Final Report

Investigating Walking and Biking Activities Among Low-Income African Americans

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Date

March 3, 2023

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ACKNOWLEDGMENT

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Investigating Walking and Biking Activities Among Low-Income African Americans		**5. Report Date** March 3, 2023
		6. Performing Organization Code
7. Author(s) Eazaz Sadeghvaziri, https://orcid.org/0000-0003-1002-237X Ramina Javid, https://orcid.org/0000-0002-5487-1560 Mansoureh Jeihani, https://orcid.org/0000-0001-8052-6931		**8. Performing Organization Report No.**
9. Performing Organization Name and Address Morgan State University 1700 E Cold Spring Ln, Baltimore, MD 21251-0001		**10. Work Unit No.**
		11. Contract or Grant No. 69A43551747123
12. Sponsoring Agency Name and Address US Department of Transportation Office of the Secretary-Research UTC Program, RDT-30 1200 New Jersey Ave., SE Washington, DC 20590		**13. Type of Report and Period Covered**
		14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Active transportation has become popular in the United States and can reduce transportation's negative effects on the environment. It also plays a critical role in sustainable transportation and reducing greenhouse emissions. To provide an equitable transportation system for the public, it is vital to fully understand low-income African Americans' active transportation needs and challenges. The goal of this study was to investigate walking and biking activities among low-income African Americans. We first conducted a systematic review of all studies related to this subject using the PRISMA guidelines. The literature on this subject suggested that bike usage was low among minorities and those with lower incomes. Furthermore, communities with poor accessibility to bike infrastructure had a larger concentration of African Americans, low-wage employees, and the elderly. For the analysis, we used 2017 NHTS data, which is the main source of national data on American travel behaviors. We conducted an analysis of 11 variables related to biking and 12 variables related to walking. Moreover, to ensure the collected data represents the U.S. population, the applied weight provided in the NHTS dataset was used in this study to ensure that the results represent the U.S. population. The results of our analyses showed that African Americans have a lower number of bike trips per week compared to White Americans, which is in line with the results of previous studies. In general, African Americans use bicycles as a way to exercise rather than a mode to travel. African Americans also use active transportation as a way to reduce the financial burden of travel more than other racial groups. Moreover, African American students tend to use active transportation to travel to and from school more than other groups. Analyzing the 2017 California-NHTS database, we found that the most common reason given for why low-income African Americans did not walk or use a bike to travel was having no path and bad lighting. Moreover, the results of the regression models indicate that the number of drivers in household, the number of household vehicles, rural residency, and not being Hispanic all had relationship with the use of active transportation to reduce the financial burden of travel among low-income African Americans. This research provides a deeper understanding of bike travel behavior among different households and informs policies that prioritize high-need communities through appropriately planned bike infrastructure development.

17. Key Words: Active Transportation, African Americans, low-income, Minority	18. Distribution Statement No restrictions.		
19. Security Classif. (of this report): Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages**	**22. Price**

TABLE OF CONTENTS

1. Introduction 10
1.1. Problem Statement 11
1.2. Goal 11
2. Literature Review 12
2.1. Active Transportation User Characteristics 13
2.2. Active Transportation to School 14
2.3. Active Transportation and Social Disparities 15
2.4. Active Transportation Infrastructure 16
2.5. Active Transportation and the Effect of the COVID-19 Pandemic 16
2.6. Summary of the Literature Review 17
3. Data and Methodology 18
3.1. Data 18
3.1.1. Person Dataset 18
3.1.2. Household Dataset 18
3.1.3. Trip dataset 19
3.1.4. Description of the Walking and Biking Variables 19
3.1.5. Methodology 29
4. Analyses and Results 30
4.1. Biking and Walking Variables among All Racial Groups 30
4.1.1. Biking Related Variables 30
4.1.2. Walking Related Variables 36
4.1.3. Variables Only Focusing on the State of California 42
4.1.4. ANOVA Test for Walking and Biking Among All Racial Groups 45
4.2. Biking and Walking Variables Among Low-income African Americans 46
4.2.1. Biking Related Variables 47
4.2.2. Walking Related Variables 52
4.2.3. Variables Only Focusing on the State of California 57
4.2.4. ANOVA Test for Walking and Biking Among Different Income Groups 60
4.3. Socio-demographic Information of Low-Income African Americans 62
4.3.1. Low-income African Americans Distribution in the U.S. 62
4.3.2. Age 63

4.3.3. Gender 63
4.3.4. Educational Attainment 63
4.3.5. Number of drivers in the household 63
4.3.6. Count of Household Vehicles 64
4.3.7. Home Ownership 64
4.3.8. Households in urban/rural areas 64
4.3.9. Average of Bike Trips and Walk Trips in a Week in the U.S. 65
4.3.10. Average Walk Trips per Week in the U.S. 65
4.3.11. Average of Bikeshare ridership in a Month in the U.S. 65
4.3.12. Households Using Bike to Reduce the Financial Burden of Travel 66
4.3.13. Percentage of Households Using Walk to Save Financial Burden of Travel 66
4.4. Modeling Analysis 66
5. Discussion 68
6. Summary and Conclusion 69
7. References 86

