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Examining the Impact of Transportation-Related Barriers on Self-Perceived Physical Health among Adults in the United States

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by

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16. Abstract

Objective: Drawing from the framework of social determinants of health, the objective of this paper was to investigate the cross-sectional association between transportation-related factors and self-perceived physical health among adults in the U.S. while adjusting for known demographic and socioeconomic-related factors.
Methods: Data for this report were derived from the 2017 National Household Travel Survey. An analytic sample of 71,235 respondents aged 18 and 64 years was analyzed using binary logistic regression. The outcome variable examined was self-perceived physical health and the main explanatory variable was a measure of household vehicle deficit.
Results: Of the 71,235 respondents examined, 8.9% perceived their physical health to be poor. About 36% of the respondents had fewer vehicles per individual in the household. Controlling for the effects of other factors, respondents who had fewer vehicles per individuals in the household were 1.27 times more likely to report poor self-perceived physical health when compared to their counterparts with more vehicles per individuals in the household (AOR=1.27, 95% CI=1.17-1.39). Having higher education, higher income, and homeownership were inversely associated with poor self-perceived physical health.
Conclusion: The findings of this study suggest that as the gap between the number of household members and the number of vehicles present increases, respondents' self-perceived physical health deteriorates due to the uncertainty in having access to transportation when the need arises. Social workers, engineers, and policymakers should begin working on viable solutions to reduce or eliminate transportation barriers and address disparities created by lack of access to reliable transportation.

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This report is based on public data from the National Household Travel Survey (NHTS) conducted by the Federal Highway Administration (FHWA). The views and opinions expressed in this report are those of the authors and do not represent the views of FHWA. Dr. Baiden had full access to the data and assumed responsibility for the integrity of the data and the accuracy of the data analysis. The authors are solely responsible for the facts and the accuracy of the material and information presented herein.

DISCLAIMER

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EXECUTIVE SUMMARY

Drawing from the framework of social determinants of health, the objective of this project was to investigate the cross-sectional association between transportation-related factors and self-perceived physical health among adults in the U.S. while adjusting for known demographic and socioeconomic-related factors.

Data for this project were derived from the 2017 National Household Travel Survey. An analytic sample of 71,235 respondents aged 18 and 64 years was analyzed using binary logistic regression. The outcome variable examined was self-perceived physical health and the main explanatory variable was a measure of household vehicle deficit.

Of the 71,235 respondents examined, 8.9% perceived their physical health to be poor. About 36% of the respondents had fewer vehicles per individual in the household. Controlling for the effects of other factors, respondents who had fewer vehicles per individuals in the household were 1.27 times more likely to report poor self-perceived physical health when compared to their counterparts with more vehicles per individuals in the household (AOR=1.27, 95% CI=1.17-1.39). Having higher education, higher income, and homeownership were inversely associated with poor self-perceived physical health.

The findings of this study suggest that as the gap between the number of household members and the number of vehicles present increases, respondents' self-perceived physical health deteriorates due to the uncertainty in having access to transportation when the need arises. Social workers, engineers, and policymakers should begin working on viable solutions to reduce or eliminate transportation barriers and address disparities created by lack of access to reliable transportation.

1.0 INTRODUCTION

Access to quality and affordable health care remains a significant problem for individuals living in the United States (U.S.) relative to their counterparts in other wealthy nations (Dickman et al., 2017; Schoen et al., 2013). Although various studies have investigated different barriers that impede access to quality health care in the U.S., including race (Boen & Hummer, 2019; Canedo et al., 2018), immigration (Balcazar et al., 2015; Wafula & Snipes, 2014), education and income (Lazar & Davenport, 2018), neighborhood (Baiden et al., 2014), housing (Arku et al., 2011; Ramsay et al., 2019), living in a rural area (Caldwell et al., 2016), one important area that has received less research attention has to do with access to transportation. Access to transportation can facilitate an individual's ability to travel to health care appointments and pharmacies to fill prescriptions. Another important factor relating to access to transportation is household vehicle ownership, which has been found to influence many aspects of travel demand (Kockelman & Kweon, 2002). The lack of access to a vehicle has the potential to significantly impede access to health care and adherence to medication and treatment regimens, thereby exacerbating the health conditions of individuals (Wolfe et al., 2020). This is especially true for individuals with chronic health conditions who require frequent visits to the doctor's office for medical appointments and pharmacies to fill prescriptions. As a result, some scholars have turned attention to the role of transportation as a social determinant of health (SDOH) (Davis et al., 2020; Dodd et al., 2014; Wolfe et al., 2020).

SDOH as a theoretical framework is generally defined as "the conditions in the environments where people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks" (U.S. Department of Health and Human Services, 2021, para 1). The World Health Organization (WHO) first introduced this definition and the theoretical framework behind it at its commission meeting in 2005 (WHO, 2008). According to the U.S. Department of Health and Human Services (2021), the five domains of SDOH include economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context. Some examples of SDOH that fall within these categories include, but or are not limited to, education, employment, income, race, safe housing, neighborhoods, access to healthy foods, access to physical activity, polluted air or water, language, literacy skills, and transportation (Braveman et al., 2011; Braveman & Gottlieb, 2014). The SDOH framework maintains that each of these determinants can either promote or negatively impact the health and overall well-being of individuals.

