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Physical activity from walking and cycling for daily travel in the United States, 2001–2017: Demographic, socioeconomic, and geographic variation

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ABSTRACT

Introduction: Research shows that walking and cycling are sustainable means of travel that contribute to improved physical, mental, and social health. Those documented benefits justify the increased investment by federal, state, and local governments in walking and cycling infrastructure and programs in the United States, especially since 2000. This study examines to what extent daily walking and cycling rates have increased between 2001 and 2017, nationally and for subgroups and regions.
Methods: The 2001, 2017 National Household Travel Surveys were used to estimate the frequency, duration, and distance of walking and cycling per capita. Person and trip files were merged to calculate the prevalence of achieving three different thresholds of minutes walking and cycling per day. Logistic regression was used to calculate prevalence rates for each variable subgroup (e.g. gender) while controlling for the effects of other variables influencing walking and cycling.
Results: National rates of daily walking rose slightly from 2001 to 2017, while cycling rates remained unchanged. There was substantial demographic, socioeconomic, and spatial variation for each year and over time. Walking and cycling were highest among well-educated persons, households with low car ownership, and residents of high-density neighborhoods. Walking and cycling fell among 5-15 year-olds, while increasing among 16-44 year-olds. Men were three times as likely to cycle as women, while walking rates were roughly the same for men and women.
Conclusions: National aggregate rates of walking and cycling have not changed substantially from 2001 to 2017, suggesting that much more needs to be done. Successful efforts of some American cities show that active travel can significantly increase with improved infrastructure, programs, and policies that make walking and cycling safer and more convenient. Such efforts should be implemented on a much greater, nationwide scale to have an impact on the prevalence of active travel among Americans.

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1. Introduction

Medical and public health research show that active travel improves physical, mental, and social health (Donnelly et al., 2016; Kelly et al., 2014; Mueller et al., 2015; Saunders et al., 2013). Moreover, studies show that the health benefits of walking and cycling far offset the potential health costs of traffic injuries (De Hartog et al., 2010). The particular advantage of walking and cycling as forms of physical activity is that they can be easily integrated into daily routines, which makes them more natural, cheaper, and utilitarian than more structured exercise, which includes visits to gyms, fitness centers or swimming pools. In addition to health benefits, transport research shows that walking and cycling are environmentally, socially, and economically sustainable means of urban travel (Fishman, 2016; Gerike et al., 2019; OECD and ITF, 2013; Pucher and Buehler, 2012).

From 2000 to 2018, there has been a 7-fold increase in academic publications documenting the many individual and societal benefits of walking and cycling: from 278 to 1901 per year (Clarivate Analytics, 2019). That boom in academic publications supporting walking and cycling, combined with coordinated advocacy by a wide range of groups, have encouraged increased government funding for walking and cycling. Federal funding grew from $297 million in 2000 to $916 million in 2018 (USDOT, 2019a). State and local funding also increased, partly as required matches to federal funding (LAB, 2019a; USDOT, 2016). That helped finance interventions such as expanded and improved cycling and walking infrastructure (e.g. bike lanes, better sidewalks, multi-use greenways and trails) and complementary programs (e.g. cycling training, bikesharing, safe routes to school, open streets, bike/walk to school/work days).

This article examines to what extent walking and cycling have actually increased during this period of burgeoning research supporting active travel and increases in government investments in walking and cycling infrastructure and programs. We use the 2001 and 2017 National Household Travel Surveys (NHTS) to examine walking and cycling trips, distance, and hours per capita for both years and to assess changes from 2001 to 2017 as well as differences by demographic and socioeconomic group. Our analysis of walking and cycling rates also uses spatial variables in the NHTS to examine differences in active travel among Census regions, between urban and rural areas, and among five categories of population density in residential neighborhoods. The public health focus of the article is on time spent walking and cycling for daily travel and the extent to which they help meet physical activity recommendations.

2. Data and methods

The 2001 and 2017 NHTS are very similar travel surveys (see Table 1). Each NHTS is representative of the non-institutionalized

Table 1
Comparison of NHTS 2001 and 2017.

	NHTS 2001	NHTS 2017
Sample size	69,817 households; 148,616 persons	129,696 households; 264,234 persons
Survey period	In both surveys: 14 months (March to May 2001/2002 and 2016/2017)	
Sampling	List-assisted Random Digit Dialing (RDD)	Address Based Sample (ABS) based on US Postal Service Computerized Delivery Sequence (CDS)
Target population	In both surveys: Civilian, non-institutionalized population	
Cash incentives	Advance letter ($5); diary mailing ($2 per household member)	Advance letter ($2); diary mailing ($5); completion ($20)
Representative	Nation, census regions, and 9 add-on areas	Nation, census regions, and 13 add-on areas
Interview methods	CATI (Computer-Assisted Telephone Interview)	Online (60%), CATI (30%), and both (10%)
Language	In both surveys: English and Spanish	
Data collection period	In both surveys: One-day travel diary; data collected during all days of the year	
Inclusion criteria	At least 50% of household members reporting	All (100%) household members reporting
Children	All ages included; proxy interviews for younger than 16[b]	5 + years included; proxy interviews for younger than 16
AAPOR[a] response rate	41.0%	15.6%
Definition of 'trip'	In both surveys: From one address to another address	
Round (loop) trips	Recorded as two trips (split at farthest distance from home)	Recorded as one trip[c]
Prompts for trips	In both surveys: Multiple prompts reminding respondents not to forget reporting short walk and bike trips including loop trips and trips to public transport	
Trip distance	Self-reported	Calculated as shortest network path between geocoded locations
Public transport access	Walking and cycling captured in access and egress mode variables	Walking captured in access and egress mode variables
Data levels available	In both surveys: Household, person, trip, vehicle	
Weights	In both surveys: Base weight: Reciprocal of probability of selection; adjusted for non-response and household and person level 'raking' procedure using US Census (2000) and ACS (2011–2015)	

[a] AAPOR = American Association for Public Opinion Research.
[b] For this analysis, we removed respondents younger than 5 years from NHTS 2001 to be comparable with 2017 NHTS.
[c] For this analysis, we split loop trips (with the same origin and destination) into two trips, as explained in the text, in order for the trip count to be comparable with the 2001 NHTS, which split loop trips in this way, counting them as two trips.
Source: Kunert et al., (2002); Westat (2018).

population of the United States, based on stratified sampling by state, census region, and metropolitan area. The surveys exclude individuals living in medical institutions, prisons, military barracks, and dormitories. Sample sizes (persons) of the two surveys were 148,616 in 2001 and 263,738 in 2017. Some differences exist between the surveys. The 2001 NHTS used random digit dialing (RDD) of landline phone numbers for recruitment. This became problematic with the rise of cell-phone-only households, which increased from 25% of U.S. households in 2009 to over 50% in 2017 (McGuckin and Fucci, 2018). In response, the 2017 NHTS employed an address-based sample (ABS) drawn from the U.S. Postal Service Computerized Delivery Sequence (CDS) file. By including formerly excluded cell-phone-only households, the 2017 NHTS sampling provided more comprehensive coverage than the 2001 NHTS (Westat, 2018). Another reason for switching from RDD to ABS was declining response rates to RDD of land-line phones, which fell from 40% in the 2001 NHTS to 20% in the 2009 NHTS (not examined here). NHTS statisticians attributed the falling response rates not only to the exclusion of cell phones, but also to the use of caller ID and screening of recruitment calls. The fall in response rate from 2009 to 2017 (20%–16%) was much less than the earlier fall from 2001 to 2009 (McGuckin and Fucci, 2018).

Each NHTS collected data during every day of a 14-month period—from March or April of the first year to May of the second year of data collection. Respondents recorded their travel activities in a travel diary during a randomly assigned travel day—submitted in either English or Spanish. The 2001 NHTS collected travel information using Computer Assisted Telephone Interviews (CATI). For the 2017 NHTS, 60% of respondents reported their travel online using a computer, tablet, or smart phone; 30% relied on CATI; and 10% used a mix of both (Westat, 2018).

For both NHTS surveys, proxy-interviews were held with adults reporting information for those aged younger than 16 years. The 2017 NHTS only included respondents who were at least 5 years old, while the 2001 NHTS included all ages (USDOT, 2019b; Westat, 2018). To increase comparability, we excluded from our analysis respondents younger than 5 years in the 2001 NHTS.