LIST OF TABLES

TABLE 1 Frequency and Percentage in Each Race in the NHTS Person Dataset 18
TABLE 2 Frequency and Percentage in Each Race in the NHTS Household Dataset..... 19
TABLE 3 Biking-Related Variables 20
TABLE 4 Walking-Related Variables 24
TABLE 5 ANOVA with post-hoc Tukey HSD Test for Biking Among Racial Groups..... 45
TABLE 6 ANOVA with post-hoc Tukey HSD Test for Walking Among Racial Groups..... 46
TABLE 7 Percentage of Different Income Groups of African Americans in Person Dataset 47
TABLE 8 Percentage of Different Income Groups of African Americans in Household Dataset 47
TABLE 9 ANOVA with post-hoc Tukey HSD Test for Biking Among Different Incomes 60
TABLE 10 ANOVA with post-hoc Tukey HSD Test for Walking Among Different Incomes... 61
TABLE 11 Age Groups Among Low-income African Americans 63
TABLE 12 Gender Among Low-income African Americans 63
TABLE 13 Educational Attainment levels Among Low-income African Americans 63
TABLE 14 Number of Household Drivers Among Low-income African Americans 64
TABLE 15 Household Vehicles Among Low-income African Americans 64
TABLE 16 Home Ownership Among Low-income African Americans 64
TABLE 17 Home Ownership Among Low-income African Americans 64
TABLE 18 Binary Logistic Regression Model of Bike to Reduce Financial Burden of Travel .. 67
TABLE 19 Binary Logistic Regression Model of Walk to Reduce Financial Burden of Travel . 67
TABLE 20 Summary of Previous Studies on Active Transportation..... 72

LIST OF FIGURES

FIGURE 1 PRISMA Flowchart for Reporting Systematic Review..... 12
FIGURE 2 Publication year of the studies included in this review 13
FIGURE 3 Average Count of Bike Trips per Week Among Different Racial Groups 30
FIGURE 4 Average Count of Bike Trips for Exercise Among Different Racial Groups 31
FIGURE 5 Average Count of Bikeshare Program Usage Among Different Racial Groups 31
FIGURE 6 Bicycle as an Alternative Mode of Transportation Among Different Racial Groups 32
FIGURE 7 Bicycle as a Mode to Work Among Different Racial groups 33
FIGURE 8 Bicycle as a Mode to School Among Different Racial Groups..... 33
FIGURE 9 Bicycle as a Mode from School Among Different Racial Groups..... 34
FIGURE 10 Frequency of Bicycle Use for Travel Among Different Racial Groups..... 35
FIGURE 11 Bicycle to Reduce Financial Burden of Travel Among Different Racial Groups.... 35
FIGURE 12 Average Count of Walk Trips per Week Among Different Racial Groups 36
FIGURE 13 Average Count of Walk Trips for Exercise per Week Among Different Racial..... 37
FIGURE 14 Walk as an Alternative Mode of Transportation Among Different Racial Groups . 37
FIGURE 15 Walk as a Mode to Work Among Different Racial Groups 38
FIGURE 16 Walking as a Mode to School Among Different Racial Groups 39
FIGURE 17 Walking as a Mode from School Among Different Racial Groups 39
FIGURE 18 Walking to Reduce Financial Burden of Travel Among Different Racial Groups .. 40
FIGURE 19 Frequency of Walking for Travel Among Different Racial Groups 41
FIGURE 20 Walk as a Mode Used to Get to Public Transit Among Different Racial Groups.... 41
FIGURE 21 Walk as a Mode Used to Get from Public Transit Among Different Racial Groups42
FIGURE 22 Reason for Not Biking More: Infrastructure, Among Different Racial Groups..... 43
FIGURE 23 Reason for Not Biking More: Safety, Among Different Racial Groups 43
FIGURE 24 Reason for Not Walking More: Infrastructure, Among Different Racial Groups.... 44
FIGURE 25 Reason for Not Walking More: Safety, Among Different Racial Groups 45
FIGURE 26 Average Count of Bike Trips per Week Among Different Income Groups 48
FIGURE 27 Count of Bike Trips for Exercise per Week Among Different Income Groups..... 48
FIGURE 28 Count of Bike Trips for Exercise per Week Among Different Income Groups..... 49
FIGURE 29 Bicycle as Alternative Mode of Transportation Among Different Income Groups . 49
FIGURE 30 Bicycle as a Mode to Work Among Different Income Groups..... 50
FIGURE 31 Bicycle as a Mode to School Among Different Income Groups..... 50

