



Trends in active transportation and associations with cardiovascular disease risk factors among U.S. adults, 2007–2016



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ABSTRACT

Active transportation (AT), or walking or bicycling for transportation, represents one way individuals can achieve recommended physical activity (PA) levels. This study describes AT prevalence and temporal trends, and examines associations between AT levels and measured CVD risk factors (hypertension, hypercholesterolemia, low high-density [HDL] cholesterol, diabetes, and obesity) among U.S. adults.

National Health and Nutrition Examination Survey (NHANES) 2007–2016 data (analyzed in 2017) were used to conduct overall trend analyses of reported AT in a typical week [none (0–9 min/week); low (10–149 min/week); or high (≥ 150 min/week)]. Logistic regression was used to examine associations between AT level and each CVD risk factor from NHANES 2011–2016 ($n = 13,943$). Covariates included age, sex, race/Hispanic origin, education, income, smoking, survey cycle, non-transportation PA, and urbanization level.

U.S. adults who engaged in high AT levels increased from 13.1% in 2007–2008 to 17.9% in 2011–2012, and then decreased to 10.6% in 2015–2016 (p for quadratic trend = 0.004). Over the same period, the quadratic trend for low AT was not significant. During 2011–2016, 14.3% of adults engaged in high AT, 11.4% in low AT, and 74.4% in no AT. High AT levels were associated with decreased odds of each CVD risk factor assessed, compared to no AT. Low AT (versus no AT) was associated with decreased odds of hypertension (aOR = 0.77, 95% CI 0.64, 0.91) and diabetes (aOR = 0.68, 95% CI 0.54, 0.85).

AT prevalence among adults has fluctuated from 2007 to 2016. Despite favorable associations between AT and CVD risk factors, most U.S. adults do not engage in any AT.

1. Introduction

Regular physical activity (PA) can reduce the risk of developing several chronic diseases, including cardiovascular disease (CVD), and also reduces the risk of early mortality (U.S. Department of Health and Human Services, 2008; Physical Activity Guidelines Advisory Committee, 2008). PA is often categorized into four domains based on the location or purpose of activity, including leisure, domestic, occupational, and transportation (Craig et al., 2003; World Health Organization). Active transportation (AT) is defined as any self-propelled human-powered mode of transportation, which primarily includes walking or bicycling. AT is increasingly recognized as one of many ways individuals can achieve recommended PA levels outlined in

the 2008 National PA Guidelines (U.S. Department of Health and Human Services, 2008; United States Department of Health and Human Services, 2015; U.S. Department of Health and Human Services, 2015; Centers for Disease Control and Prevention, 2011), which encourage adults to engage in ≥ 150 min of moderate-intensity PA per week (Physical Activity Guidelines Advisory Committee, 2008; Furie and Desai, 2012).

To promote population-based AT, several national initiatives and priorities have recently emerged (U.S. Department of Health and Human Services, 2008; United States Department of Health and Human Services, 2015; U.S. Department of Health and Human Services, 2015; Centers for Disease Control and Prevention, 2011). These include, but are not limited to, AT-related objectives that are outlined in Healthy

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People 2020, such as PA-13 (Increase the proportion of trips made by walking) and PA-14 (Increase the proportion of trips made by bicycling), and the 2015 Surgeon General's Call to Action to Promote Walking and Walkable Communities (United States Department of Health and Human Services, 2015; U.S. Department of Health and Human Services, 2015). The Surgeon General's report promotes walking across multiple PA domains, including transportation, and encourages communities to improve access to safe and convenient places to walk, bike, use a wheelchair, and be active in other ways (U.S. Department of Health and Human Services, 2015). In 2016, the U.S. Community Preventive Services Task Force determined there was sufficient evidence on the association between the built environment and AT to recommend built environment strategies to improve pedestrian and bicycle transportation systems, and land use and environmental design interventions to encourage PA (Centers for Disease Control and Prevention, 2017a). Despite these national initiatives and priorities to promote AT among individuals and in communities, data from various national surveillance systems have demonstrated inconsistent trends in the prevalence of AT among adults (Whitfield et al., 2015).

Few studies to date have described the health benefits of AT among U.S. adults (Furie and Desai, 2012; Gordon-Larsen et al., 2009; Boone-Heinonen et al., 2009). To our knowledge, only one study has reported significant associations between AT and measured CVD risk factors (Furie and Desai, 2012). Using nationally representative data from 2007 to 2010, the investigators found that adults engaging in AT had lower odds of hypertension and diabetes. Additionally, adults engaging in AT had a lower body mass index (BMI) and smaller waist circumference (Furie and Desai, 2012).