Each survey defines a 'trip' as from 'one address to another,' excluding short trips within the same address, such as going to the mailbox. Both NHTS surveys include multiple prompts reminding respondents to report short walk and bike trips. All surveys capture walking trips to and from public transport (PT)—with walking accounting for about 90% of access/egress trips. NHTS 2001 also captured bicycle trips to and from PT—which, however, accounted for only 0.5% of PT access/egress trips. NHTS 2017 groups these bicycle trips in the 'other' category. Thus, our analysis could not include bicycle trips to and from PT for NHTS 2017 (McGuckin and Fucci, 2018; Westat, 2018).

NHTS 2001 recorded loop trips starting and ending at the same address (e.g. walking the dog) as two separate trips—split at the farthest distance from the starting address. NHTS 2017 recorded loop trips as only one trip. For this analysis, we split loop-trips in the 2017 NHTS into two trips to assure comparability between the two surveys. NHTS 2017 calculated shortest-path distances of trips between two geocoded addresses, while NHTS 2001 relied on self-reported trip distances. Overall trip distances in NHTS 2017 are almost certainly more accurate, but not fully comparable to the self-reported trip distances from 2001 (McGuckin and Fucci, 2018).

NHTS surveys use a complex weighting procedure. The base weight for all sampled addresses is the reciprocal of the probability of selection. Each survey adjusts the base weight for non-response. In addition, a 'raking' procedure adjusts weights at both the household and person levels based on external data from the US Census Bureau on region, state, city size; race/ethnicity; income; household size; vehicle ownership; and week and month of the year (Westat, 2018).

The NHTS surveys provide data in four different files for households, persons, trips, and vehicles. For our analysis, number, duration, and distance of walking and cycling trips were aggregated from the trip file to the person file, yielding per-capita daily rates. These rates include zero walk or zero bike trips for individuals who did not report any trips during the assigned travel day. We multiplied the daily rates by 365 to obtain approximations of annual rates per capita. For the daily physical activity analysis, we used the aggregated trip duration information to estimate three different measures at the person level: at least 10, 20, or 30 min of walking or cycling during a travel day, as even small increments in active commuting may have benefits (Rissel et al., 2012). The category of 30 min a day approximates the previous U.S. physical activity guideline of 30 min a day at least 5 days a week. The category of 20 min a day approximates the current U.S. physical activity guideline of 150 min per week (CDC, 2019; USDHHS, 2018, 2008).

Using the person file, we stratified the analysis by characteristics of individuals (gender, age, education, employment, race/ethnicity) and their households (car ownership, income, population density, urban vs rural location, and U.S. Census Region). Population density was measured at the level of Census Block Group, which approximates a neighborhood of about 1500 residents. The variable race/ethnicity was based on self-reported identification of respondents. The groups reported by NHTS are mutually exclusive to avoid double counting. Due to small sample sizes for some racial/ethnic categories (especially for cycling), our analysis aggregated them into only two groups: non-Hispanic white and all others. Although there is almost certainly variation among those "other" groups, they did not have enough observations to yield reliable estimates for both walking as well as cycling.

Statistical significance was determined by calculating differences in weighted proportions or means between independent samples ($P < 0.05$ and $P < 0.01$). To control for the effects of covariates and possible confounders, logistic regression was used to calculate the likelihood of walking or cycling at three physical activity thresholds in 2001 and 2017 after adjusting for the effects of other variables. The adjusted odds ratios for each variable were calculated relative to a base group category for each variable, with a base odds ratio value of 1.0. We also assessed changes in coefficients for the same variable between 2001 and 2017 using logistic regressions with interaction effects. Those regressions are not shown in this paper, but coefficients that differed significantly between 2001 and 2017 are indicated by # ($P<0.05$) in Tables 6 and 7. Employment, income, and urban/rural variables were excluded from the logistic regressions because of their multicollinearity with the other explanatory variables. For example, income was strongly correlated with car ownership as well as education and employment. Similarly, the variable urban/rural was strongly correlated with residential density. We assessed sign, magnitude, and significance of coefficients of variables and their sub-categories in each year and over time.

Although there was also an NHTS survey in 2009, we did not include it in our analysis. The 2009 NHTS estimates of walking and cycling in the USA were almost certainly boosted during the March 2008–April 2009 survey period by a sharp, temporary increase in gasoline prices and by one of the most severe economic recessions in recent decades (McGuckin and Fucci, 2018; Pucher et al., 2011; USDOT, 2019b; Westat, 2018). Thus, increases in reported active travel between 2001 and 2009 were inflated by temporary conditions, also resulting in smaller increases between 2009 and 2017 than would have been observed without the recession and high gas prices in 2009. In addition, the longer-term period 2001–2017 seemed more reliable than the two shorter-term periods 2001–2009 and 2009–2017.

2.1. *Strengths and limitations*

A major strength is that the NHTS surveys are the only source of information on daily travel by Americans for all trip purposes, whereas the annual American Community survey (ACS) of the United States Census Bureau provides data only on the journey to work, which accounts for less than a fifth of all trips. NHTS surveys also allow estimation of total time spent walking and cycling—for all trip purposes—and changes over time. Moreover, they enable assessment of the extent to which walking and cycling contribute to meeting physical activity recommendations.

The two NTHS surveys used the same stratified weighting procedures. The 2017 NHTS employed the more representative ABS sampling procedure, while the 2001 NHTS relied on random digit dialing (RDD). Declining response rates and increasing shares of cell-phone-only households would have severely limited the coverage of an RDD-based NHTS in 2017. Similar to virtually all personal travel surveys, the NHTS surveys rely on self-reported information, which may not be completely reliable. The NHTS relies on respondents' memory recall of specific trips, even short trips, the means of travel, and travel time for each of those trips. For both NHTS surveys, weights were applied to the sample so that all days of the week and all months of the year are equally represented.

There has been concern about falling response rates and declining per-capita trip rates reported in the NHTS (McGuckin and Fucci, 2018; Westat, 2018). As discussed above, the response rate for the NHTS fell from 40% to 16% between 2001 and 2017. However, falling response rates are not unique to the NHTS, but have also been reported for most other national household surveys in addition to transportation (USDHHS, 2016). In addition, reported trip rates per person fell from 2001 to 2017, continuing a long-term trend in declining trip rates in the USA: 4.3 in 1995, 4.1 in 2001, 3.7 in 2009, and 3.4 in 2017. Thus, the most recent decline is not an aberration. The largest contributor to falling daily trip rates was a decline in trips made for shopping and errands—down from 2.0 trips per person per day in 2001 to 1.3 in 2017. The decrease in shopping and errand trips may be related to an increase in reported home deliveries from online shopping—which more than doubled between 2009 and 2017 (McGuckin and Fucci, 2018). In addition, the share of respondents reporting no trips during the travel day in NHTS has increased since 1995—in particular for age groups younger than 60 (McGuckin and Fucci, 2018). An increase in the percentage of employed persons working regularly from home (telecommuting) may also help explain the decrease in reported trips. Between 2000 and 2017, the share of employees regularly working from home increased from 3.3% to 4.7% (USDOC, 2000, 2019).

Our regression analyses could not test nor control for the influence of transport policy variables, such as the supply and quality of bikeway or walkway infrastructure. In addition, we could not capture perceptions, such as perceived cyclist and pedestrian safety. Those transport policy and perception variables are not available in NHTS.

The data from the NHTS surveys are cross-sectional for each year. Thus, they do not permit analysis of changes in travel behavior of the same individuals over time, as a panel time-series dataset would allow. However, the comparability of the two surveys facilitates examination of changes over time among subgroups. Another limitation of our analysis is that it cannot prove causality, but only show associations between walking and cycling levels and the variables within the dataset.

Table 2
Annual walking and cycling trips, duration, and distance per capita in the United States, 2001–2017.

	2001		2017		Difference
	Mean	95% CI	Mean	95% CI	2001–2017
Number of trips					
Walking	168.6	164.3–173.0	179.2	173.4–185.1	+10.6*
Cycling	12.4	11.3–13.1	12.4	11.2–13.5	0.0
Active travel	181.0	176.7–185.4	191.3	185.4–197.1	+10.2*
Duration (hours)					
Walking	33.0	31.9–36.1	37.1	35.7–38.6	+4.1*
Cycling	4.5	4.1–5.0	4.3	3.8–4.8	−0.2
Active travel	37.5	36.3–38.8	41.4	39.9–42.9	+3.9*
Distance (miles)					
Walking	91.3	(87.2–93.8)	91.3	87.1–101.5	0.0
Cycling	25.6	(20.8–26.6)	29.2	23.4–31.0	+3.7
Active travel	114.2	(109.9–119.0)	116.8	104.8–129.6	+2.6

*$P < 0.05$.
Note. Sample sizes were: 148,616 (2001) and 263,738 (2017). Respondents younger than 5 years were excluded to ensure comparability among the three surveys. Caution must be used in interpreting changes between 2001 and 2017 because of changes in survey methodology in 2017.
Source: Calculated by the authors based on NHTS 2001 and 2017.