The SDOH framework not only looks at social factors and processes that promote or undermine individuals' health but also the uneven distribution of these factors between groups who hold different positions in society (Graham, 2004). For instance, the framework often examines the role of socioeconomic status (SES) and how it impedes individuals' access to resources or facilitates access to certain psychosocial experiences that will either promote or hinder an individual's health (Howden-Chapman,

2004; Kubzansky et al., 2001). Individuals with low SES may face greater challenges in accessing needed services and resources, including medical appointments (Braveman & Gottlieb, 2014). Factors such as lack of healthy food, transportation, and physical activity may impact an individual's health by increasing the occurrence or severity of chronic conditions such as hypertension, diabetes, heart disease, and obesity (WHO, 2009). The SDOH framework highlights the role that SES and other SDOH factors can have on individuals' health and well-being (Lazar & Davenport, 2018), and it shows how unequal access, distribution, and experience of these can result in significant disparities in health access and health outcomes (Braveman & Gottlieb, 2014).

Conceptualization of Transportation as a SDOH

Access to transportation is often cited as an important SDOH that is closely associated with health care access and outcomes across different populations (Davis et al., 2020; Dodd et al., 2014; Wolfe et al., 2020). Lack of transportation often leads to negative health outcomes for a variety of individuals, as it limits their access to healthy food, grocery stores, employment, community resources, physical activity facilities, and medical appointments (D'Agostino et al., 2019). For instance, the extant literature has found that lack of transportation may increase the risk for suicidal ideation, attempts, and emergency department visitation (Blosnich et al., 2019; Davis et al., 2020). Furthermore, lack of access to reliable transportation is often cited as the main barrier in getting access to medical care, attending appointments, buying medications, and receiving other types of medical services and procedures (Wallace et al., 2005; Wolfe et al., 2020). Therefore, the objective of this report was to investigate the cross-sectional association between transportation-related factors and self-perceived physical health among adults in the U.S. while adjusting for known demographic and SES-related factors.

DATA AND METHODS

2.1 Data Source and Participants

Data for this report were derived from the 2017 National Household Travel Survey (NHTS) conducted by the Federal Highway Administration (FHWA). The NHTS obtained information about travel behavior, including trips made by different modes of travel and for all purposes from U.S. residents in the 50 states and the District of Columbia. The NHTS has been used to monitor the performance and adequacy of current travel facilities and infrastructure. The NHTS also covers the field of public health, environmental analysis, energy consumption, and social welfare. The 2017 NHTS is the eighth in the series, with previous cycles conducted in 1969, 1977, 1983, 1995, 2001, and 2009. The 2017 NHTS covered topics such as travel behavior linked to demographic, economic, geographic factors, and self-perceived physical health that is used to forecast travel demands. A detailed description of the 2017 NHTS, including the objectives, methodology, and sampling procedure, is available at https://nhts.ornl.gov.

The 2017 NHTS employed a two-phase survey consisting of a household recruitment survey and a person-level retrieval survey. The 2017 NHTS used an address-based sampling technique with mail-back as the main approach to data collection with telephone or web-based as secondary options, while the person-level survey was conducted using telephone and web-based options. The 2017 NHTS included over 960,000 respondents. However, the analysis presented in this report only considered the 71,235 respondents aged 18 and 64 years who had valid data for all the variables included in the analysis.

2.2. Measures

2.2.1. Outcome Variable

The outcome variable investigated in this report was self-perceived physical health. The original question asked respondents to rate their physical health on a 5-point Likert scale ranging from excellent, very good, good, fair, and poor. For the purposes of this report, self-perceived physical health was recoded into a binary variable by grouping excellent, very good, and good into one category called “good physical health” (score = 0) and grouping fair and poor together into a category called “poor physical health” (score = 1).

2.2.2. Explanatory Variables

Explanatory variables examined in this report were grouped under demographic factors (i.e., age, sex, race, and ethnicity); socioeconomic factors (i.e., education, income, and homeownership); and transportation-related factors (frequency of mode of transportation and household vehicle deficit). Age was measured as a continuous variable with a range of 18-64. Sex was coded as a binary variable, with male coded as

the reference category. Race was measured as a nominal variable into the following categories: “0 = White”, “1 = Black/African American”, “2 = Asian”, “3 = American Indian/Alaska Native/Native Hawaiian/Pacific Islander”, and “4 = Other.” Ethnicity was measured as a binary variable with Hispanic coded as 1, otherwise, it was coded as 0.

Education was measured as an ordinal variable into “0 = High school or less,” “1 = Some college or associate degree,” and “2 = College degree or higher.” Household income was measured as an ordinal variable into “0 = less than $25,000,” “1 = $25,000 to $49,999,” “2 = $50,000 to $74,999,” “3 = $75,000 to $99,999,” and “4 = $100,000 and above.” Homeownership was measured as a nominal variable into “0 = owner,” “1 = renter,” and “2 = Other.”

With respect to transportation-related factors, respondents were asked to indicate the frequency of use for the following modes of transportation, walking, biking, personal vehicle, taxi/rideshare, bus, train, and paratransit. Response options range from daily, a few times a week, a few times a month, a few times a year, and never. Respondents who indicated daily, a few times a week, a few times a month, or a few times a year were recoded as 1, and compared to respondents who indicated never. These transportation-related factors are not mutually exclusive. A measure of household vehicle deficit was computed by subtracting household size from the number of vehicles in the house. Respondents with a negative value were considered as having fewer vehicles per household size and were coded as 2. Respondents with a score of zero were considered as having enough vehicles per household size and were coded as 1. Lastly, respondents with a positive value were considered as having more vehicles per household size and were coded as 0.