FIGURE 32 Bicycle as a Mode from School Among Different Income Groups 51
FIGURE 33 Frequency of Bicycle Use for Travel Among Different Income Groups 51
FIGURE 34 Bicycle to Reduce Financial Burden of Travel Among Different Income Groups .. 52
FIGURE 35 Average Count of Walk Trips per Week Among Different Income Groups 52
FIGURE 36 Count of Walk Trips for Exercise per Week Among Different Income Groups..... 53
FIGURE 37 Walk as an Alternative Mode of Transportation Among Different Income Groups 53
FIGURE 38 Walk as a Mode to Work Among Different Income Groups 54
FIGURE 39 Bicycle as a Mode to School Among Different Income Groups..... 54
FIGURE 40 Bicycle as a Mode from School Among Different Income Groups 55
FIGURE 41 Walk to Reduce Financial Burden of Travel Among Different Income Groups 55
FIGURE 42 Frequency of Walking for Travel Among Different Income Groups..... 56
FIGURE 43 Walk as a Mode Used to Get to Public Transit Among Different Income Groups .. 56
FIGURE 44 Walk as a Mode Used to Get from Public Transit Among Different Incomes 57
FIGURE 45 Reason for Not Biking More: Infrastructure Among Different Income Groups..... 58
FIGURE 46 Reason for Not Biking More: Safety Among Different Income Groups 58
FIGURE 47 Reason for Not Walking More: Infrastructure Among Different Income Groups... 59
FIGURE 48 Reason for Not Walking More: Safety Among Different Income Groups 59
FIGURE 49 Distribution of Low-income African American Participants in NHTS Dataset..... 62
FIGURE 50 Distribution of Low-income African Americans in the U.S. 62
FIGURE 51 Average of Bike Trips per Week of Low-income African Americans in the U.S. .. 65
FIGURE 52 Average of Walk Trips per Week of Low-income African Americans in the U.S. . 65
FIGURE 53 Bikeshare Use per Month of Low-income African Americans in the U.S..... 65
FIGURE 54 Bike to Reduce Financial Burden of Travel of Low-income African Americans.... 66
FIGURE 55 Walk to Reduce Financial Burden of Travel of Low-income African Americans... 66

ABSTRACT

Active transportation has become popular in the United States and can reduce transportation's negative effects on the environment. It also plays a critical role in sustainable transportation and reducing greenhouse emissions. To provide an equitable transportation system for the public, it is vital to fully understand low-income African Americans' active transportation needs and challenges. The goal of this study was to investigate walking and biking activities among low-income African Americans. We first conducted a systematic review of all studies related to this subject using the PRISMA guidelines. The literature on this subject suggested that bike usage was low among minorities and those with lower incomes. Furthermore, communities with poor accessibility to bike infrastructure had a larger concentration of African Americans, low-wage employees, and the elderly. For the analysis, we used 2017 NHTS data, which is the main source of national data on American travel behaviors. We conducted an analysis of 11 variables related to biking and 12 variables related to walking. Moreover, to ensure the collected data represents the U.S. population, the applied weight provided in the NHTS dataset was used in this study to ensure that the results represent the U.S. population. The results of our analyses showed that African Americans have a lower number of bike trips per week compared to White Americans, which is in line with the results of previous studies. In general, African Americans use bicycles as a way to exercise rather than a mode to travel. African Americans also use active transportation as a way to reduce the financial burden of travel more than other racial groups. Moreover, African American students tend to use active transportation to travel to and from school more than other groups. Analyzing the 2017 California-NHTS database, we found that the most common reason given for why low-income African Americans did not walk or use a bike to travel was having no path and bad lighting. Moreover, the results of the regression models indicate that the number of drivers in household, the number of household vehicles, rural residency, and not being Hispanic all had relationship with the use of active transportation to reduce the financial burden of travel among low-income African Americans. This research provides a deeper understanding of bike travel behavior among different households and informs policies that prioritize high-need communities through appropriately planned bike infrastructure development.

Key Words: Active Transportation, African Americans, low-income, Minority

1. INTRODUCTION

Active transportation has become increasingly popular in the United States (*1*), and much effort has been made to reduce traffic congestion and air pollution in American cities in recent years (*2–7*). In dense urban areas, walking and biking are among the main modes of transportation (*8*). Bicycles, in particular, are fast, affordable, and flexible enough to be used for both urban and rural trips. These transportation modes can reduce transportation's negative effects on the environment and increase human health and physical activity (*8*, *9*, *9–13*). These modes types also play a critical role in sustainable transportation and reducing greenhouse emissions (*14*).

Moreover, a bicycle is an affordable mode of transportation. It has flexibility and speed and is also suitable for many urban or rural trips. Moreover, it can improve personal health because it is not only a mode of travel but also a physical activity (*10*). However, in the southeastern United States, walking and biking are less common as a mode of transportation (*15*). Many factors affect walking and bicycling behaviors, and people base their travel decisions on different factors, such as cost, travel time, convenience, and the environment. Sociodemographic characteristics – e.g., age, gender, ethnicity, education, income, household size, car ownership, and employment status – also shape travel behaviors (*10*, *14*, *16–22*). According to the 2017 National Household Travel Survey (NHTS), 35% of automobile journeys in the U.S. are fewer than two miles, and almost half are less than three miles—distances that might be accomplished by walking or cycling in a variety of scenarios. According to the same report, just 10.5% of journeys are made, and only 1% of trips are made by bicycling (*1*, *8*). From 2001 to 2017, the national rates of daily walking increased slightly while cycling rates stayed steady, indicating that much more needs to be done (*23*). The use of non-motorized transportation thus remains low in the U.S., and the environmental and health benefits of these modes remain out of reach for most Americans (*8*).