3. Results

Table 2 shows the annual number of trips, total duration, and distances walked or cycled per capita in each survey year. Across the 16-year period from 2001 to 2017, Americans reported around eleven more walking trips and four more hours of walking per year ($p < 0.05$), with negligible changes in the number of cycling trips and time spent cycling per year. The minimal growth in walking and cycling trips must be considered relative to the overall decline in daily travel in the USA over the same period. Total daily trips per capita per year (all modes of travel) fell by 17% from 2001 to 2017, compared to a 6% increase in walk and bike trips per capita. Total hours of travel per person per year (all modes) declined by 0.5% from 2001 to 2017, compared to a 10% increase in hours of walking and cycling. Total distance traveled per person per year (all modes) fell by 3.5% from 2001 to 2017, compared to a 2% increase in distance walked and cycled per person per year. Thus, declining overall daily travel may help explain why walking and cycling have not increased more. Indeed, relative to motorized travel, active travel has increased considerably: the combined mode share of walking and cycling rose from 9.6% of all daily trips in 2001 to 12.9% in 2017.

Table 3 shows the proportion of Americans achieving at least 10, 20, and 30 min of daily physical activity through walking and cycling. Between 2001 and 2017, the share of Americans achieving at least 30 min of walking per day increased significantly ($P < 0.05$) from 7.2% to 7.9%. Changes in the proportions achieving any level of daily cycling minutes suggest no change or small but statistically significant reductions ($P < 0.05$). Thus, increased prevalence of walking or cycling (combined) for at least 30 min per day is solely attributable to increases in walking.

Table 4 shows demographic, socioeconomic, and spatial variations in the prevalence of achieving at least 10, 20, and 30 min of walking per day in 2001 and 2017. Walking increased among men ($P < 0.05$), but not among women. Walking increased significantly among middle-aged adults 25–64 years, but declined significantly among children and adolescents aged 5–15 years ($P < 0.05$). Walking increased among people with a university degree and with household incomes in the lowest and highest income quartiles ($P < 0.05$). People in households without a car showed, by far, the largest walking increases of any of the subgroups of any of the variables shown in Table 4 (+7.2 percentage points, e.g. from 20.6% to 27.8% achieving the 30-min threshold ($P < 0.05$)). Walking also increased more among non-Hispanic whites than other racial/ethnic groups ($P < 0.05$). Geographic differences are striking, with the largest increases in Census Block Groups with the highest population density, in urban areas (vs. rural), and in the Northeast Census Region ($P < 0.05$).

Similarly, Table 5 shows the population prevalence of attaining at least 10, 20, and 30 min of daily cycling in 2001 and 2017. As noted previously, overall changes in cycling were small. There were significant increases, however, among middle-aged adults (25–64), university graduates, people in households without a car, and those living in neighborhoods with high residential density ($P < 0.05$). There was a large and statistically significant decline in cycling among children and adolescents aged 5–15 ($P < 0.05$). Cycling also declined significantly in households with two or more cars, in rural areas, at lower population densities, and in the South ($P < 0.05$). In both years, rates of cycling were highest for non-Hispanic whites and persons in the highest-income category, with only very small changes from 2001 to 2017.

Tables 6 and 7 show results from our logistic regression indicating the relative likelihood of attaining at least 10, 20, and 30 min of walking and cycling in 2001 and 2017 for different demographic and socioeconomic groups and different geographic categories. The adjusted odds ratios shown for each variable are calculated relative to a base group category for each variable, with a base ratio value of 1.0. Statistically significant differences among categories within each variable in each year are indicated in Tables 6 and 7 for $P < 0.05$ (*) and $P < 0.01$ (**). Coefficients for the same variable that differed significantly between 2001 and 2017 are indicated by # ($P<0.05$) in the 2017 columns.

As shown in Table 6, women reported slightly higher walking rates than men in 2001, while men had slightly higher walking rates

Table 3

Prevalence of attaining at least 10-, 20-, and 30-minute physical activity thresholds through daily walking and cycling in the United States, 2001–2017.

	2001		2017		Percentage Point Change 2001–2017
	Percent	95% CI	Percent	95% CI	
At least 10 min of walking	14.0	13.6–14.4	14.3	13.9–14.7	+0.3
At least 20 min of walking	10.1	9.8–10.5	10.6	10.2–11.0	+0.5
At least 30 min of walking	7.2	6.9–7.4	7.9	7.6–8.2	+0.7*
At least 10 min of cycling	1.5	1.4–1.7	1.3	1.2–1.5	−0.2*
At least 20 min of cycling	1.2	1.1–1.3	1.1	1.0–1.2	−0.1*
At least 30 min of cycling	0.9	0.8–0.9	0.9	0.8–1.0	0.0
At least 10 min of walking or cycling	15.2	14.8–15.7	15.3	14.9–15.8	+0.1*
At least 20 min of walking or cycling	11.2	10.8–11.6	11.5	11.2–11.9	+0.3*
At least 30 min of walking or cycling	8.0	7.8–8.3	8.7	8.4–9.0	+0.8*

*$P < 0.05$.

Note. Sample sizes were: 148,616 (2001) and 263,738 (2017). Respondents younger than 5 years were excluded to ensure comparability among the three surveys. Caution must be used in interpreting changes between 2001 and 2017 because of changes in survey methodology in 2017.

Source: Calculated by the authors based on NHTS 2001 and 2017.

Table 4
Prevalence of 10, 20, and 30 min Walking per Day by Demographic Group and Geography in the United States, 2001–2017

