activity. Add Health questionnaires included a standard physical activity behavior recall that is similar to other self-reported questionnaires that have been used and validated in other large-scale epidemiological studies (24–28). Information was elicited on participation in moderate-vigorous leisure-time physical activity (5 to 8 metabolic equivalents; skating and cycling, exercise, and active sports) in the previous week. One metabolic equivalent represents the resting metabolic rate or 3.5 mL O_2/kg body weight per minute. In Wave III, participants reported the frequency of the activities that were included in the Wave I questionnaire, and additional questions that are applicable to the young adult age group were also included. To account for potential reporting bias and the likely artificial increase in reported activities due to inclusion of additional questionnaire items, a scaled sum of moderate-vigorous activities was used. These methods have been described in detail elsewhere (17,21).

Overweight Status. The risk-based BMI cut point of 25 kg/m^2 was used to define overweight (29,30). Although there were respondents between the ages of 18 to 20 years in our sample, we made the decision to use the adult cut points rather than the CDC/National Center for Health Statistics 2000 reference curves (31), designed for use among 2- to 20-year-olds, to avoid having two distinct definitions of overweight for those under and over the age of 20 years in our sample (16).

Physical Activity Status. Respondents were classified as achieving ≥five bouts moderate to vigorous physical activity/wk or not achieving this amount of activity (<five bouts moderate to vigorous physical activity/wk). National recommendations suggest engaging in 30 minutes of moderate physical activity on most, if not all, days of the week (32). Despite the fact that the Add Health data are characterized by frequency alone, our data approximate these activity guidelines and, thus, represent a conservative estimate of the magnitude of the failure to meet these guidelines.

Sociodemographic Data. A combination of in-home surveys of parents and adolescents provided race/ethnicity, household income, and education data. Race/ethnicity was categorized as Hispanic, non-Hispanic white, non-Hispanic black, or Asian-American. Age was the reported age at last birthday. Highest education achieved for either parent was grouped into the following categories: less than high school, high school or equivalent, and college degree and higher. Income was reported in \$1000 increments and grouped into tertiles: ≤\$26,000, \$26,000 to 50,000, and >\$50,000. Where missing (n = 1502; 13.9%), income was imputed using data on parental occupation, family structure, and school community. This method is similar to that used in other national surveys, such as the National Health and Nutrition Examination Surveys, to deal with missing data (33,34).

Statistical Analysis. This is a descriptive study investigating the associations between patterns of active and nonactive transportation and patterns of activity and overweight.

Statistical analyses were carried out using STATA Version 8.0 (35). The widely accepted series of STATA survey procedures were used to correct for multiple stages of cluster sample design and unequal probability of selection to ensure that results were nationally representative and that bias in estimates and SEs was reduced. A Student's t statistic was used to test the statistical significance of differences in group means for mode of transportation by race/ethnicity and by overweight and physical activity status. The Bonferroni correction for multiple comparisons was applied.

Table 1. Prevalence of different modes of transportation to work and school by full- and part-time work and school, reported in percentage (SE)*

	Car	Public	Active
Work			
Total (N = 10,271)†	90.4 (0.8)	5.5 (0.7)	8.1 (0.6)
Full (N = 7225)†	91.7 (0.8)	4.9 (0.8)	6.1 (0.5)
Part (N = 3046)†	86.9 (1.1)	7.0 (1.1)	13.1 (1.0)
School			
Total (N = 4843)†	74.7 (1.9)	8.7 (0.9)	26.7 (1.9)
Full (N = 3675)†	70.7 (2.1)	9.2 (0.9)	33.0 (2.1)
Part (N = 1168)†	88.9 (1.6)	6.9 (1.3)	3.9 (0.9)

* Data from Wave III (2001), National Longitudinal Survey of Adolescent Health. Results are weighted for national representation, and SEs are corrected for multiple stages of cluster sample design and unequal probability of selection.
† Response categories are not mutually exclusive.

Results

Active and Nonactive Transportation

The vast majority of young adults used car travel to get to and from work and school, particularly for work travel (Table 1). Overall, more than one-quarter of the young adults used active transport to school, whereas only 8% used active transport to work.

Active commuting was more common in full- vs. part-time students and among part- vs. full-time workers (Table 2). A significantly greater proportion of black young adults used public transportation to work (both full- and part-time) than whites, whereas greater proportions of full-time Asian students used public transportation than whites. A smaller percentage of black and Hispanic young adults who were full-time students used active transportation to school than whites.