2.3. Data Analyses

Descriptive statistics, bivariate, and multivariable analytic techniques were employed in analyzing the data. First, the general distribution of all the variables included in the analysis was examined using percentages for the categorical variables and mean and standard deviation for the continuous variables. Next, we examined the bivariate association between household vehicle deficit and the categorical variables was examined using Pearson chi-square test of association. The main analysis involves the use of binary logistic regression to examine the association between transportation-related factors and self-perceived physical health while simultaneously controlling for demographic factors and SES-related factors. Binary logistic regression was chosen as it is more robust in predicting binary outcomes with explanatory variables that could be measured as continuous or categorical variables. Three additive regression models were fitted in a hierarchical manner. In Model 1, we regressed self-perceived physical health on demographic factors. Model 2 consists of variables in Model 1 plus SES factors. The final and fully adjusted model includes variables in Model 2 plus transportation-related factors. The Omnibus Tests of Model Coefficients and the Nagelkerke pseudo-R square were employed in assessing the fitness of the models. The Omnibus Tests of Model Coefficients, which follows a chi-square distribution, was used to evaluate the statistical significance of each block. The proportion of variance in

self-perceived physical health that could be explained by the set of predictors was assessed using the Nagelkerke pseudo-R square. Variables were considered significant if the *p*-value was less than 0.05. Adjusted odds ratios (AOR) and their 95% C.Is. were reported. All statistical analyses were conducted using SPSS Version 26 for Windows (SPSS, Inc., Chicago, IL, USA).

3.0 RESULTS

3.1. Sample Characteristics

Table 1 shows the general distribution of the variables examined in this report. Of the 71,235 respondents examined, 8.9% perceived their physical health to be poor. The average age of respondents in the sample was 47, with a standard deviation of 12.06. On average, there were 2.41 (SD = 1.30) individuals per household. On average, each household has 2.1 vehicles with a standard deviation of 1.21. The majority of the respondents were female (55.7%). The majority of the respondents (81.3%) self-identified as White, 8% as Black/African American, 4.6% as Asian, 0.9% as American Indian/Alaska Native/Native Hawaiian/Pacific Islander, and 5.2% as Other. With respect to SES, the majority of the respondents (56%) had a college degree or higher, 29.6% had some college or associate degree, and 14.4% had high school or less education. About a third of the respondents (33.5%) made $100,000 or more in household income. A little over seven out of 10 respondents (71.1%) owned their house, 28.1% were renters, and 0.8% indicated other. The distribution of transportation-related factors are as follows: use of a personal vehicle (97.3%), walking (73.4%), taxi/rideshare (38.6%), biking (35.3%), train (24.8%), bus (21.8%), and paratransit (2.2%). With respect to household vehicle deficit, one in five respondents (20.3%) had more vehicles per individual in the household, 43.9% had enough vehicles per individual in the household, and 35.8% had fewer vehicles per individual in the household.

Table 1.1
Sample Characteristics (N = 71,235)

Variables	Frequency (%)	Mean (SD)
Outcome variable		
Self-perceived physical health		
Good	64,866 (91.1)	
Poor	6,369 (8.9)	
Demographic factors		
Age		47.00 (12.06)
Household size		2.41 (1.30)
Sex		
Male	31,545 (44.3)	
Female	39,690 (55.7)	
Race		
White	57,913 (81.3)	
Black/African American	5,711 (8.0)	
Asian	3,275 (4.6)	
American Indian/Alaska Native/Native Hawaiian/Pacific Islander	613 (0.9)	
Other race	3,723 (5.2)	
Ethnicity		
Not Hispanic	65,265 (91.6)	
Hispanic	5,970 (8.4)	
Socio economic factors		
Education		
High school or less	10,246 (14.4)	
Some college or associate degree	21,075 (29.6)	
College degree or higher	39,914 (56.0)	
Household income		
Less than $25,000	10,862 (15.2)	
$25,000-$49,999	13,336 (18.7)	
$50,000-$74,999	12,773 (17.9)	
$75,000-$99,999	10,396 (14.6)	
$100,000 and more	23,868 (33.5)	
Home ownership		
Owner	50,643 (71.1)	
Renter	20,036 (28.1)	
Other	556 (0.8)	
Transportation related factors		
Number of vehicles in the house		2.10 (1.21)
Frequency of walking for travel		
Never	18,930 (26.6)	
Sometimes	52,305 (73.4)	
Frequency of Biking for travel		
Never	46,097 (64.7)	
Sometimes	25,138 (35.3)	
Frequency of using personal vehicle for travel		
Never	1,907 (2.7)	
Sometimes	69,328 (97.3)	
Frequency of using taxi/ride share for travel		
Never	43,739 (61.4)	

Sometimes	27,496 (38.6)
Frequency of using bus for travel	
Never	55,733 (78.2)
Sometimes	15,502 (21.8)
Frequency of using train for travel	
Never	53,560 (75.2)
Sometimes	17,675 (24.8)
Frequency of using paratransit for travel	
Never	69,691 (97.8)
Sometimes	1,544 (2.2)
Household-vehicle deficit	
More vehicles per individuals in household	14,473 (20.3)
Enough vehicles per individuals in household	31,248 (43.9)
Less vehicles per individuals in household	25,514 (35.8)

3.2. Bivariate Results

A number of categorical variables were significantly associated with household vehicle deficit at the bivariate level in Table 2. About 42% of respondents who perceived their physical health as poor compared to 35.2% of respondents who perceived their physical health as good had fewer vehicles per individual in the household ($\chi^2 = 138.54$, df = 2, $p < 0.001$). The proportion of females who had fewer vehicles per individual in the household (38.3%) was significantly greater than the proportion of males who had fewer vehicles per individual in the household (32.6%; $\chi^2 = 650.67$, df = 2, $p < 0.001$). More than half of respondents who self-identified as Asians (53.1%) compared to 47.0% of American Indian/Alaska Native/Native Hawaiian/Pacific Islanders, 46.8% of Black/African Americans, and 33.1% of Whites had fewer vehicles per individual in the household ($\chi^2 = 1188.60$, df = 8, $p < 0.001$). Respondents were more likely to have fewer vehicles per individual in the household if they have high school education or less, have low household income, or are either renters or indicated “Other” in terms of homeownership.