	10 min		20 min		30 min		Percentage Point Change 2001–2017		
	2001	2017	2001	2017	2001	2017			
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	10 min	20 min	30 min
All	14.0% (13.6–14.4)	14.3% (13.9–14.7)	10.1% (9.8–10.5)	10.6% (10.2–11.0)	7.2% (6.9–7.4)	7.9% (7.6–8.2)	+0.3	+0.5	+0.7*
Sex									
Male	13.2% (12.7–13.8)	14.2% (13.7–14.7)	9.4% (8.9–9.4)	10.5% (10.1–10.9)	6.6% (6.2–6.9)	7.8% (7.4–8.2)	+1.0*	+1.1*	+1.3*
Female	14.7% (14.1–15.3)	14.4% (13.9–14.9)	10.9% (10.5–11.5)	10.7% (10.3–11.2)	7.8% (7.4–8.2)	8.1% (7.7–8.5)	−0.3	−0.2	+0.3
Age group									
5-15′	17.5% (16.4–18.7)	12.8% (11.6–14.0)	11.5% (10.5–12.5)	8.5% (7.6–9.5)	7.5% (6.8–8.1)	5.9% (5.1–6.8)	−4.8*	−3.0*	−1.6*
16–24	13.5% (12.4–14.7)	14.7% (13.5–16.0)	9.6% (8.6–10.7)	10.4% (9.4–11.5)	6.7% (5.9–7.5)	7.6% (6.8–8.5)	+1.2	+0.8	+0.9
25–44	13.3% (12.6–14.0)	15.8% (15.1–16.5)	9.8% (9.3–10.4)	11.8% (11.2–12.4)	7.1% (6.6–7.6)	8.8% (8.2–9.4)	+2.5*	+2.0*	+1.7*
45–64	13.1% (12.5–13.7)	14.2% (13.6–14.8)	10.0% (9.5–10.6)	10.8% (10.3–11.3)	7.3% (6.9–7.8)	8.1% (7.6–8.6)	+1.1*	+0.8*	+0.8*
65+	12.9% (12.1–13.8)	13.0% (12.3–13.7)	9.9% (9.2–10.6)	10.3% (9.7–10.9)	7.4% (6.8–8.0)	8.2% (7.7–8.8)	0.0	+0.4	+0.9*
Education									
Less than HS Degree	12.6% (11.6–13.8)	14.7% (13.6–15.9)	9.3% (8.4–10.3)	10.5% (9.5–11.5)	7.0% (6.2–7.8)	8.2% (7.3–9.1)	+2.1*	+1.2	+1.2
HS Degree	11.5% (11.1–12.1)	11.5% (11.0–12.0)	8.5% (8.1–8.9)	8.6% (8.2–9.0)	6.1% (5.8–6.4)	6.5% (6.2–6.9)	0.0	+0.1	+0.4
University Degree	17.2% (16.4–18.0)	18.7% (18.1–19.3)	13.2% (12.5–13.9)	14.2% (13.6–14.8)	9.5% (8.9–10.0)	10.6% (10.1–11.1)	+1.5*	+1.0*	+1.2*
Working status									
Employed	12.5% (12.1–13.0)	10.3% (9.9–10.8)	9.1% (8.7–9.5)	14.3% (13.8–14.8)	6.4% (6.1–6.7)	7.6% (7.2–7.9)	−2.2*	+5.2*	+1.2*
Not in workforce/unemployed	14.9% (14.2–15.6)	11.9% (11.5–12.5)	11.5% (10.9–12.2)	15.1% (14.5–14.7)	8.5% (8.0–9.0)	9.4% (9.0–9.9)	−3.0*	+3.6*	+0.9*
Number of cars in household									
No car	38.9% (36.2–41.7)	45.9% (43.3–48.5)	28.5% (26.1–30.9)	35.7% (33.4–38.0)	20.6% (18.9–22.5)	27.8% (25.7–30.1)	+7.0*	+7.2*	+7.2*
One car	17.6% (16.6–18.7)	18.2% (17.3–19.2)	13.0% (12.1–14.0)	13.4% (12.6–14.3)	9.3% (8.7–10.0)	10.1% (9.4–10.9)	+0.6	+0.4	+0.8
2 cars	12.2% (11.6–12.8)	11.6% (11.0–12.2)	8.8% (8.3–9.4)	8.3% (7.8–8.8)	6.0% (5.7–6.4)	6.2% (5.8–6.6)	−0.6	−0.5	+0.2
≥3 cars	9.9% (8.9–10.5)	8.5% (7.9–9.0)	7.0% (6.5–7.5)	6.2% (5.8–6.7)	5.1% (4.7–5.5)	4.4% (4.0–4.9)	−1.5*	−0.8*	−0.7*
Race/Ethnicity[a]									
All others	17.1% (16.1–18.2)	16.1% (15.3–16.8)	12.2% (11.3–13.2)	11.8% (11.1–12.4)	8.8% (8.0–9.6)	8.7% (8.1–9.2)	−1.0*	−0.4	−0.1
Non-Hispanic White	12.7% (12.3–13.1)	13.2% (12.8–13.7)	9.3% (8.9–9.6)	9.9% (9.5–10.3)	6.5% (6.2–6.8)	7.5% (7.1–7.8)	+0.5*	+0.6*	+1.0*
Income Quartiles									
Lowest	16.8% (15.7–17.9)	17.0% (16.1–18.0)	12.3% (11.3–13.4)	13.0% (12.2–13.8)	8.9% (8.0–9.8)	10.5% (9.4–11.1)	+0.2	+0.7	+1.6*
2nd	12.7% (12.0–13.5)	12.1% (11.4–12.9)	8.9% (8.3–9.5)	8.8% (8.2–9.4)	6.3% (5.8–6.8)	6.3% (5.8–6.9)	−0.6	−0.1	0.0
3rd	12.2% (11.4–13.1)	12.7% (12.0–13.5)	8.9% (8.1–9.6)	9.3% (8.6–9.9)	6.3% (5.7–6.9)	6.8% (6.3–7.4)	+0.5	+0.4	+0.5
Highest	14.6% (13.8–15.6)	15.9% (15.0–16.8)	10.8% (10.1–11.5)	11.5% (10.7–12.3)	7.6% (7.0–8.2)	8.5% (7.8–9.2)	+1.3*	+0.7	+0.9*
Population Density									
<=300 ppsqm	8.8% (8.3–9.4)	6.9% (6.4–7.5)	6.4% (6.0–7.0)	5.4% (4.9–5.9)	4.6% (4.2–5.1)	4.2% (3.8–4.7)	−1.9*	−1.1*	−0.4
300<=1500 ppsqm	10.9% (10.1–11.7)	10.1% (9.3–10.9)	7.8% (7.1–8.6)	7.1% (6.6–7.8)	5.6% (5.0–6.2)	5.3% (4.8–5.8)	−0.8	−0.7	−0.3
1500<=3,000ppsqm	13.2% (12.3–14.1)	12.8% (11.9–13.8)	9.6% (8.8–10.4)	9.2% (8.6–10.0)	6.4% (5.8–7.1)	7.0% (6.4–7.7)	−0.4	−0.3	+0.6
3000 + ppsqm	21.5% (20.5–22.5)	23.7% (22.9–24.6)	15.6% (14.7–16.4)	17.7% (17.0–18.5)	11.1% (10.4–11.9)	13.1% (12.4–13.8)	+2.3*	+2.2*	+2.0*
Urban vs. Rural									
Rural	8.0%	5.9%	5.7%	4.5%	4.2%	3.5%	−2.1*	−1.2*	−0.7*

(*continued on next page*)

Table 4 (*continued*)

	10 min		20 min		30 min		Percentage Point Change 2001–2017		
	2001	2017	2001	2017	2001	2017			
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	10 min	20 min	30 min
	(7.5–8.6)	(5.3–6.4)	(5.3–6.1)	(4.1–5.1)	(3.8–4.6)	(3.0–3.9)			
Urban	15.7% (15.2–16.2)	16.2% (15.7–16.7)	11.4% (11.0–11.9)	11.9% (11.5–12.3)	8.0% (7.8–8.4)	8.9% (8.5–9.3)	+0.5	+0.5*	+0.9*
U.S. Census Region									
Northeast	21.0% (20.0–22.1)	22.6% (22.4–23.9)	15.2% (14.3–16.1)	17.0% (16.0–18.1)	11.0% (10.3–11.8)	12.8% (11.9–13.8)	+1.6*	+1.8*	+1.8*
Midwest	12.3% (11.6–13.2)	12.8% (11.9–13.7)	8.7% (8.1–9.4)	9.2% (8.5–10.1)	5.9% (5.4–6.4)	6.8% (6.1–7.5)	+0.4	+0.5	+0.8*
South	9.8% (9.2–10.4)	10.2% (9.6–10.8)	7.3% (6.7–7.8)	7.4% (6.9–7.9)	5.0% (4.6–5.5)	5.5% (5.1–6.0)	+0.4	+0.1	+0.5*
West	16.3% (15.3–17.4)	16.1% (15.4–16.9)	11.9% (11.0–12.9)	12.1% (11.5–12.8)	8.7% (7.9–9.5)	9.1% (8.5–9.7)	−0.2	+0.2	+0.4

Note: Sample sizes were: 148,616 (2001) and 263,738 (2017). Respondents younger than 5 years were excluded to ensure comparability between the 2001 and 2017 surveys. Statistically significant changes between 2001 and 2017 are indicated by * ($P < 0.05$).

[a] Race/ethnicity is as reported by the respondents. Other races and ethnicities not shown in the table, including mixed races and ethnicities, accounted for so few cases that reliable estimates could not be reported.

Source: Calculated by the authors based on NHTS 2001 and 2017.

in 2017, but with no significant gender gap in either year. Younger adults aged 16–24 were more likely to walk for at least 10 and at least 20 min daily than all older ages. The age group 5–15 was excluded from this logistic regression (and in Tables 6 and 7) because of the strong multi-collinearity between that age group and the education variable. Those with a university education walked much more at all thresholds in both years. Compared to people in households without cars, people in households with at least one car were much less likely to walk. People in households with three or more cars were only a fifth to a tenth as likely to walk, depending on which minute threshold. Compared to non-Hispanic whites, other racial/ethnic groups (in aggregate) were generally less likely to walk at any level. People in the highest-income quartile were more likely to walk compared to the lowest-income quartile. Geographic variables showed strong relationships with walking rates. In both 2001 and 2017, rates of walking were consistently higher for those living in neighborhoods with high population density, with the likelihood of walking in the densest neighborhoods more than twice as high as in the least dense neighborhoods. Walking rates also increased most between 2001 and 2017 for the highest-density category. As seen in Tables 4 and 5, differences in walking rates among the four residential density categories are much larger than differences between urban and rural, suggesting that density is more important. Residents of the Northeast Census Region were far more likely to walk than in other regions in both years.

Table 7 shows the logistic regression models for cycling. As suggested by Table 5 as well, there is a large, significant and growing gender gap in cycling, with men nearly three times as likely as women to achieve any of the daily minutes of cycling thresholds in 2017. Excluding children and adolescents 5–15 years old (to avoid multicollinearity with education), the largest and only statistically significant age differences in cycling rates were for adults over 65 years. Relative to the 16–24 age group, cycling rates for older adults have fallen sharply over time, from roughly a third less in 2001 to almost two-thirds less in 2017. The relationship between cycling rates and higher education has increased significantly over time. In 2001 there was almost no difference in cycling rates between university graduates and people without a high school diploma (the base group), while in 2017, university graduates had cycling rates roughly twice as high.