Active and Nonactive Transportation by Socioeconomic Background

Differences in mode of transportation did not vary substantially by income and education (Table 3). Car transit was more common in middle- vs. low-income full- and part-time workers. Public transportation was more common in high- vs. low-income full-time students. Active transpor-

Table 2. Prevalence of different modes of transportation to work and school by ethnicity, reported in percentage (SE)*

	Total (N = 10,771)	White (N = 6125)	Black (N = 2059)	Hispanic (N = 1759)	Asian (N = 828)
Car transit					
Work full-time	91.7 (0.8)	93.5 (0.7)	86.7 (2.2)‡	88.7 (2.7)	85.2 (4.4)
Work part-time	86.9 (1.1)	89.0 (1.0)	73.5 (4.6)‡	88.4 (2.8)	85.1 (4.0)
School full-time	70.7 (2.1)	70.1 (2.6)	72.4 (3.8)	77.4 (4.1)	65.3 (5.4)
School part-time	88.9 (1.6)	89.2 (1.9)	83.7 (4.1)	90.9 (3.2)	91.1 (6.5)
Public transit					
Work full-time	4.9 (0.8)	2.9 (0.5)	11.1 (2.2)‡	8.0 (2.3)	10.8 (3.3)
Work part-time	7.0 (1.1)	4.6 (0.8)	21.1 (4.5)‡	6.3 (2.4)	9.3 (2.9)
School full-time	9.2 (0.9)	8.0 (0.8)	9.6 (2.1)	10.5 (3.2)	22.1 (5.3)†
School part-time	6.9 (1.3)	5.1 (1.5)	15.5 (4.2)	7.6 (3.0)	8.2 (6.5)
Active transit					
Work full-time	6.1 (0.5)	6.3 (0.7)	6.2 (1.0)	4.8 (1.1)	7.9 (2.3)
Work part-time	13.1 (1.0)	13.1 (1.2)	13.0 (2.7)	11.5 (3.1)	16.1 (4.1)
School full-time	33.0 (2.1)	35.8 (2.6)	25.9 (3.4)†	20.0 (3.3)‡	32.5 (5.4)
School part-time	3.9 (0.9)	3.8 (1.1)	3.5 (1.7)	3.6 (1.8)	7.0 (6.4)

* Data from Wave III (2001), National Longitudinal Study of Adolescent Health. Results are weighted for national representation, and SEs are corrected for multiple stages of cluster sample design and unequal probability of selection.
† Results are statistically significant at $p \leq 0.05$ when compared with whites, using Bonferroni correction.
‡ Results are statistically significant at $p \leq 0.01$ when compared with whites, using Bonferroni correction.

tation was more common among full-time students of high vs. low income and education.

Overall results did not differ statistically by sex across most categories, so results are presented for the total sample. The only statistically significant differences by sex were for public transportation to work, which was higher among men than women (data not shown) and for Asian men who had higher use of public transportation to school (data not shown).

Active and Nonactive Transportation by Overweight Status

A significantly greater proportion of nonoverweight vs. overweight young adults used active modes of transportation to work and school, particularly among full-time students (Table 4), whereas a significantly smaller proportion used car transit to work and school.

Active and Nonactive Transportation by Physical Activity Status

Prevalence of transport by activity status were similar to those seen for overweight. A greater proportion of young adults who achieved five or more bouts of physical activity per week in leisure-time activities used active modes of transportation to work and school (Table 5). Comparing those who met the PA recommendation with those who did not, statistically significant differences in the use of active transportation to work and school were seen only for those who were full-time students and full-time employees. Car transit was highest in those full-time employees and students who did not meet the PA recommendation, but was lower in part-time students.

Discussion

These nationally representative data indicate that the vast majority of adolescents do not use active modes of transportation to work or school. This Add Health analysis sample represents over 16 million young adults; a very small proportion use active transportation to work (1.3 million) or school (4.3 million). Furthermore, use of active modes of transportation was more common among the nonoverweight and the physically active. These figures highlight an important potential area for future public health promotion efforts, particularly in combating alarming population-wide increases in obesity (16), declines in physical activity, and stability of inactivity patterns (17) during the transition to adulthood.