Bikeshare programs have been on the rise in the U.S. as well. Yet despite their popularity and effectiveness, there is growing evidence that some groups are using and benefiting from these programs more than others. This evidence has led to growing interest in researching public bikeshare systems (*24*). A bikeshare system has the potential to assist impoverished neighborhoods if the service better suits their needs and requirements. Equity considerations are becoming more prominent in bicycle planning, but claims of disparity have lacked quantitative evidence. For example, advocacy reports have frequently mentioned differences in infrastructure access across the U.S. without giving particular proof of such national trends (*25*).

Because active transportation and bikeshare programs involve such controversial concerns, the most recent NHTS included questions asking why Americans are not using a bicycle or walking more. More specifically, there is limited understanding of walking and biking patterns among minorities, especially low-income African Americans. Even though different research employed diverse datasets, most of which are modest in size, to the authors' knowledge, no study employing the NHTS data focused on the walking and biking behaviors of low-income African Americans.

1.1. Problem Statement

There are various reasons to believe that people of color and those with lower socioeconomic status (SES) in the U.S. do not get the full health advantages of walking and cycling (*12*). Studies have shown that low-income and minority populations have disproportionately high cycling fatality rates and limited access to biking infrastructure despite significant growth in ridership in recent years (*25*).

There is a growing body of literature on walking and biking in the U.S., and different transportation organizations have collected various data related to walking and biking activities. However, since the NHTS data was not used to focus on low-income African Americans, there is still a need to investigate this subject through a comprehensive study.

Additionally, while previous studies have explored implementing infrastructure for walking and biking, no studies have comprehensively investigated the prevalence of and motivations for walking and biking among low-income African Americans in the U.S. In order to provide an equitable transportation system for the general public, it is vital to fully understand minorities' walking and biking activities and their reasons for not taking part in these activities. The more comprehensive knowledge of the walking and biking activities of minorities is available, the more success municipalities will have in planning and implementing an equitable transportation system. This research fills this gap by analyzing the walking and biking variables in the 2017 NHTS data.

1.2. Goal

The main goal of this study was to investigate the walking and biking activities of low-income African Americans in the U.S. To achieve this, the following objectives were undertaken:

- Investigating use of walking and biking activities among all racial and ethnic groups.
- Investigating the reasons for not walking and biking among low-income African Americans.
- Investigating low-income African American's use of walking and biking activities for exercise and bikeshare programs.
- Investigating the use of active transportation to reduce the financial burden of travel among African Americans.
- Investigating the sociodemographic characteristics of low-income African Americans.

2. LITERATURE REVIEW

This review of the literature focuses on studies of African Americans' travel patterns conducted over the past decade. The results summarized in this review encompass multiple domains of walking and biking activities. Understanding the current state of the research reveals the significant effect that walking and biking activities of low-income African Americans have on equity in transportation. This study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (*26*) to systematically review relevant publications. The review was conducted on academic publications that were found on Scopus, Science Direct, and Transportation Research Record (TRR) using keywords such as "African American" AND "Micro-mobility" AND "Active Transportation" (OR "African American" AND "Active Transportation" AND "National Household Travel Survey" OR "African American" AND "Low-income" AND "Bike"), with dates ranging from 2013 to 2022. This period was chosen to reflect the most recent findings in literature. The first step, which involved the preliminary search, found 3,393 articles. The next step excluded duplicates from the databases (n=1,718); afterward, exclusions were first made based on the title (n = 1,531), and then on the abstract (n = 86). Some 62 articles were retrieved for full text, and finally, 60 articles were included in the review. A flowchart of the literature search is shown in **Figure 1**.

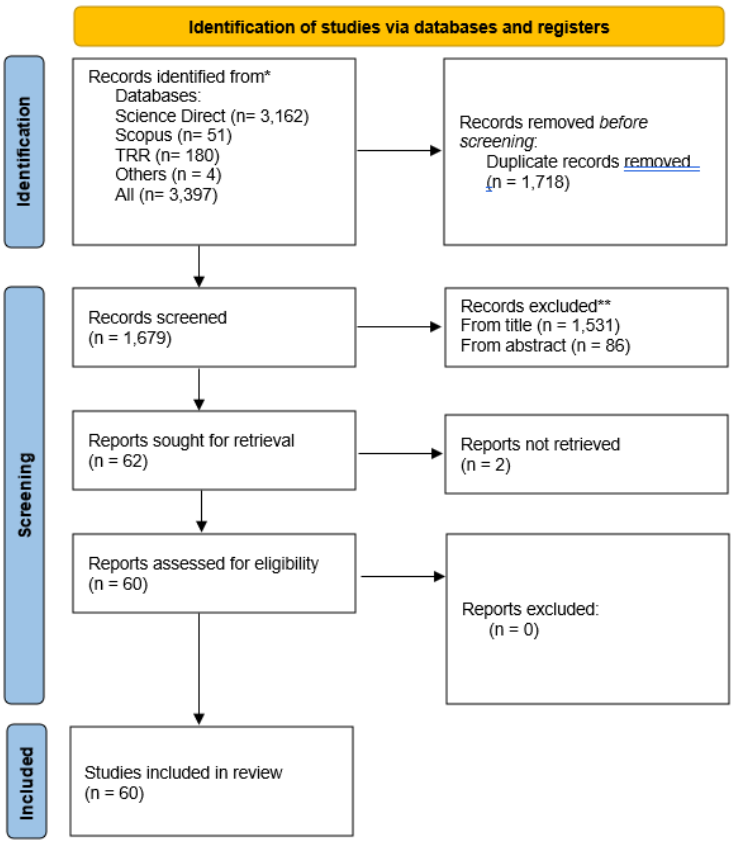

FIGURE 1 PRISMA Flowchart for Reporting Systematic Review

Figure 2 shows the publication year of the studies included in this review. This time-series analysis of publications indicated that active transportation and its focus on underrepresented populations began receiving more attention over time, with the number of publications increasing significantly beginning in 2019. Increases in the availability of data (such as the 2017 NHTS) may be one of the reasons behind this change.