Similar to walking, car ownership was strongly and inversely related to the likelihood of cycling in both years. Compared to individuals in households without cars (the base group), those in households with at least one car were less than half as likely to cycle in 2001 and only slightly more than a third as likely in 2017. Rates were even lower for households with two cars and lowest for those with three or more cars, which had cycling rates in 2017 only a tenth as high as households without a car. Compared to other racial/ethnic groups (in aggregate), non-Hispanic white Americans were more than twice as likely to cycle at any of the 10-, 20-, and 30-minute thresholds. Geographic indicators showed strong relationships with and cycling rates. In both 2001 and 2017, greater population density was associated with higher cycling rates. The likelihood of cycling in the densest neighborhoods was more than twice as high as in the least dense neighborhoods. In both 2001 and 2017, residents of the West Census Region were much more likely to cycle in the other Census regions, and about twice as likely as in the base Northeast Region.

4. Discussion

From 2001 to 2017, national prevalence rates of daily walking increased only slightly, while cycling remained mostly unchanged. In both years, however, there were large and statistically significant variations in walking and cycling rates among many of the variable subcategories. Moreover, for some variable subgroups, there were statistically significant changes in prevalence rates between the two years. Although our analysis cannot prove causality, the estimated relationships suggest important and consistent demographic, socioeconomic, and spatial variation in rates of walking and cycling and the extent to which they contribute to daily

Table 5
Prevalence of 10, 20, and 30 min cycling per day by demographic group and geography in the United States, 2001–2017.

	10 min		20 min		30 min		Percentage Point Change 2001–2017		
	2001	2017	2001	2017	2001	2017			
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	10 min	20 min	30 min
All	1.5% (1.4–1.7)	1.3% (1.2–1.5)	1.2% (1.1–1.3)	1.1% (1.0–1.2)	0.9% (0.8–1.0)	0.9% (0.8–1.0)	−0.2	−0.1	0.0
Sex									
Male	2.1% (1.9–2.3)	2.0% (1.8–2.1)	1.7% (1.5–1.9)	1.6% (1.5–1.8)	1.3% (1.1–1.4)	1.3% (1.1–1.4)	−0.1	−0.1	0.0
Female	1.0% (0.9–1.1)	0.8% (0.7–0.9)	0.7% (5.3–8.1)	0.6% (0.5–0.7)	0.5% (0.4–0.6)	0.5% (0.4–0.6)	−0.2*	−0.1	0.0
Age group									
5-15′	4.5% (4.0–5.0)	1.9% (1.6–2.2)	3.2% (2.8–3.7)	1.3% (1.1–1.7)	2.4% (2.1–2.7)	0.9% (0.7–1.2)	−2.6*	−1.9*	−1.5*
16–24	1.0% (0.8–1.4)	1.2% (0.9–1.5)	0.9% (0.6–1.2)	1.0% (0.8–1.4)	0.6% (0.4–0.9)	0.8% (0.6–1.1)	0.0	+0.1	+0.2
25–44	1.1% (0.9–1.3)	1.8% (1.5–2.0)	0.8% (0.7–1.0)	1.4% (1.2–1.7)	0.7% (0.6–0.9)	1.2% (1.0–1.4)	+0.7*	+0.6*	+0.5*
45–64	0.8% (0.6–0.9)	1.2% (1.0–1.3)	0.6% (0.5–0.8)	1.0% (0.9–1.2)	0.5% (0.4–0.7)	0.8% (0.7–1.0)	+0.4*	+0.4*	+0.3*
65+	0.7% (0.5–0.9)	0.6% (0.5–0.8)	0.5% (0.4–0.7)	0.5% (0.4–0.7)	0.3% (0.2–0.5)	0.5% (0.4–0.6)	0.0	0.0	+0.2
Education									
Less than HS Degree	1.0% (0.7–1.3)	1.3% (1.0–1.6)	0.8% (0.6–1.2)	1.0% (0.7–1.3)	0.6% (0.4–0.9)	0.7% (0.5–1.0)	+0.2	+0.1	+0.1
HS Degree	0.7% (0.6–0.8)	0.9% (0.8–1.0)	0.5% (0.4–0.7)	0.7% (0.6–0.9)	0.4% (0.3–0.5)	0.6% (0.5–0.7)	+0.2*	+0.2*	+0.2*
University Degree	1.3% (1.1–1.6)	1.8% (1.6–2.0)	1.1% (0.9–1.4)	1.6% (1.4–1.9)	1.0% (0.8–1.2)	1.3% (1.1–1.5)	+0.5*	+0.5*	+0.4*
Working status									
Employed	1.0% (0.9–1.1)	1.4% (1.3–1.6)	0.8% (0.7–0.9)	1.2% (1.1–1.3)	0.7% (0.6–0.8)	1.0% (0.9–1.1)	+0.4*	+0.4*	+0.4*
Not in workforce/unemployed	0.9% (0.7–1.1)	1.0% (0.9–1.2)	0.7% (0.5–0.8)	0.9% (0.8–1.0)	0.5% (0.4–0.6)	0.7% (0.6–0.9)	+0.1	+0.2	+0.2
Number of cars in household									
No car	1.9% (1.3–2.7)	3.7% (2.9–4.6)	1.5% (1.0–2.2)	3.4% (2.7–4.3)	1.1% (0.7–1.7)	2.8% (2.1–3.7)	+1.8*	+1.9*	+1.7*
One car	1.3% (1.0–1.6)	1.8% (1.5–2.0)	1.0% (0.8–1.2)	1.5% (1.2–1.7)	0.7% (0.5–0.8)	1.1% (0.9–1.3)	+0.5*	+0.5*	+0.4*
2 cars	1.7% (1.5–2.0)	1.2% (1.0–1.3)	1.3% (1.1–1.5)	0.9% (0.8–1.1)	1.0% (0.9–1.1)	0.7% (0.6–0.9)	−0.6*	−0.4*	−0.3*
≥3 cars	1.4% (1.2–1.7)	0.8% (0.7–1.0)	1.1% (0.9–1.3)	0.6% (0.5–0.8)	0.9% (0.7–1.1)	0.5% (0.4–1.0)	−0.6*	−0.5*	−0.4*
Race/Ethnicity[a]									
All others	1.2% (1.0–1.4)	1.0% (0.9–1.2)	0.9% (0.7–1.2)	0.8% (0.7–1.0)	0.7% (0.5–0.9)	0.6% (0.5–0.8)	−0.2	−0.1	0.0
Non-Hispanic White	1.7% (1.5–1.9)	1.6% (1.4–1.7)	1.3% (1.2–1.4)	1.3% (1.1–1.4)	1.0% (0.9–1.1)	1.0% (0.9–1.2)	−0.1	0.0	+0.0
Income Quartiles									
Lowest	1.3% (1.1–1.7)	1.4% (1.2–1.7)	1.0% (0.8–1.3)	1.2% (1.0–1.5)	0.7% (0.6–1.0)	0.9% (0.8–1.1)	+0.1	+0.2	+0.2
2nd	1.4% (1.1–1.6)	1.2% (1.0–1.4)	1.1% (0.9–1.4)	0.9% (0.8–1.1)	0.9% (0.7–1.1)	0.8% (0.6–0.9)	−0.2	−0.2	−0.1
3rd	1.9% (1.5–2.3)	1.3% (1.1–1.5)	1.3% (1.1–1.6)	1.0% (0.8–1.2)	1.0% (0.8–1.3)	0.8% (0.7–1.0)	−0.6*	−0.3	−0.2
Highest	1.9% (1.6–2.2)	1.7% (1.4–1.9)	1.4% (1.1–1.6)	1.4% (1.2–1.7)	1.0% (0.8–1.3)	1.1% (0.9–1.3)	−0.2	0.0	+0.1
Population Density									
<=300 ppsqm	1.4% (1.1–1.6)	0.7% (0.6–0.9)	1.0% (0.8–1.2)	0.6% (0.5–0.8)	0.7% (0.6–0.9)	0.5% (0.4–0.6)	−0.7*	−0.4*	−0.2*
300<=1500 ppsqm	1.8% (1.5–2.1)	1.0% (0.8–1.2)	1.4% (1.1–1.8)	0.8% (0.6–1.0)	1.0% (0.8–1.4)	0.7% (0.5–0.8)	−0.8*	−0.6*	−0.3*
1500<=3,000ppsqm	1.5% (1.2–1.8)	1.3% (1.1–1.6)	1.1% (0.9–1.4)	1.0% (0.8–1.2)	0.8% (0.7–1.1)	0.8% (0.6–1.0)	−0.2	−0.1	+0.0
3000 + ppsqm	1.6% (1.3–1.9)	2.1% (1.9–2.4)	1.2% (1.0–1.5)	1.8% (1.6–2.0)	1.0% (0.8–1.2)	1.4% (1.2–1.6)	+0.5*	+0.5*	+0.4*
Urban vs. Rural									
Rural	1.3%	0.6%	1.0%	0.5%	0.7%	0.4%	−0.7*	−0.5*	−0.3*