Table 3. Prevalence of different modes of transportation to work and school by socioeconomic background, reported in percentage (SE)*

	Income			Education		
	Low tertile (≤$26K) (*N* = 3004)	**Middle tertile ($26K to 50K) (*N* = 4175)**	**High tertile (>$50K) (*N* = 3592)**	**Less than high school (*N* = 1524)**	**High school or equivalent (*N* = 3088)**	**≥College (*N* = 6159)**
Car transit						
Work full-time	89.6 (1.1)	93.3 (1.1)‡	91.7 (1.3)	90.5 (1.6)	92.9 (1.0)	91.1 (1.1)
Work part-time	83.2 (2.4)	89.1 (1.5)†	86.8 (1.4)	83.6 (4.3)	88.1 (1.8)	87.0 (1.1)
School full-time	74.0 (2.8)	74.9 (1.8)	66.2 (3.3)	72.1 (4.2)	76.9 (2.1)	68.5 (2.6)
School part-time	91.5 (2.0)	87.9 (2.4)	88.2 (3.1)	89.4 (4.4)	90.0 (2.6)	88.2 (2.2)
Public transit						
Work full-time	5.6 (1.0)	4.2 (1.0)	5.2 (0.9)	5.7 (1.4)	4.4 (1.0)	5.0 (0.8)
Work part-time	9.2 (2.0)	6.2 (1.3)	6.6 (1.0)	12.8 (4.3)	7.0 (1.5)	6.1 (0.9)
School full time	7.3 (1.3)	8.0 (1.4)	10.8 (1.0)‡	13.5 (2.9)	9.0 (1.6)	8.9 (0.9)
School part-time	6.9 (2.0)	7.7 (2.1)	5.9 (2.0)	6.8 (3.5)	6.0 (2.0)	7.4 (1.9)
Active transit						
Work full-time	6.3 (0.8)	5.0 (0.6)	7.5 (1.1)	5.2 (1.0)	4.7 (0.7)	7.4 (0.8)
Work part-time	12.3 (2.1)	9.7 (1.2)	17.1 (1.7)	10.1 (2.6)	11.7 (1.9)	14.2 (1.3)
School full-time	24.4 (2.8)	27.2 (1.8)	40.8 (3.3)‡	19.4 (3.8)	25.7 (2.5)	36.7 (2.5)‡
School part-time	3.9 (1.6)	3.8 (1.2)	4.1 (1.7)	4.1 (2.4)	3.0 (1.3)	4.5 (1.3)

* Data from Wave III (2001), National Longitudinal Study of Adolescent Health. Results are weighted for national representation, and SEs are corrected for multiple stages of cluster sample design and unequal probability of selection.
† Results are statistically significant at $p \leq 0.05$ when compared with lowest income or education, using Bonferroni correction.
‡ Results are statistically significant at $p \leq 0.01$ when compared with lowest income or education, using Bonferroni correction.

International research has shown negative relationships between active transportation and overweight and positive associations between active transportation and physical activity (10–14). The association between self-reported obesity and use of car transit has been shown in a study of Atlanta adults (15). The present study adds a national perspective in the investigation of the prevalence of active transport by overweight and leisure-time physical activity status. In addition, this study provides prevalence data on use of active vs. nonactive transit by race/ethnicity in a diverse national data set. This study showed that active transportation to work and school was more likely in nonoverweight and active individuals and was inequitably distributed by ethnicity. Furthermore, active transport was more likely in full-time students of high income and education relative to their counterparts of low income and education.

Overall, physical activity comprises both leisure and nonleisure activities (including walking for transportation purposes). In an attempt to maximize the time and opportunities that the public has to incorporate exercise into their daily routine, public health officials have begun looking at nonleisure physical activity, such as biking and walking to work, as a possible source of exercise.

Walking is associated with many positive health outcomes, including reductions in cardiovascular and cancer-related mortality risk (36,37). Walking has been shown to be acceptable and accessible to populations at highest risk and, thus, an excellent candidate for intervention efforts to increase activity and decrease obesity (5,38).

As we have shown in this paper, there is much room for improvement in terms of increasing the proportion of the population that uses active means of transportation to and from work and school. Recent research suggests that increasing walkability of the neighborhood will increase walking or cycling behaviors (8). In particular, walking for transportation has been shown to be particularly sensitive to environmental features (39). Walking to work is more likely in activity-promoting environments (8,40,41). It is particularly interesting to note that our research shows that active transport is highest in full-time students, who are most likely to live in walkable communities (e.g., on or near college campuses).