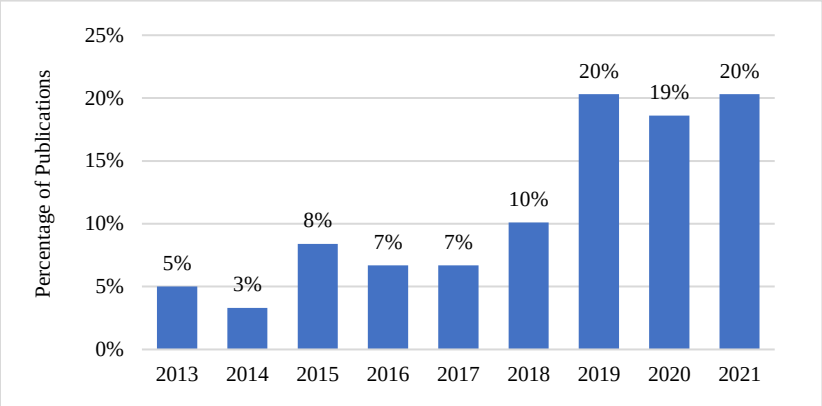

FIGURE 2 Publication year of the studies included in this review

Existing research has contributed significantly to the methodologies and data practices connected to equity and active transportation. Based on the literature review, previous studies fall into five main categories.

2.1. Active Transportation User Characteristics

Several demographic factors, like age, gender, education level, income, and race, affect biking and walking activities. A study showed that walking frequency is associated with income, age, and employment status (*27*). A growing body of literature states that bike lanes and bikeshare stations tend to be created in socioeconomically advantaged regions. According to these studies, some groups do not benefit from the proper infrastructure or conditions necessary to reliably walk or bike. The following studies focus on the effects of these factors on the use of active transportation.

Generally, previous studies indicated that age and riding a bike are inversely related (*10*, *28*). As age increases, the likelihood of cycling decreases (*11*). Another study also indicated that younger respondents were more likely to use active transportation across transportation networks (*29*). However, the bus and walking are the most common modes of transportation for elderly people seeking medical care, and bicycles and electric bicycles are used less by the elderly because of their physical limitations (*30*). In general, active travel and daily transport trips declined from younger to older age groups (*31*).

Gender gaps existed in the mobility patterns of active transportation users as well (*29*, *32*). Being female decreases the likelihood of cycling (*10*), and males have a higher chance of commuting and traveling by bike, but a lower chance of walking (*33*). Similarly, using the Canadian Community Health Survey (CCHS), Branion-Calles et al. (2021) concluded that bicycling was more popular among males, whereas walking was more popular among females. This fact is also reported in the U.S. Moreover, males are at a higher risk of crashes when riding a bicycle (*28*). A study on college

students in Baltimore suggested that males are less concerned about danger indicators like theft and environment-related challenges like bad road conditions. Females, on the other hand, are more enthusiastic about bike-friendly development projects (*34*).

A similar study indicated that bike usage was found to be low among minorities and those with lower incomes (*13*). A survey conducted in low-income neighborhoods in Boston stated that safety issues, lack of helmets, lack of nearby stations, difficulty renting or returning a bike, and bad weather are the most common barriers to using a bike. Convenience, nearby stations, environmental advantages, economic benefits, entertainment, and health benefits were the key facilitators. The significance of these factors rose as ridership increased (*35*).

Several studies on educational attainment (*10*, *25*) focused on the relationship between active transportation and education level. Quinn et al. (2016) used the 2009 NHTS data to show that young, low-income, and urban-dwelling respondents had a greater probability of using active transportation. This was also true for those in the highest and lowest education categories. Among bicycle owners, frequency of riding was greater among young, male, white, and educated subgroups (*36*). More specifically, Acheampong and Siiba (2018) investigated the effects of personal characteristics and socio-environmental factors on biking as a mode of transportation in Ghana. The results of their analysis indicated that participants' gender and educational attainment impacted whether or not they cycled. Being female was shown to be negatively connected with commuting by bicycle in the city; males were about two-and-a-half times more likely than females to bike. When compared to people with greater levels of education, those with the equivalent of a high school education were 2.5 times more likely to cycle for utility purposes (*10*).