(continued on next page)

Table 5 (*continued*)

	10 min		20 min		30 min		Percentage Point Change 2001–2017		
	2001	2017	2001	2017	2001	2017			
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	10 min	20 min	30 min
	(1.0–1.5)	(0.4–0.8)	(0.8–1.2)	(0.3–0.7)	(0.6–0.9)	(0.3–0.6)			
Urban	1.6% (1.5–1.8)	1.6% (1.4–1.7)	1.2% (1.1–1.4)	1.3% (1.1–1.4)	1.0% (0.9–1.1)	1.0% (0.9–1.1)	0.0	+0.1	+0.1
U.S. Census Region									
Northeast	1.3% (1.1–1.6)	1.3% (1.1–1.6)	1.0% (0.8–1.3)	1.1% (0.8–1.3)	0.8% (0.6–1.0)	0.9% (0.7–1.1)	0.0	+0.1	+0.1
Midwest	1.6% (1.3–1.9)	1.3% (1.1–1.6)	1.2% (1.0–1.5)	1.1% (0.9–1.3)	0.9% (0.7–1.2)	0.9% (0.7–1.1)	−0.3	−0.1	0.0
South	1.3% (1.1–1.6)	1.0% (0.8–1.2)	1.0% (0.8–1.2)	0.8% (0.6–0.9)	0.7% (0.6–0.9)	0.6% (0.5–0.8)	−0.3*	−0.2*	−0.1
West	2.0% (1.6–2.3)	2.0% (1.7–2.3)	1.6% (1.3–1.9)	1.7% (1.5–2.0)	1.2% (1.0–1.5)	1.3% (1.1–1.5)	0.0	+0.2	+0.1

Note: Sample sizes were: 148,616 (2001) and 263,738 (2017). Respondents younger than 5 years were excluded to ensure comparability between the 2001 and 2017 surveys. Statistically significant changes between 2001 and 2017 are indicated by * ($P < 0.05$).

[a] Race/ethnicity is as reported by the respondents. Other races and ethnicities not shown in the table, including mixed races and ethnicities, accounted for so few cases that reliable estimates could not be reported.

Source: Calculated by the authors based on NHTS 2001 and 2017.

physical activity.

Most demographic differences in cycling and walking persisted over the two decades. For example, cycling rates among men remained more than twice as high as among women in both 2001 and 2017. In contrast, walking rates were similar for men and women in both years. Rates of walking and cycling among adults 65 years and older were lower than for other age groups in both years.

One notable change was the significant decline in walking and cycling rates of children aged 5–15. The decline in cycling by children indicated by the 2001 and 2017 NHTS is corroborated by the 48% decline in recreational cycling from 1997 to 2017 in the age group 7–17 reported by the National Sporting Goods Association (2018). The falling rates of walking and cycling by children are a continuation of a trend over previous decades, as documented by the earlier 1973–1995 NPTS surveys, which the NHTS superseded in 2001 (McDonald, 2007; Kontou et al., 2019). The long-term decline in children's walking and cycling from 1973 to 2017 has reduced an important source of children's regular physical activity and might be a contributor to rising child obesity rates in the United States (Ogden et al., 2016). Possible explanations include parental concern about traffic and about "stranger danger," which has led many parents to curtail their children's unaccompanied walking and cycling. Many parents now chauffeur their children to and from school by car (McDonald and Aalborg, 2009; Kontou et al., 2019; Sener et al., 2019). In addition, the consolidation of smaller schools into larger ones has increased the average distance to schools, putting them outside the range of walking and cycling for many children. Unsafe, unconnected, or non-existent walking and cycling infrastructure is probably an important reason for low walking and cycling rates among children in both 2001 and 2017. Combined with longer trip distances and greater concern for the safety of their children, the lack of good infrastructure has become an even greater deterrent to walking and cycling to school.

Low rates of cycling among women and older adults—combined with the sharp decline in children cycling—may indicate a need for more cycling facilities separated from motor vehicle traffic, both on-road (cycle tracks) and off-road (greenways). Several studies indicate that vulnerable and risk-averse individuals prefer such separate facilities due to safety concerns and the greater comfort and pleasure of cycling on such lower-stress facilities (Broach and Dill, 2016; Cervero et al., 2009; Dill and McNeil, 2013, 2016; Furth, 2012; Garcia et al., 2019; Lusk et al., 2011; Prati et al., 2019; Teschke et al., 2012; Teschke et al, 2017; Willis et al., 2015; Winters et al., 2015). Traffic-calmed neighborhood streets (with low speeds and traffic volumes) might also encourage more cycling and walking by women, children, and seniors (Brown et al., 2017; Dill and McNeil, 2013; Pucher and Buehler, 2008). Better cycling infrastructure is only one part of the solution, with a wide range of complementary programs and policies required as well (LAB, 2019a; Pucher and Buehler, 2008, Pucher et al., 2010).

It is also important to ensure safe, convenient, and pleasant walking facilities across population groups and geographic settings. That might encourage more walking by children and seniors, in particular, given their greater vulnerability in traffic (LAB, 2019a). For example, improved walking facilities are obviously a prerequisite for Safe Routes to School and Walk-to-School programs. Non-existent, unconnected, or low-quality sidewalks discourage walking. Uneven sidewalks, for example, increase the risk of falls by pedestrians, with particularly serious health consequences for seniors (Methorst et al., 2017).

Similar to a previous analysis comparing the 2001 and 2009 NHTS surveys (Pucher et al., 2011), our analysis of the 2001 and 2017 NHTS shows that cycling has grown fastest among persons highly educated, employed, high-income, non-Hispanic white, male, and in the age group 16–44 (Table 5). Some of those increases may have resulted from higher-income groups moving to denser, mixed-use inner-city neighborhoods with short trip distances (Golub et al., 2017; LAB, 2019a; Newman and Kenworthy, 2015). Recent research has criticized American cities for providing better walking and cycling facilities in higher-income neighborhoods while often ignoring the needs of marginalized communities of low income and color (Golub et al., 2017; LAB, 2019a; Martens, 2017). Walking and cycling conditions in low-income neighborhoods are often dangerous, inconvenient, or stressful. Equity should be an important aspect of

Table 6
Adjusted odds ratios[a] for prevalence of at least 10, 20, and 30 minutes of walking per day by population subgroup, 2001, 2017.

	10 Minutes		20 Minutes		30 Minutes	
	2001	2017	2001	2017	2001	2017
Sex						
female	1.00	1.00	1.00	1.00	1.00	1.00
male	0.95	1.04#	0.93*	1.02	0.93	1.01
Age group[b]						
16–24	1.00	1.00	1.00	1.00	1.00	1.00
25–44	0.73**	0.72**	0.77**	0.77**	0.80*	0.81*
45–64	0.81**	0.74**	0.88	0.82**	0.92	0.87
65+	0.67**	0.59**	0.74**	0.69**	0.81*	0.78**
Education						
Less than High School Degree	1.00	1.00	1.00	1.00	1.00	1.00
High School Degree	1.16*	1.08	1.17*	1.11	1.08	1.07
University Degree	1.96**	1.97**	2.00**	1.99**	1.80**	1.81**
Number of cars in household						
No car	1.00	1.00	1.00	1.00	1.00	1.00
One car	0.31**	0.27**	0.35**	0.28**	0.38**	0.30**
2 cars	0.21**	0.17**,#	0.24**	0.18**,#	0.27**	0.20**,#
≥3 cars	0.18**	0.13**,#	0.20**	0.14**,#	0.23**	0.15**,#
Race/Ethnicity[c]						
All others	1.00	1.00	1.00	1.00	1.00	1.00
Non-Hispanic White	1.03	1.20*,#	1.08	1.21**	1.01	1.26**,#
Population Density						
<=300 ppsqm	1.00	1.00	1.00	1.00	1.00	1.00
300<=1500 ppsqm	1.19**	1.38**	1.10*	1.27**	1.16*	1.24**
1500<=3,000ppsqm	1.42**	1.58**	1.42**	1.46**	1.36**	1.43**
3000 + ppsqm	1.95**	2.74**,#	1.86**	2.51**,#	1.76**	2.30**,#
U.S. Census Region						
Northeast	1.00	1.00	1.00	1.00	1.00	1.00
Midwest	0.73**	0.70**	0.75**	0.71**	0.71**	0.71**
South	0.59**	0.59**	0.65**	0.63**	0.63**	0.63**
West	0.79**	0.76**	0.83**	0.81**	0.88*	0.82**
Constant	0.55**	0.53**	0.31**	0.32**	0.22**	0.22**

Note: Number of observations was 116,261 for 2001 and 220,951 for 2017. For all columns, statistically significant differences within each variable and between subcategories are indicated by * (P<0.05) and ** (P<0.01). For the 2017 columns, statistically significant differences between 2001 and 2017 are indicated by # (P<0.05). **, # and *,# indicate statistically significant differences both within variables and over time.