Table 1.2
Bivariate Association Between Self-Perceived Physical Health and Categorical Variables (N = 71,235)

Variables	Household-vehicle deficit			Chi-square(sig.)
	More vehicles per individuals in household N (%)	Enough vehicles per individuals in household N (%)	Less vehicles per individuals in household N (%)	
Self-perceived physical health				138.54, $p <$ .001
Good	13443 (20.7)	28580 (44.1)	22843 (35.2)	
Poor	1030 (16.2)	2668 (41.9)	2671 (41.9)	
Sex				650.67, $p <$ .001
Male	7716 (24.5)	13536 (42.9)	10293 (32.6)	
Female	6757 (20.3)	17712 (44.6)	15221 (38.3)	
Race				1188.60, $p<.001$
White	12601 (21.8)	26166 (45.2)	19146 (33.1)	
Black/African American	830 (14.5)	2209 (38.7)	2672 (46.8)	
Asian	309 (9.4)	1227 (37.5)	1739 (53.1)	
American Indian/Alaska Native/Native Hawaiian/Pacific Islander	114 (18.6)	211 (34.4)	288 (47.0)	
Other race	619 (16.6)	1435 (38.5)	1669 (44.8)	
Ethnicity				492.86, $p <$ .001
Not Hispanic	13591 (20.8)	29078 (44.6)	22596 (34.6)	
Hispanic	882 (14.8)	2170 (36.3)	2918 (48.9)	
Education				406.60, $p<.001$
High school or less	2230 (21.8)	3867 (37.7)	4149 (40.5)	
Some college or associate education	4929 (23.4)	9044 (42.9)	7102 (33.7)	
College degree	7314 (18.3)	18337 (45.9)	14263 (35.7)	
Household income				1824.47, $p<.001$
Less than $25,000	1097 (10.1)	4468 (41.1)	5297 (48.8)	
$25,000-$49,000	2287 (17.1)	6638 (49.8)	4411 (33.1)	
$50,000-$74,999	2796 (21.9)	6017 (47.1)	3960 (31.0)	
$75,000-$99,000	2418 (23.3)	4674 (45.0)	3304 (31.8)	
$100,000 and more	5875 (24.6)	9451 (39.6)	8542 (35.8)	
Home ownership				2733.93, $p<.001$
Owner	12738 (25.2)	21583 (42.6)	16322 (32.2)	
Renter	1645 (8.2)	9451 (47.2)	8940 (44.6)	
Other	90 (16.2)	241 (38.5)	252 (45.3)	
Frequency of walking for travel				169.58, $p <$ .001
Never	4402 (23.3)	8295 (438)	6233 (32.9)	

Sometimes	10071 (19.3)	22953 (43.9)	19281 (36.9)	
Frequency of Biking for travel				172.14, p < .001
Never	8988 (19.5)	21044 (45.7)	16065 (34.9)	
Sometimes	5485 (21.8)	10204 (40.6)	9449 (37.6)	
Frequency of using personal vehicle for travel				2816.96, p<.001
Never	20 (1.0)	108 (5.7)	1779 (93.3)	
Sometimes	14453 (20.8)	31140 (44.9)	23735 (34.2)	
Frequency of using taxi/ride share for travel				284.21, p < .001
Never	9767 (22.3)	18657 (42.7)	15315 (35.0)	
Sometimes	4706 (17.1)	12591 (45.8)	10199 (37.1)	
Frequency of using bus for travel				1311.41, p<.001
Never	12415 (22.3)	25145 (45.1)	18173 (32.6)	
Sometimes	2058 (13.3)	6103 (39.4)	7341 (47.4)	
Frequency of using train for travel				198.21, p < .001
Never	11500 (21.5)	23387 (43.7)	18673 (34.9)	
Sometimes	2973 (16.8)	7861 (44.5)	6841 (38.7)	
Frequency of using paratransit for travel				187.37, p < .001
Never	14287 (20.5)	30690 (44.0)	24714 (35.5)	
Sometimes	186 (12.0)	558 (36.1)	800 (51.8)	

3.3. Multivariable Results

The results of the multivariable logistic regression results examining the association between transportation-related measures and self-perceived physical health are presented in Table 3.

Model 1

All the variables included in Model 1 were significantly associated with poor self-perceived physical health. Each additional increase in age increased the odds of reporting poor self-perceived physical health by a factor of 4%, controlling for sex, race, and ethnicity AOR = 1.04, p < .001, 95% C.I. = 1.04-1.05). This significant association held through when SES factors were included in Model 2, and transportation-related factors in Model 3. In Model 1, odds were 1.15 times greater for females to report poor self-perceived physical health when compared to their male counterparts (AOR = 1.15, p < .001, 95% CI = 1.09-1.21). However, the direction of the odds ratio changes with the addition of SES factors in Model 2 and transportation-related factors in Model 3. Controlling for the effect of other factors in Model 3, females had 13% lower odds of reporting poor self-perceived physical health when compared to their male counterparts (AOR = 0.87, p < .001, 95% CI = 0.82-0.93). Controlling for the effect of other factors in

Model 3, respondents who self-identified as Black/African American were 1.21 times more likely to report poor self-perceived physical health when compared to respondents who self-identified as White (AOR = 1.21, $p < .001$, 95% CI = 1.11-1.32).