However, it is unknown whether national initiatives and priorities implemented over the past several years have influenced the uptake and prevalence of AT. Furthermore, the associations between AT and CVD health previously reported could be examined with a wider array of measured outcomes (Furie and Desai, 2012). The objectives of this study were to (1) describe the prevalence of and assess trends in AT among adults (≥ 20 years) using data from the National Health and Nutrition Examination Survey (NHANES) over five cycles (2007–2008, 2009–2010, 2011–2012, 2013–2014, and 2015–2016) and (2) to comprehensively examine the associations between AT levels and measured CVD risk factors from the most recent NHANES cycles (2011–2016).

2. Methods

The NHANES is a nationally representative survey of the U.S. civilian, non-institutionalized population with a complex, multistage sampling design. Since 1999, NHANES has operated continuously and data are released in 2-year cycles. Participants completed in-home interviews and physical examinations in a mobile examination center. NHANES was approved by the National Center for Health Statistics (NCHS) Research Ethics Review Board and written informed consent was obtained from participants. Additional details are available elsewhere (Centers for Disease Control and Prevention, 2012; Centers for Disease Control and Prevention, 2014).

2.1. Study sample

In 2007, a measurement change was made to assess AT on the NHANES physical activity questionnaire, which has also resulted in improved concordance with the 2008 PA Guidelines for Americans (U.S. Department of Health and Human Services, 2008; Physical Activity Guidelines Advisory Committee, 2008). Therefore, we examined trends using data from adults aged ≥ 20 years from the 2007–2016 NHANES cycles. The unweighted interview response rate ranged from 64.3% to 72.9% (National Center for Health Statistics, 2017).

Interview and examination data from the 2011–2016 NHANES

cycles (16,381 adults aged ≥ 20 years) were analyzed to examine whether previously observed associations between AT and CVD risk factors remained robust (Furie and Desai, 2012). The examination response rate for this age group was 62.6% in 2011–2012, 63.7% in 2013–2014, and 54.8% in 2015–2016 (National Center for Health Statistics, 2017). Participants who were pregnant ($n = 192$) or reported physical mobility limitations (needing special equipment to walk, much difficulty or inability to walk for $\frac{1}{4}$ mile, or much difficulty or inability to walk up to ten steps without resting, $n = 2225$) were excluded from analysis, yielding an initial analytic sample of 13,964 adults. Participants missing data for AT level ($n = 21$) were further excluded, resulting in a final analytic sample of 13,943 adults.

Participants missing responses for one or more CVD risk factors were excluded from the specific analysis for that risk factor; 378 individuals were excluded from the hypertension analysis (2.7% missing from analytic sample), 638 individuals were excluded from the hypercholesterolemia analysis (4.6%), 743 individuals were excluded from the low HDL cholesterol analysis (5.3%), 554 individuals were excluded from the diabetes analysis (4.0%), and 89 individuals were excluded from the analysis on obesity (0.6%).

2.2. Measures

2.2.1. Dependent variables

Hypertension was defined as measured systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or self-reported current use of hypertension medication, according to hypertension guideline recommendations in effect through 2016 (Bakris et al., 2015). Hypercholesterolemia was defined as serum total cholesterol ≥ 240 mg/dL or self-reported current use of cholesterol-lowering medication. Low HDL cholesterol was defined as serum HDL cholesterol < 40 mg/dL. Diabetes was defined as self-reported physician diagnosis of diabetes or hemoglobin A1c $\geq 6.5\%$. Obesity was defined as BMI (measured weight in kilograms divided by measured height in meters squared) ≥ 30 .

2.2.2. Independent variables

The main independent variable was level of AT, or walking or bicycling for transportation. As part of the NHANES physical activity questionnaire, participants were asked “Do you walk or use a bicycle for at least 10 minutes continuously to get to and from places?” (e.g., to work, for shopping, to school). Only participants responding yes were then asked “In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?” and “How much time do you spend walking or bicycle for travel on a typical day?” (Centers for Disease Control and Prevention, 2012; Centers for Disease Control and Prevention, 2014) Minutes/week were calculated by multiplying the number of days/week on which AT was reported by the number of minutes/day. AT levels were categorized for the entire sample as none (0–9 min/week, which includes participants who responded “no” to the first question asking “Do you walk or use a bicycle for at least 10 min continuously to get to and from places?”), low (10–149 min/week), or high (≥ 150 min/week). The categories reflect the 2008 aerobic PA Guidelines (Physical Activity Guidelines Advisory Committee, 2008; Furie and Desai, 2012). NHANES does not assess self-reported intensity of AT.

Other covariates (selected a priori based on previous research (Furie and Desai, 2012; Gordon-Larsen et al., 2009; Berger et al., 2017)) included the following self-reported characteristics: age group (20–39, 40–59, ≥ 60 years), sex (male or female), race/Hispanic origin (Hispanic, non-Hispanic white, non-Hispanic black, and non-Hispanic Asian), highest level of education attained by participant ($<$ high school, high school, some college, \geq college), poverty income ratio (a measure of family income to poverty guidelines specific to survey year), smoking status (never smoked, former smoker, current smoker), survey cycle (2011–2012, 2013–2014, and 2015–2016), non-transportation

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