[a] The adjusted odds ratios shown in this table are coefficients from a logistic regression that controls for the effects of all other variables in the table, thus isolating the independent effect of the variable indicated.

[b] The age group 5–15 years is excluded from the logistic regression for this table in order to avoid direct collinearity between the 5–15 age category and the education variable. Virtually all respondents younger than 16 years old would be reported as not having a high school degree.

[c] Race/ethnicity is as reported by the survey respondents. The NHTS uses the term "white" for Caucasian. In addition to non-Hispanic white, there were several other racial and ethnic categories reported in the NHTS, including mixed race and mixed ethnicity categories. Those other racial/ethnic categories are consolidated here into the one category 'other' because there were too few cases in each of the other race/ethnicity categories to yield reliable coefficient estimates. In addition to limited cases for other racial/ethnic sub-categories, the unreliability of coefficient estimates for other racial/ethnic categories was exacerbated by multi-collinearity with variables such as education and car ownership.

Source: Calculated by the authors based on NHTS 2001 and 2017.

transportation policies and should require the provision of safe walking and cycling facilities for all socioeconomic groups. Because walking and cycling are inexpensive, they have the potential to be especially important sources of mobility and physical activity for low-income groups (Lusk et al., 2017, 2019; Noyes et al., 2014).

High car ownership is strongly related to low levels of walking and cycling. Moreover, between 2001 and 2017, prevalence rates of walking and cycling at least 30 min per day increased the most for car-free households. Similarly, one-car households have almost twice the levels of walking and cycling as households with two or more cars. Indeed, people in households with two or more cars had statistically significant declines from 2001 to 2017 in their prevalence of meeting any of the four walking and cycling thresholds.

Thus, policies that facilitate a car-free or car-light lifestyle would probably encourage more physical activity through active travel. Candidate policies might include car-restrictive measures such as higher taxation of car ownership, parking, and use, which help explain the much higher walking and cycling rates in Europe (Buehler et al., 2017a,b; Cervero, 2017). Traffic calming of residential neighborhoods (with reduced car speeds and traffic volumes), home zones (shared streets), and car-free zones, all of which are widespread in European cities, not only make car use slower and less convenient, but they increase the attractiveness and safety of walking and cycling. Moreover, expanded and improved public transport facilitates a car-free or car-light lifestyle by serving trips too long to make by walking or cycling (Newman and Kenworthy, 2015).

The geographic variables in Tables 4–7 show large variations in both walking and cycling levels by region of the country, by urban vs. rural location, and by neighborhood residential density—both in the prevalence rates of walking and cycling in each year as well as in changes over time. As seen in Tables 4 and 5, cycling and walking rates vary much more by residential density than by urban vs. rural

Table 7
Adjusted odds ratios[a] for prevalence of at least 10, 20, and 30 minutes of cycling per day by population Subgroup, 2001, 2017.

	10 Minutes		20 Minutes		30 Minutes	
	2001	2017	2001	2017	2001	2017
Sex						
female	1.00	1.00	1.00	1.00	1.00	1.00
male	2.55**	2.81**	2.76**	2.79**	2.61**	2.87**
Age group[b]						
16–24	1.00	1.00	1.00	1.00	1.00	1.00
25–44	1.11	1.02	1.06	0.87	1.30	0.97
45–64	0.87	0.82	0.84	0.79	1.00	0.86
65+	0.75	0.36**,#	0.57*	0.32**	0.56*	0.37**
Education						
Less than High School Degree	1.00	1.00	1.00	1.00	1.00	1.00
High School Degree	0.54**	1.10#	0.57**	1.09#	0.47**	1.01#
University Degree	0.92	1.91**,#	1.09	2.22**,#	1.00	2.03**,#
Number of cars in household						
No car	1.00	1.00	1.00	1.00	1.00	1.00
One car	0.38**	0.39**	0.41**	0.34**	0.40*	0.33**
2 cars	0.35**	0.18**,#	0.38*	0.16**,#	0.37**	0.16**,#
≥3 cars	0.26**	0.13**,#	0.30**	0.11**,#	0.35**	0.12**,#
Race/Ethnicity[c]						
All others	1.00	1.00	1.00	1.00	1.00	1.00
Non-Hispanic White	2.66**	2.40**	2.70**	2.34**	2.93**	2.31**
Population Density						
<=300 ppsqm	1.00	1.00	1.00	1.00	1.00	1.00
300<=1500 ppsqm	1.77**	1.71**	2.18**	1.57*	2.35**	1.72**
1500<=3,000ppsqm	1.22	1.98**	1.44	1.65**	1.47	1.75**
3000 + ppsqm	1.64**	2.80**,#	1.97**	2.38**	2.12**	2.37**
U.S. Census Region						
Northeast	1.00	1.00	1.00	1.00	1.00	1.00
Midwest	1.25	1.40*	1.43	1.49*	1.32	1.51*
South	1.25	1.11	1.26	1.08	1.19	1.04
West	1.95**	1.97**	2.09**	2.31**	2.05**	2.13**
Constant	0.01**	0.01**	0.01**	0.01**	0.01**	0.01**

Note: Number of observations was 116,261 for 2001 and 220,951 for 2017. For all columns, statistically significant differences within each variable and between subcategories are indicated by * (P<0.05) and ** (P<0.01). For the 2017 columns, statistically significant differences between 2001 and 2017 are indicated by # (P<0.05). **, # and *,# indicate statistically significant differences both within variables and over time.

[a] The adjusted odds ratios shown in this table are coefficients from a logistic regression that controls for the effects of all other variables in the table, thus isolating the independent effect of the variable indicated.

[b] The age group 5–15 years is excluded from the logistic regression for this table in order to avoid direct collinearity between the 5–15 age category and the education variable. Virtually all respondents younger than 16 years old would be reported as not having a high school degree.

[c] Race/ethnicity is as reported by the survey respondents. The NHTS uses the term “white” for Caucasian. In addition to non-Hispanic white, there were several other racial and ethnic categories reported in the NHTS, including mixed race and mixed ethnicity categories. Those other racial/ethnic categories are consolidated here into the one category ‘other’ because there were too few cases in each of the other race/ethnicity categories to yield reliable coefficient estimates. In addition to limited cases for other racial/ethnic sub-categories, the unreliability of coefficient estimates for other racial/ethnic categories was exacerbated by multi-collinearity with variables such as education and car ownership.

Source: Calculated by the authors based on NHTS 2001 and 2017.

location. That is consistent with the analysis of Tribby and Tharp (2019), who found that urban vs. rural differences in cycling were minimal when controlling for residential density. As confirmed by many studies, cycling and walking rates are higher in high-density urban neighborhoods with mixed-use development that generates trips short enough to make by walking or cycling. In contrast, the extremely low residential densities and single-use development in car-oriented rural and suburban areas lead to trip distances that are too long for walking or cycling (Cervero et al., 2009; Ewing and Cervero, 2017; Newman and Kenworthy, 2015).

As documented by the studies cited above, it is most feasible to increase walking and cycling in medium-to high-density mixed-use environments, which are usually in central cities and inner suburbs, where many trips are short enough to make by foot or bike. In such areas, the main need is for safe, convenient, and well-connected walking and cycling infrastructure. Some rural and outer suburban communities are compact enough to facilitate walking and cycling for daily travel and would also benefit from the same sort of walking and cycling infrastructure improvements. However, in most rural and outer suburban areas, land-use patterns are generally so polycentric, low-density, and car-dependent that most daily trips are too long to walk or bike. In such low-density areas, integrated systems of off-road greenways and trails might be the best approach to facilitate walking and cycling for recreation, exercise, and sports, which could help offset the lack of daily utilitarian walking and cycling.

The NHTS sample is not large enough to disaggregate to individual cities or even states. The 2000 Decennial Census and 2017 American Community Survey (ACS), however, both had very large sample sizes, which enabled estimates for individual cities. Since 2005, the journey-to-work data of the annual ACS has superseded that formerly provided via the long form of the decennial Census (sent to one-sixth of the population) (USDOC, 2019).