2.2. Active Transportation to School

Walking and biking were historically popular ways for children to go to school (*37*). Studies have shown that there is a link between childhood travel behavior and adult walking behavior later in life (*38*). Therefore, it is necessary to investigate the travel modes of schoolchildren to have a better insight into this matter. In 2012, a study on students' transportation modes in the U.S. revealed that the most popular means of traveling from school to home for students who lived within one mile of the school was walking or bicycling (28.4 %) (*37*). Another study used the 2017 NHTS dataset to investigate the mode of transportation for students ages 5 to 17. The results suggested that 9.6% of students walked to school, and 1.1% rode their bikes. For children who walk to school, 77.5 % of their trips were less than 1 mile. As the distance to the school rose, students' rates of walking to school fell, whereas the rates of bicycling to school peaked when the distance was between 0.5 and 1 mile (*39*).

Comfortable bicycle routes, the racial and economic makeup of the student population, and numerous environmental elements – e.g., day of week, season, weather – were all found to impact rates of cycling to school (*40*). Because of the specific social and environmental variables, local solutions to school transportation issues are required to effectively promote students' cycling activity. Changes in active school travel (AST) correlations throughout time should be taken into account when evaluating current policy methods and developing new policy, legislation, design,

and program initiatives (*41*). Active travel promotion could leverage the potential for schools and local government offices to serve as anchor institutions for health-promoting travel behavior (*42*).

2.3. Active Transportation and Social Disparities

Bikeshare programs, which encourage bicycling, have been growing rapidly over the last ten years (*8, 11*, *24*). Such programs are available in all 50 U.S. states and the District of Columbia. By the end of 2018, roughly 250 municipalities, either cities or counties, were home to operational bikesharing systems according to the Pan American Health Organization (*43*).

Generally, bikeshare stations are located in areas where residents have higher incomes and sociodemographic status (*11*). Several studies (*11*, *44–47*) focused on equity and access to transportation for all groups of people, especially disadvantaged groups. According to the findings, communities with poor accessibility had a larger concentration of African Americans, Hispanics, Asians, low-wage employees, residents with little education, and the elderly (*45*). These studies found evidence of disparities and barriers to the usage of bikeshare programs (*44*). Capsi and Noland (2019) investigated the travel pattern for Indego, a bikeshare program in Philadelphia, and found that bikeshare journeys from docking stations in low-income neighborhoods were for work commutes. Moreover, the results suggested that lower-income areas generate fewer trips (*48*). In a similar study, Auchincloss et al. (2020) initiated a survey in Philadelphia, and the results of their research indicated that participants who used bikeshare programs were mostly young and non-Hispanic white, as they predicted (*11*).

A study by MacArthur et al. (2020) showed that there is an underserved market of people who believe they are unable to use existing bikesharing systems due to physical limitations (*49*). Similarly, Qian and Jaller (2021) assessed Divvy's bikeshare dataset in Chicago, and the results indicated that bikeshare journeys are more likely to occur in areas with increased accessibility (i.e., the ability to use various mobility services and technologies, and/or the ability to reach farther destinations/opportunities) (*50*). CitiBike in New York City is one of the largest bikeshare programs in the U.S. (*51*). One study suggested that bikeshare initiatives were not reaching segments of the population who were not already prone to cycling in New York City (*51*). Another study by Gehrke et al. (2021) stated that neighborhoods with a larger proportion of renter-occupied dwellings and historically disadvantaged populations have less access to dockless bikes while simultaneously having higher bike utilization rates (*52*). On the other hand, research showed that people who live in areas with a high concentration of minorities and low socioeconomic status (SES) residents use bikeshare more frequently, and have more frequently used origin-destination pairings of stations (*53*). Cycling is frequently debated from the standpoint of health equity, as riding may provide health advantages associated with physical exercise (*25*). However, recently, some bikeshare programs have been initiating equity strategies and focusing on disadvantaged groups (*11, 54*). One out of four bikeshare programs has equity-related policies (*24*). For instance, the city of Philadelphia placed docking stations in low-income communities, permitted cash payments, and offered discounts to people receiving food stamps to entice more low-income residents to use bikeshare systems.

Smart mobility solutions might solve many of the demands of transportation-challenged communities by cutting prices and enhancing service for public transit, ridesharing, and active transportation (*55*). In addition to the overall budget and staffing levels, bike-share systems identified cost, access, and outreach as the most significant impediments to equity (*24*).

2.4. Active Transportation Infrastructure

The built environment and related social influences can also affect biking and walking activities. Emerging data suggest a link between active transportation infrastructure investment and gentrification, potentially excluding people of color and those with low socioeconomic status from infrastructure that encourages walking and cycling (*12*). Moreover, studies showed that dedicated bicycle lanes, the availability of alternative roads and traffic calming systems, on-street parking and blockages on neighborhood routes, land use, density, diversity, topography, distance of the trip, and traffic are all factors that influence bicycle use. For instance, mixed land use and higher density can increase bicycling (*8*, *56*, *10*, *57*, *58*).

Low-income and minority neighborhoods in the U.S. have disproportionately limited access to bike lanes, according to cycling activists (*25*). Using the 2011-2015 American Community Survey (ACS) and GIS data, Braun et al. (2019) examined access to bike lanes in 22 American cities at the census block group level. Their analysis showed that those who had less educational attainment, lower income, and were African American or Hispanic had less access to bike infrastructure such as bike lanes (*25*).