Model 2

The association between SES factors and poor self-perceived physical health was in the hypothesized direction in both Models 2 and 3. Controlling for the effects of other factors in Model 3, respondents with some college or an associate's degree had 24% lower odds of reporting poor self-perceived physical health (AOR = 0.76, $p < .001$, 95% CI = 0.71-0.81), and respondents with a college degree or higher had 54% lower odds of reporting poor self-perceived physical health (AOR = 0.46, $p < .001$, 95% CI = 0.42-0.50) both when compared to respondents with high school or less education. Respondents with higher household income were significantly less likely to perceive their physical health as poor. Compared to respondents who owned their homes, respondents who are renting were 1.42 times more likely to perceive their physical health as poor (AOR = 1.42, $p < .001$, 95% CI = 1.32-1.52) and respondents who indicated "Other" in terms of homeownership were 1.52 times more likely to perceive their health as poor (AOR = 1.52, $p < .001$, 95% CI = 1.21-1.92).

Model 3

In Model 3, we found that respondents were less likely to perceive their physical health as poor if they sometimes walk (AOR = 0.79, $p < .001$, 95% CI = 0.74-0.84); bike (AOR = 0.62, $p < .001$, 95% CI = 0.58-0.67); use their personal vehicles for travel (AOR = 0.81, $p < .001$, 95% CI = 0.72-0.92); or use the train for travel (AOR = 0.78, $p < .001$, 95% CI = 0.72-0.86). Respondents who sometimes use bus (AOR = 1.18, $p < .001$, 95% CI = 1.09-1.28) or paratransit for travel (AOR = 1.53, $p < .001$, 95% CI = 1.32-1.79) were significantly more likely to perceive their physical health as poor. Controlling for the effects of other factors in Model 3, respondents who had fewer vehicles per individuals in the household were 1.27 times more likely to report poor self-perceived physical health when compared to their counterparts with more vehicles per individuals in the household (AOR = 1.27, $p < .001$, 95% CI = 1.17-1.39). There was no statistically significant difference between respondents who had enough vehicles per individuals in the household and respondents who had more vehicles per individuals in the household.

Table 1.3
Binary Logistic Regression Results Examining the Association Between Transportation-Related Factors and Self-Perceived Physical Health (N = 71,235)

Variables	Model 1 Demographic factors AOR (95% C.I)	Model 2 Demographic + SES AOR (95% C.I)	Fully adjusted model AOR (95% C.I)
Demographic factors			
Age in years	1.04 (1.04-1.05)***	1.04 (1.04-1.05)***	1.04 (1.04-1.05)***
Sex (Male)			
Female	1.15 (1.09-1.21)***	0.94 (0.89-1.00)*	0.87 (0.82-0.93)***
Race (White)			
Black/African American	2.57 (2.38-2.78)***	1.34 (1.23-1.46)***	1.21 (1.11-1.32)***
Asian	0.80 (0.68-0.94)**	1.01 (0.84-1.19) ns	0.94 (0.79-1.11) ns
American Indian/Alaska Native/Native Hawaiian/Pacific Islander	2.63 (2.13-3.24)***	1.64 (1.31-2.06)***	1.63 (1.30-2.05)***
Other race	2.00 (1.80-2.22)***	1.43 (1.28-1.60)***	1.43 (1.28-1.60)***
Ethnicity (Not Hispanic)			
Hispanic	1.46 (1.33-1.60)***	1.12 (1.01-1.23)*	1.07 (0.97-1.18) ns
Socio economic factors			
Education (High school or less)		0.71 (0.67-0.76)***	0.76 (0.71-0.81)***
Some college or associate degree		0.41 (0.38-0.44)***	0.46 (0.42-0.50)***
College degree or higher			
Household income (Less than $25,000)			
$25,000-$49,000		0.39 (0.36-0.42)***	0.41 (0.38-0.44)***
$50,000-$74,999		0.23 (0.21-0.25)***	0.24 (0.22-0.27)***
$75,000-$99,000		0.18 (0.16-0.20)***	0.19 (0.17-0.22)***
$100,000 and more		0.11 (0.10-0.13)***	0.13 (0.11-0.14)***
Home ownership (Owner)			
Renter		1.46 (1.37-1.56)***	1.42 (1.32-1.52)***
Other		1.60 (1.27-2.01)***	1.52 (1.21-1.92)***
Frequency of walking for travel (Never)			
Sometimes			0.79 (0.74-0.84)***

Frequency of Biking for travel (Never)	
Sometimes	0.62 (0.58-0.67)***
Frequency of using personal vehicle for travel (Never)	
Sometimes	0.81 (0.72-0.92)***
Frequency of using taxi/ride share for travel (Never)	
Sometimes	0.96 (0.89-1.03) ns
Frequency of using bus for travel (Never)	
Sometimes	1.18 (1.09-1.28)***
Frequency of using train for travel (Never)	
Sometimes	0.78 (0.72-0.86)***
Frequency of using paratransit for travel (Never)	
Sometimes	1.53 (1.32-1.79)***
Household-vehicle deficit (More vehicles per individuals in household)	
Enough vehicles per individuals in household	1.03 (0.95-1.12) ns
Less vehicles per individuals in household	1.27 (1.17-1.39)***

NOTE: Reference category is indicated in parenthesis.
ns = not significant; * $p < .05$; ** $p < .01$; *** $p < .001$

4.0 DISCUSSION

This report investigates the cross-sectional association between transportation-related factors and self-perceived physical health among adults in the U.S. after adjusting for known demographic and SES-related factors. We found that about one in 10 respondents (8.9%) perceived their physical health as poor, and respondents, on average, had 1.21 vehicles per household. A number of demographic and SES-related factors emerged as significantly associated with poor self-perceived physical health.