Table 8 shows the 2000 and 2017 percentages of workers regularly commuting by bicycle (as their main means of travel to work) in twelve large American cities that have been officially designated as "Bicycling Friendly Communities" (BFCs) by the League of American Bicyclists (LAB, 2019b). To obtain this designation, cities must file an application with LAB every year (for renewals as well) documenting how they have promoted more and safer cycling along many different dimensions, including not just cycling infrastructure but also a range of supportive programs and policies. Over the past two decades, the BFCs listed in Table 8 have greatly expanded and improved their bikeway networks: off-street bike paths (often mixed-use greenways), on-street bike lanes (some physically separated from motor vehicles), bike-friendly intersection modifications, and bike routes on specially traffic-calmed residential streets (sometimes called bike boulevards or neighborhood greenways). They have also developed bikesharing programs, improved bike parking and integration with public transport, and organized cycling training programs and promotional events (LAB, 2019a,b; People for Bikes, 2019).

The share of workers commuting by bicycle in those twelve BFC cities, on average, increased from 1.2% in 2000 to 2.9% in 2017 (+142%), more than doubling. By comparison, the national average share of workers commuting by bike rose far less: from 0.4% in 2000 to 0.6% in 2017 (+50%). In 10 of the 12 BFC cities, the increases were statistically significant, as indicated by the 2017 estimates with * in the table (See footnote to Table 8 for an explanation of the significance calculations.). The large improvements to cycling infrastructure and programs in the twelve BFC cities, as listed above, may help explain the sharp contrast between the much larger increases in bike commuting to work in those cities compared to the country as a whole. The spatial concentration of pro-cycling policies in only a few American cities is highlighted by two examples: the 12 cities in Table 8 have only 7% of the country's population but accounted for 47% of the country's protected bike lanes in 2018 and for 44% of the country's bikesharing bikes (Meddin, 2019; PFB, 2019).

It is notable that, in the same twelve cities, trends in walking to work have been very different. The average increase in the walking share of work trips was less than a tenth as large as the increase in cycling to work (+12% vs. +146%). Indeed, four of the cities show small declines. Seattle (+45%) and San Francisco (+31%) had the largest increases in walking, but even those were smaller than the smallest increase in cycling for any of the twelve cities (+54% in Seattle and Los Angeles). Only four of the twelve cities had statistically significant increases in walking, compared to ten for cycling. Nevertheless, walking rates in the twelve cities, on average, rose from 7.8% to 8.7% of work commuters, compared to a decrease from 2.9% in 2000 to 2.7% in 2017 for the country as a whole. Thus, the twelve cities outperformed the country as a whole in rates of walking to work as well as cycling to work, although the increases are much larger for cycling.

The large difference between walking and cycling trends is puzzling because the same twelve cities in Table 8 have also implemented a range of measures to promote safer and more pleasant walking: extensive off-road, mixed-use greenways and trails, more and better sidewalks and pedestrian crossings, improved crossing signals, car-free pedestrian plazas, and either reduced general speed limits or traffic-calming of selected residential neighborhoods. As a result, these twelve cities have also been ranked by various studies as being among the most walking-friendly cities in the United States (HRSC, 2019; LAB, 2019a,b; Walkscore, 2019). Indeed, one of the rankings (Walkscore, 2019) included eight of the twelve cities in Table 8 among the top-ten most walking-friendly cities in the country. The available walkability indices are less comprehensive than LAB's Bicycling Friendly Community program, but taken together, they strongly suggest that the cities in Table 8 are not just bicycle-friendly but also walking-friendly.

One possible explanation for the much smaller growth in walking to work than in cycling to work might be that increasing trip distances to work over the past two decades have affected walking more than cycling, which can more readily cover longer distances. Indeed, the share of work trips (all modes of travel in aggregate) shorter than 1 mile fell from 13.0% of all work trips in 2001 to 9.0% of all work trips in 2017 (USDOT, 2016).

Although the ACS and NHTS are not fully comparable because of the difference in trip purposes included, the disaggregate ACS numbers for specific cities show that there were large increases in cycling in some cities even though the NHTS national averages show no growth at all. Thus, it would be misleading to infer from the NHTS numbers that no progress at all has been made anywhere in promoting cycling. Our analysis suggests that it varies greatly among specific cities as well as by geographic region and residential density.

In addition, the minimal growth in active travel reported for the USA as a whole from 2001 to 2017 must be viewed in the context of declining per-capita travel by all modes of travel in aggregate. As noted earlier, total travel per capita decreased along all three measures: trips, hours, and distance. Thus, declining daily travel overall may help explain why walking and cycling have not increased more.

While some cities are vigorously implementing pro-walk, pro-bike policies, others are lagging far behind, thus reducing the national average. In addition, the overall magnitude of efforts to promote walking and cycling in the USA are not nearly sufficient. For example, over the NHTS and ACS survey periods examined above (2000/2001–2017/2018), cumulative federal government funding for pedestrian and cycling projects amounted to only 2% of federal roadway expenditures, although walking and cycling together accounted for 10–13% of all daily trips in the USA during this period. On a per-capita basis, less than $3 in federal funds were spent on pedestrian and cycling projects in 2018. Given that minimal funding, it is perhaps not surprising that increases in walking and cycling have been so small.

5. Conclusions

Our analysis of the NHTS shows that, so far, efforts to increase walking and cycling in the United States have not been sufficient. Much more needs to be done to improve walking and cycling conditions in order to achieve population-level increases in physical activity from daily travel by Americans. The enormous public health benefits generated by physical activity justify the investment in

Table 8
Population shares of bicycle and walk commuters in large bicycle-friendly and pedestrian-friendly cities in the United States, 2000–2017.

	Bicycle Share of Commuters			Walk Share of Commuters		
	2000	2017	%-change '00-'17	2000	2017	%-change '00-'17
Boston, MA	1.0	2.2*	+123	13.4	14.7*	+10
New York, NY	0.5	1.3*	+174	10.7	10.5	−2
Philadelphia, PA	0.9	2.7*	+211	9.2	8.8	−5
Washington, DC	1.2	5.4*	+343	12.3	13.7	+12
Miami, FL	0.6	0.9	+65	3.7	3.7	−1
Chicago, IL	0.5	1.8*	+249	5.8	7.0*	+21
Minneapolis, MN	2.0	4.1*	+111	6.8	7.0	+2
Denver, CO	1.0	2.4*	+144	4.5	4.8	+7
Seattle, WA	2.0	3.0	+54	7.7	11.2*	+45
Portland, OR	1.8	6.9*	+277	5.5	6.2	+14
San Francisco, CA	2.1	3.3*	+61	9.8	12.9*	+31
Los Angeles, CA	0.6	1.0*	+54	3.7	3.5	−5
12-City Average	1.2	2.9	+146	7.8	8.7	+12

Note: The U.S. Census Bureau reports only the regular and main mode for the work commute. Thus, bicycle and walk trips used to access other modes, such as public transport, are not included. The 2017 mode shares marked by * are statistically different from mode shares for 2000 ($p < 0.05$). In those cases, the 95% confidence intervals for the 2017 American Community Survey estimates do not overlap with the mode share estimate based on the long form of the 2000 Census, which samples one sixth of U.S. household. The U.S. Census Bureau did not provide margins of error for those 2000 estimates because the sample size was so large (almost 50 million respondents, which would have yielded very narrow confidence intervals).
Source: U.S. Department of Commerce, 2000, 2019.

infrastructure and programs required to significantly raise population-level rates of walking and cycling.

To promote greater equity and social justice among socioeconomic groups, measures to increase active travel should target children, adolescents, and older adults, whose rates of walking and cycling are either lower than average or declining. Many studies indicate that separate, protected cycling facilities and traffic-calmed neighborhood streets would help encourage more cycling among women, children, and seniors, as well as by vulnerable or risk-averse individuals. Special efforts must also be made to ensure safe and convenient walking and cycling conditions for low-income and other disadvantaged communities, which have been inadequately served in many American cities. Physical activity through walking and cycling has the potential of greatly improving the physical, mental, and social health of both men and women, all ages, and all income levels. Unlike formal exercise programs, walking and cycling can be integrated into daily routines and are affordable for virtually everyone.

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Ralph Buehler: Writing - original draft, Formal analysis, Conceptualization, Writing - review & editing. **John Pucher:** Writing - original draft, Conceptualization, Writing - review & editing. **Adrian Bauman:** Writing - original draft, Conceptualization, Writing - review & editing.

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