Many barriers in the built environment can hinder the use of active transportation. A study conducted by Knight et al. (2018) indicated that walkable block groups are concentrated in specific regions of the city. The study's data also showed that housing values in walkable areas are rising, and people in poverty and members of particular minority groups dwell in block groups with a disproportionately low WalkScore® (*59*). Similarly, a study conducted by Lowe (2016) indicated that minority communities and, to a lesser extent, low-income groups are substantially related to poor sidewalk connectivity (*60*). Another study regarding students at a university found that if there were safer cycling routes, better illumination, and more visible bikers, then professors, staff, and students would ride their bikes more (*61*). Barajs (2021) investigated the accident rate for bicyclists, and the results showed that on high-traffic routes, bicycle infrastructure was linked to lower traffic law enforcement, although this infrastructure was disproportionately lacking in minority communities (*56*). Crime was also cited as a barrier to cycling among African Americans (*56*).

2.5. Active Transportation and the Effect of the COVID-19 Pandemic

Due to the COVID-19 pandemic, human mobility patterns have changed significantly. Several research studies investigated the effects of the COVID-19 pandemic on walking, biking, bikeshare programs, and travel behavior before and during the pandemic. An online survey of commute travel in Philadelphia, for instance, showed that almost 50% of respondents changed their mode of transportation during the COVID-19 pandemic (*62*).

According to these studies, the bike is one of the best modes of transportation to use during a pandemic (*62–65*). A study by Wang and Noland (2021) showed that subway and bikeshare ridership have been declining since the beginning of the pandemic. However, bikeshare usage has recently returned to near pre-pandemic levels while subway ridership remains substantially below pre-COVID levels (*29*). Moreover, Hu et al. (2021) investigated changes in the Divvy bikeshare program in Chicago during the pandemic. The results of their analysis showed a 32% decrease in bikeshare ridership in Chicago during COVID-19, but the duration of the trips increased during the pandemic. Comparing bikeshare to other modes of transportation showed that bikeshare is more resilient than the others, making it one of the best choices during the pandemic (*63*). Another study conducted in San Antonio, Texas, indicated that those who were unemployed as a result of the epidemic reported using the bikesharing system more frequently (*64*). It is worth mentioning that statistical analysis conducted by several of these studies indicated that subway ridership declined more than bikeshare ridership (*63*, *65*).

2.6. Summary of the Literature Review

This literature review is designed to identify studies related to walking and biking activities that focus on the African American population in the U.S., evaluate the quantification approaches used in the literature, and uncover barriers to the use of active transportation among them. We used PRISMA guidelines to systematically review relevant publications. After screening and reviewing the literature, some 60 articles were included in the review.

Based on this review, several factors affect biking and walking activities, including age, gender, education level, income, race, etc. Age has an inverse relationship with active transportation usage, and males have a higher chance of commuting and transporting by bike but a lower chance of walking. Lower-income areas generate fewer trips, and bike usage was low among minorities and those with lower incomes. Generally, bikeshare stations are in areas where residents have higher incomes and sociodemographic status.

The built environment and infrastructure can also be a factor in choosing a mode of transportation (*66–69*), especially biking and walking activities. For instance, mixed land use and higher population density can increase bicycle usage. Low-income and minority neighborhoods in the U.S. have disproportionately limited access to bike lanes, and walkable block groups are concentrated in specific regions of the city where housing values are higher. Comparing bikeshare to other modes of transportation showed that bikeshare is more resilient than others, making it one of the best choices during the COVID-19 pandemic. This shows that more people are shifting from public transportation to bikeshare as a substitute for their transit trips. It is therefore necessary to address concerns regarding the accessibility of bikeshare systems for disadvantaged groups. Policymakers may consider supporting services like bikeshare to keep communities connected during health emergencies.

3. DATA AND METHODOLOGY

This section explains the data used in this study, which was obtained from the 2017 NHTS dataset, and describes the variables used in this research.

3.1. Data

The NHTS is the largest and most valid national transportation-related dataset in the U.S. The NHTS is a survey conducted by the FHWA designed to better understand the travel behaviors and patterns of Americans. The NHTS is the main national source of data on how the travel behavior of the American public is changing as demographic, economic, and cultural changes take place. The NHTS dataset contains several different datasets, including person-, household-, trip-, and vehicle-level data. The person dataset, which is used in this study, consists of the personal characteristics of each respondent from each household. The household dataset describes the household characteristics of each respondent. The trip dataset consists of the trip characteristics for each trip that was taken on the travel day. The vehicle dataset describes the vehicle characteristics of each vehicle in the household (*70*).

3.1.1. Person Dataset

The person dataset was collected from 264,234 participants who took part in the survey. One of the variables in the person dataset is "R_RACE", which represents the race of the participants. In the original dataset, this variable contained nine categories, including: Black or African American, White, Asian, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, Multiple responses, some other race, Don't know, and Refused. For the purposes of this study; however, we aggregated the levels into five categories, including African American, White, Asian, Other (which includes American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and Multiple responses selected), and Unknown (don't know, and refused). **Table 1** shows the frequency of each race in the dataset. Since this report focuses on the race of the participants, we removed 0.55% of the participants who did not respond to the question about their race (unknown) in the analysis section. Therefore, the new sample data includes 262,782 participants, and the weighted data includes 299,366,245 people.