Interestingly, there was no statistically significant difference between respondents who had enough vehicles per individual in the household and respondents who had more vehicles per individual in the household. This may suggest that as the gap between the number of household members and the number of vehicles present increases, respondents' self-perceived physical health is likely to deteriorate due to the uncertainty in having access to transportation when the need arises. The finding that more than one in three respondents (35.8%) had vehicle-deficits and are more likely to be poor, with lower education, renters, and Black/African American or Hispanic is consistent with one prior study by Blumenberg et al. (2020) who also found that car-deficit households are much more likely to be poor and headed by a Black or Hispanic individual. Blumenberg et al. (2020) futher highlighted the importance of having at least one household vehicle particularly for low income households.

Transportation as a SDOH affects many areas of individuals' lives, but it is particularly significant when talking about health care access and quality of care. Recently, Wolfe et al. (2020) examined data from the 1997 to 2017 National Health Interview Survey (NHIS) and found that in 2017, more than 5.8 million individuals in the U.S., representing 1.8%, experienced a delay in accessing medical care as a result of not having access to transportation. Furthermore, the authors found a significant increase in transportation barriers between 2003 and 2009, with those living in poverty and who have chronic conditions disproportionately impacted by these transportation barriers.

Transportation barriers have also been noted across different settings and populations. For instance, Sommerfeld et al. (2021), in their recent study, found transportation barriers as one of the main reasons impeding access to health care among American Indian elders. Other barriers reported included long travel times to doctors or emergency care and lack of community health programs as major transportation-related challenges. Another study found that incarcerated youth reported a lack of access to a household vehicle as a barrier for accessing health care post-incarceration (Barnert et al., 2020). Similarly, low-income rural adolescents also reported transportation as a barrier to getting access to dental care (Dodd et al., 2014). In addition, Bellamy et al. (2016) found that more than one in three of their study participants with serious mental illness reported transportation barriers as the main reason for not accessing primary care. Recently, McDonald et al. (2021) also found that close to half (44%) of their study participants with mental health problems reported transportation barriers as their major

concern during discharge planning. Furthermore, other studies have found transportation to be a significant barrier in getting access to HIV care (Gonzalez et al., 2016; Park et al., 2020). Taber et al. (2021) also found that individuals with lupus reported transportation as the most prevalent SDOH challenge to care. Patients in these studies often depended on other people for transportation, not always had people to ask for rides, people who could offer rides were also in impoverished situations, they could not afford a car, or had comorbid substance and mental health issues that made it cognitively challenging to use public transportation (Park et al., 2020). Taken together, these studies have demonstrated that the need for transportation spreads widely to different settings and populations and can impact the quality and access to health care in a variety of ways. Interventions that can remove or reduce transportation barriers to treatment must be developed and implemented.

The finding that older individuals are more likely to rate their physical health as poor is consistent with several studies that have found an inverse association between age and other health-related outcomes. That females are less likely to perceive their physical health as poor relative to their male counterparts corroborate several studies (Grosios et al., 2012; Kwak et al., 2016; Takahashi et al., 2018). In trying to explain the finding that females are more likely to have better health than males, some scholars have maintained that frequent contact with the health care system, either through child birth or annual physical checkups, offers females more opportunities to access health care and address any health-related issues they might have and thereby improves their overall physical health and well-being (Cavalieri, 2013; Singh et al., 2013). The finding that respondents who self-identified as Black/African American or American Indian/Alaska Native/Native Hawaiian/Pacific Islander are more likely to have fewer vehicles per individuals in the household and also report poor physical health is consistent with past studies that have documented poor health outcomes among individuals of color in the U.S. This finding may be partially explained by Larimer et al. (2017), who identified the cost of transportation, maps and drivers being English only, and the availability of timelines as some barriers that Mexican Americans have to face in using public transportation in their community. However, other studies contradict these findings and show that Hispanics were less likely to report lack of transportation as a barrier to treatment compared to Whites and African Americans (Gonzalez et al., 2016; Sorkin et al., 2016). Based on the existing literature, it appears that racial and ethnic differences related to transportation needs are not equal across all settings and populations.

It is also important to note, access to a vehicle not only facilitates health care access but also access to health-promoting activities such as participating in recreational activities. Duncan et al. (2016), in their study, found that barriers to physical activity in neighborhoods were greater for African American and Hispanic females who lack access to a vehicle in the household when compared to their White counterparts. These barriers reduce physical activity opportunities and may negatively and disproportionately impact the health of minority groups. Similarly, lack of access to a vehicle at home has been found to impede visitation to national parks (Xiao et al., 2017). Yue et al. (2019), in their study, also found that providing enabling services that improve access to care

through care coordination and transportation support can lead to increased health center visits, routine checkups, flu shots, and patient satisfaction. Having reliable access to transportation is more likely to facilitate access to care and may consequently help reduce the occurrence, risk, or severity of chronic health conditions such as diabetes, hypertension, heart disease, or obesity.

Based on the evidence and what we know about transportation as a SDOH, it is imperative for social workers, health professionals, engineers, and policymakers to begin working on viable solutions to reduce or eliminate this barrier and address the disparities created by the lack of access to reliable transportation. Furthermore, we must improve the quality and access of health care for all community members, but especially those who are most vulnerable or most impacted by transportation needs and barriers.

This report has some limitations that are worth noting. First, the analysis presented in this report is based on secondary data. Hence, we were unable to examine other theoretically important factors that might influence access to transportation and health. Factors such as availability and accessibility of public transit, fuel prices, and public transport fares are all relevant in ascertaining the true impact of transportation-related factors on self-perceived physical health. Also, there were no measures related to stress or mental health in the 2017 NHTS datasets for us to adjust for. Second, the data used in this report are cross-sectional, thereby limiting our ability to make any causal claims between transportation-related factors and self-perceived physical health. A longitudinal study that follows individuals with transportation needs over time to ascertain its impact on self-perceived physical health would be a major addition to the literature.