Table 4. Prevalence of modes of transportation by overweight and obesity status, reported by percentage (SE)*

	Non-overweight BMI < 25 (*N* = 5541)	Overweight BMI ≥ 25 (*N* = 5230)
Car transit to work	89.2 (1.0)	91.5 (0.9)†
Full-time only	90.6 (1.1)	92.7 (0.9)
Part-time only	86.2 (1.4)	88.0 (1.6)
Car transit to school	71.8 (2.4)	78.6 (1.6)‡
Full-time only	68.0 (2.6)	74.7 (1.9)‡
Part-time only	87.5 (2.3)	90.3 (2.0)
Public transit to work	5.5 (0.7)	5.4 (0.9)
Full-time only	5.0 (0.8)	4.9 (0.9)
Part-time only	6.8 (1.0)	7.1 (1.6)
Public transit to school	9.3 (1.0)	7.9 (1.0)
Full-time only	9.8 (1.1)	8.4 (1.1)
Part-time only	7.4 (2.0)	6.4 (1.6)
Active transit to work	9.2 (0.7)	6.8 (0.6)‡
Full-time only	6.8 (0.7)	5.4 (0.6)
Part-time only	14.6 (1.4)	11.2 (1.4)
Active transit to school	29.7 (2.4)	22.6 (1.7)‡
Full-time only	35.9 (2.5)	28.9 (2.0)‡
Part-time only	4.3 (1.2)	3.5 (1.2)

* Data from Wave III (2001), National Longitudinal Study of Adolescent Health. Results are weighted for national representation, and SEs are corrected for multiple stages of cluster sample design and unequal probability of selection.
† Results are statistically significant at $p \leq 0.05$, using Bonferroni correction.
‡ Results are statistically significant at $p \leq 0.01$, using Bonferroni correction.

Table 5. Prevalence of modes of transportation by leisure-time physical activity status, reported by percentage (SE)*

	Met physical activity recommendation (*N* = 889)	Did not meet physical activity recommendation (*N* = 9882)
Car transit to work	85.6 (1.8)	90.8 (0.8)†
Full-time only	86.4 (2.4)	92.1 (0.9)†
Part-time only	83.6 (3.2)	87.2 (1.2)
Car transit to school	68.3 (3.6)	75.3 (1.9)
Full-time only	61.3 (3.8)	71.7 (2.1)‡
Part-time only	96.0 (1.8)	88.2 (1.6)‡
Public transit to work	5.6 (1.2)	5.5 (0.8)
Full-time only	6.2 (1.6)	4.8 (0.8)
Part-time only	4.0 (1.9)	7.2 (1.1)
Public transit to school	5.9 (1.6)	9.0 (0.9)
Full-time only	5.6 (1.9)	9.5 (1.0)
Part-time only	7.2 (3.5)	6.9 (1.4)
Active transit to work	15.2 (1.7)	7.5 (0.6)‡
Full-time only	12.5 (0.2)	5.6 (0.6)‡
Part-time only	21.8 (4.2)	12.4 (1.1)
Active transit to school	37.0 (3.8)	25.6 (2.0)‡
Full-time only	44.7 (3.9)	31.8 (2.2)‡
Part-time only	6.4 (3.8)	3.7 (0.9)

* Data from Wave III (2001), National Longitudinal Study of Adolescent Health. Results are weighted for national representation, and SEs are corrected for multiple stages of cluster sample design and unequal probability of selection.
† Results are statistically significant at $p \leq 0.05$, using Bonferroni correction.
‡ Results are statistically significant at $p \leq 0.01$, using Bonferroni correction.

This is a cross-sectional prevalence study. Limitations of the study include self-reported modes of static transportation, as opposed to a travel diary, and no data on intensity and duration of transportation-related activity. In addition, self-reported measures of leisure-time physical activity were used. This study did not consider time or distance associated with transit use. Nonetheless, this study provides a national perspective on patterns of active and nonactive transportation by overweight and leisure-time physical activity status and helps to determine groups at highest risk. Future research directions include modeling the causal relationship between active transport and overweight.

At present, there are no data in the physical activity literature on reliability and validity of such active transportation questions. However, several groups have put forth goals to increase walking and bicycling among adults (7,42). Walking trips made by adults have dropped substantially over the past 2 decades (43). Although the importance of active transport is clear, the recent attention to this issue will likely prompt research on reliability and validity of these measures.

The transition from adolescence to young adulthood is an important time to promote both leisure and non-leisure physical activity. Given the fact that a very small portion of adolescents are active and maintain active lifestyles into adulthood, active transportation may play a very important role in raising overall activity levels and decreasing obesity. Active transportation is more common among those who are nonoverweight and achieve five or more bouts of weekly moderate to vigorous physical activity. Furthermore, our findings show that active transportation is highest in full-time students, particularly those of high income and education. Public health efforts to promote active transportation can help to boost overall activity levels, particularly among inactive adults. Population-based efforts to increase environmental supports for physical activity are sorely needed.

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