5.0 CONCLUSION

In conclusion, this report sought to examine the cross-sectional association between transportation-related factors and self-perceived physical health. We found that females, racial/ethnic minority individuals, and individuals with low SES were more likely to have fewer vehicles per individual in the household. Also, respondents who had fewer vehicles per individual in the household were more likely to report poor self-perceived physical health when compared to their counterparts with more vehicles per individual in the household.

6.0 REFERENCES

Arku, G., Luginaah, I., Mkandawire, P., Baiden, P., & Asiedu, A. B. (2011). Housing and health in three contrasting neighborhoods in Accra, Ghana. *Social Science & Medicine*, *72*(11), 1864–1872.

Baiden, P., Den Dunnen, W., Arku, G., & Mkandawire, P. (2014). The role of sense of community belonging on unmet health care needs in Ontario, Canada: Findings from the 2012 Canadian community health survey. *Journal of Public Health*, *22*(5), 467–478.

Balcazar, A. J., Grineski, S. E., & Collins, T. W. (2015). The durability of immigration-related barriers to health care access for Hispanics across generations. *Hispanic Journal of Behavioral Sciences*, *37*(1), 118–135.

Barnert, E. S., Lopez, N., Pettway, B., Keshav, N., Abrams, L. S., Zima, B., & Chung, P. J. (2020). The role of parent engagement in overcoming barriers to care for youth returning home after incarceration. *Journal of Community Health*, *45*(2), 329–337.

Bellamy, C. D., H. Flanagan, E., Costa, M., O'Connell-Bonarrigo, M., Tana Le, T., Guy, K., Antunes, K., & Steiner, J. L. (2016). Barriers and facilitators of healthcare for people with mental illness: Why integrated patient centered healthcare is necessary. *Issues in Mental Health Nursing*, *37*(6), 421–428.

Blosnich, J. R., Montgomery, A. E., Dichter, M. E., Gordon, A. J., Kavalieratos, D., Taylor, L., Ketterer, B., & Bossarte, R. M. (2019). Social determinants and military veterans' suicide ideation and attempt: A cross-sectional analysis of electronic health record data. *Journal of General Internal Medicine*, 1–9.

Blumenberg, E., Brown, A., & Schouten, A. (2020). Car-deficit households: Determinants and implications for household travel in the US. *Transportation*, *47*(3), 1103-1125.

Boen, C. E., & Hummer, R. A. (2019). Longer—But harder—Lives?: The Hispanic health paradox and the social determinants of racial, ethnic, and immigrant–native health disparities from midlife through late life. *Journal of Health and Social Behavior*, *60*(4), 434–452.

Braveman, P., Egerter, S., & Williams, D. R. (2011). The social determinants of health: Coming of age. *Annual Review of Public Health*, *32*, 381–398.

Braveman, P., & Gottlieb, L. (2014). The social determinants of health: It's time to consider the causes of the causes. *Public Health Reports*, *129*(1_suppl2), 19–31.

Caldwell, J. T., Ford, C. L., Wallace, S. P., Wang, M. C., & Takahashi, L. M. (2016). Intersection of living in a rural versus urban area and race/ethnicity in explaining access to health care in the United States. *American Journal of Public Health*, *106*(8), 1463–1469.

Canedo, J. R., Miller, S. T., Schlundt, D., Fadden, M. K., & Sanderson, M. (2018). Racial/ethnic disparities in diabetes quality of care: The role of healthcare access and socioeconomic status. *Journal of Racial and Ethnic Health Disparities*, *5*(1), 7–14.

Cavalieri, M. (2013). Geographical variation of unmet medical needs in Italy: A multivariate logistic regression analysis. *International Journal of Health Geographics*, *12*(1), 1–11.

D'Agostino, E. M., Patel, H. H., Hansen, E., Mathew, M. S., Nardi, M. I., & Messiah, S. E. (2019). Does transportation vulnerability explain the relationship between changes in exposure to segregation and youth cardiovascular health? *Health & Place*, *57*, 265–276.
Davis, C. I., Montgomery, A. E., Dichter, M. E., Taylor, L. D., & Blosnich, J. R. (2020). Social determinants and emergency department utilization: Findings from the Veterans Health Administration. *The American Journal of Emergency Medicine*, *38*(9), 1904–1909.
Dickman, S. L., Himmelstein, D. U., & Woolhandler, S. (2017). Inequality and the health-care system in the USA. *The Lancet*, *389*(10077), 1431–1441.
Dodd, V. J., Logan, H., Brown, C. D., Calderon, A., & Catalanotto, F. (2014). Perceptions of oral health, preventive care, and care-seeking behaviors among rural adolescents. *Journal of School Health*, *84*(12), 802–809.
Duncan, S. C., Strycker, L. A., Chaumeton, N. R., & Cromley, E. K. (2016). Relations of neighborhood environment influences, physical activity, and active transportation to/from school across African American, Latino American, and white girls in the United States. *International Journal of Behavioral Medicine*, *23*(2), 153–161.
Gonzalez, M., Precht, A., Fletcher, J., Catrambone, J., Bailey, L., & Espino, S. R. (2016). Welcome back survey: Exploring concerns impacting HIV care engagement and retention. *AIDS Care*, *28*(9), 1128–1131.
Graham, H. (2004). Social determinants and their unequal distribution: Clarifying policy understandings. *The Milbank Quarterly*, *82*(1), 101–124.
Grosios, K., Gahan, P. B., & Burbidge, J. (2012). Healthcare in the UK–predictive, preventive and personalised medicine perspective at the beginning of the twenty-first century. In *Healthcare overview* (pp. 31–44). Springer.
Howden-Chapman, P. (2004). Housing standards: A glossary of housing and health. *Journal of Epidemiology & Community Health*, *58*(3), 162–168.
Kockelman, K. M., & Kweon, Y.-J. (2002). Driver injury severity: An application of ordered probit models. *Accident Analysis & Prevention*, *34*(3), 313–321.
Kubzansky, L. D., Sparrow, D., Vokonas, P., & Kawachi, I. (2001). Is the glass half empty or half full? A prospective study of optimism and coronary heart disease in the normative aging study. *Psychosomatic Medicine*, *63*(6), 910–916.
Kwak, L., Berrigan, D., Van Domelen, D., Sjöström, M., & Hagströmer, M. (2016). Examining differences in physical activity levels by employment status and/or job activity level: Gender-specific comparisons between the United States and Sweden. *Journal of Science and Medicine in Sport*, *19*(6), 482–487.
Larimer, K. A., Gulanick, M., & Penckofer, S. (2017). Understanding determinants of cardiovascular health in a Mexican American community. *Health Promotion Practice*, *18*(4), 534–544.
Lazar, M., & Davenport, L. (2018). Barriers to health care access for low income families: A review of literature. *Journal of Community Health Nursing*, *35*(1), 28–37.
McDonald, K. L., Hoenig, J. M., & Norman, C. C. (2021). Identifying profiles of need among psychiatric inpatients approaching discharge in New York City: A latent class analysis. *Social Psychiatry and Psychiatric Epidemiology*, *56*(1), 63–73.
Park, E., Stockman, J. K., Thrift, B., Nicole, A., & Smith, L. R. (2020). Structural barriers to women's sustained engagement in HIV care in southern California. *AIDS and Behavior*, *24*(10), 2966–2974.

Ramsay, N., Hossain, R., Moore, M., Milo, M., & Brown, A. (2019). Health care while homeless: Barriers, facilitators, and the lived experiences of homeless individuals accessing health care in a Canadian regional municipality. *Qualitative Health Research*, *29*(13), 1839–1849.
Schoen, C., Osborn, R., Squires, D., & Doty, M. M. (2013). Access, affordability, and insurance complexity are often worse in the United States compared to ten other countries. *Health Affairs*, *32*(12), 2205–2215.
Singh, P. K., Singh, L., Kumar, C., & Rai, R. K. (2013). Correlates of maternal healthcare service utilisation among adolescent women in Mali: Analysis of a nationally representative cross-sectional survey, 2006. *Journal of Public Health*, *21*(1), 15–27.
Sommerfeld, D. H., Jaramillo, E. T., Lujan, E., Haozous, E., & Willging, C. E. (2021). Health care access and utilization for American Indian Elders: A concept-mapping study. *The Journals of Gerontology: Series B*, *76*(1), 141–151.
Sorkin, D. H., Murphy, M., Nguyen, H., & Biegler, K. A. (2016). Barriers to mental health care for an ethnically and racially diverse sample of older adults. *Journal of the American Geriatrics Society*, *64*(10), 2138–2143.
Taber, K. A., Williams, J. N., Huang, W., McLaughlin, K., Vogeli, C., Cunningham, R., Wichmann, L., & Feldman, C. H. (2021). Use of an Integrated Care Management Program to Uncover and Address Social Determinants of Health for Individuals With Lupus. *ACR Open Rheumatology*, *3*(5), 305–311.
Takahashi, Y., Fujiwara, T., Nakayama, T., & Kawachi, I. (2018). Subjective social status and trajectories of self-rated health status: A comparative analysis of Japan and the United States. *Journal of Public Health*, *40*(4), 713–720.
United States Department of Health and Human Services (USDHHS), Office of Disease Prevention and Health Promotion (n.d.). *Healthy People 2030*. https://health.gov/healthypeople/objectives-and-data/social-determinants-health Retrieved Accessed on June 29, 2021.
Wafula, E. G., & Snipes, S. A. (2014). Barriers to health care access faced by black immigrants in the US: Theoretical considerations and recommendations. *Journal of Immigrant and Minority Health*, *16*(4), 689–698.
Wallace, R., Hughes-Cromwick, P., Mull, H., & Khasnabis, S. (2005). Access to health care and nonemergency medical transportation: Two missing links. *Transportation Research Record*, *1924*(1), 76–84.
Wolfe, M. K., McDonald, N. C., & Holmes, G. M. (2020). Transportation barriers to health care in the United States: Findings from the national health interview survey, 1997–2017. *American Journal of Public Health*, *110*(6), 815–822.
World Health Organization (WHO) Commission on Social Determinants of Health (2008). Closing the gap in a generation: Health equity through action on the social determinants of Health: Commission on social determinants of health final report. World Health Organization: Geneva, Switzerland.
World Health Organization (WHO). (2009). The financial crisis and global health: report of a high-level consultation. World Health Organization: Geneva, Switzerland.
Xiao, X., Perry, E., Manning, R., Krymkowski, D., Valliere, W., & Reigner, N. (2017). Effects of transportation on racial/ethnic diversity of National Park Visitors. *Leisure Sciences*, *39*(2), 126–143.

Yue, D., Pourat, N., Chen, X., Lu, C., Zhou, W., Daniel, M., Hoang, H., Sripipatana, A., & Ponce, N. A. (2019). Enabling services improve access to care, preventive services, and satisfaction among health center patients. *Health Affairs*, *38*(9), 1468–1474.