TABLE 1 Frequency and Percentage in Each Race in the NHTS Person Dataset

Race	Frequency	Percentage	Weighted Frequency	Weighted Percentage
White	214,237	81.08%	217,020,774	72.49%
African American	19,426	7.35%	38,056,296	12.71%
Asian	12,064	4.57%	15,950,256	5.33%
Others	17,055	6.45%	28,338,919	9.47%

3.1.2. Household Dataset

Data from a total of 129,696 households were included in the 2017 NHTS dataset. One of the variables in the person dataset is "HH_RACE", which represents the race of each household respondent. In the original dataset, this variable contained nine categories, including: Black or

African American, White, Asian, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, Multiple responses selected, some other race, Don't know, and Refused. For the purposes of this study; however, we aggregated the levels into five categories, including African American, White, Asian, Other races (which includes American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and Multiple responses selected), and Unknown (Don't know, and Refused). **Table 2** shows the frequency of each race in the dataset. Since this report focuses on the race of the participants, we removed 0.53% of the participants who did not respond to the question about their race (unknown) in the analysis section. Therefore, the new sample dataset includes 129,012 households. Also, after weighting the data, 117,448,239 were considered for the analysis. The weighted data shows that 12.3% of household respondents were African American.

TABLE 2 Frequency and Percentage in Each Race in the NHTS Household Dataset

Race	Frequency	Percentage	Weighted Frequency	Weighted Percentage
White	107602	83.40%	89227401	75.97%
African American	9894	7.67%	14448968	12.30%
Asian	4792	3.71%	5315095	4.53%
Others	6724	5.21%	8456775	7.20%

The NHTS dataset has several variables related to walking and biking. In the following sections, these variables will be explained.

3.1.3. Trip dataset

Data from a total of 129,696 records of trip characteristics for each trip that was taken on the travel day were included in the 2017 NHTS dataset. One of the variables in the person dataset is "HH_RACE" which represents the race of each household respondent.

3.1.4. Description of the Walking and Biking Variables

Overall, there are 11 variables in all four datasets of the NHTS that are related to biking and 12 variables related to walking. **Table 3** and **Table 4** show these variables and their descriptions. In these two tables, the "aggregated levels" column shows the new aggregated levels for each variable that we developed to make the analysis easier to understand in the next section.

TABLE 3 Biking-Related Variables

Dataset	Variable Name	Description	Question Asked from the Participants	Levels	Aggregated levels
Person	NBIKETRP	Count of bike trips	In the past 7 days, how many times did you ride a bicycle outside including bicycling to exercise, or to go somewhere (e.g., bike to a friend's house, bike around the neighborhood, bike to the store, etc.)?	0-210 -9=Not ascertained -8=I don't know -7=I prefer not to answer	0-210 Unknown
	BIKE4EX	Count of bike trips for exercise	How many of these bicycle rides were strictly to exercise?	0 to 99 -9=Not ascertained -8=I don't know -7=I prefer not to answer	0 to 99 Unknown
	BIKESHARE	Count of bikeshare program usage	In the past 30 days, how many times did you use a bike share program (e.g. Bikeshare, Zagster, or CycleHop)?	0 to 99 -1=Appropriate skip -8=I don't know -7=I prefer not to answer	0 to 99 Unknown
	ALT_45	Alternative Mode of Transportation: Bicycle or Walk		01=Bicycle 02=Walk 03=Both 01 and 02 04=Neither item selected -9=Not ascertained -1=Appropriate skip	Bicycle Walk Both Neither
	WRKTRANS	Mode to work	How did you usually get to job last week? If you used more than one mode of transportation, please select the one used for most of the distance	01=Walk 02=Bicycle 03=Car 04=SUV 05=Van 06=Pickup truck 07=Golf cart / Segway 08=Motorcycle / Moped 09=RV (motor home, ATV, snowmobile) 10=School bus 11=Public or Commuter bus 12=Paratransit / Dial-a-ride 13=Private / Charter / Tour / Shuttle bus	Walk Bicycle Motorized

				14=City-to-city bus (Greyhound, Megabus) 15=Amtrak / Commuter rail 16=Subway / Elevated / Light rail / Street car 17=Taxi / Limo (including Uber / Lyft) 18=Rental car (Including Zipcar / Car2Go) 19=Airplane 20=Boat / Ferry / Water taxi 97=Something Else -9=Not ascertained -8=I don't know -7=I prefer not to answer -1=Appropriate skip	
	BIKE_DFR	Reason for not biking more: Infrastructure		01=No nearby paths or trails 02=No sidewalks or sidewalks are in poor condition 03=No nearby parks 04=01 and 02 05=01 and 03 06=02 and 03 07=01, 02, and 03 -9=Not ascertained -1=Appropriate skip	No nearby paths or trails No sidewalks or sidewalks are in poor condition No nearby parks No paths and sidewalk No path or parks No sidewalks or parks All above
	BIKE_GKP	Reason for not biking more: Safety		01=Street crossings are unsafe 02=Heavy traffic with too many cars 03=Not enough lighting at night 04=01 and 02 05=01 and 03 06=02 and 03 07=01, 02, and 03 -9=Not ascertained -1=Appropriate skip	Street crossings are unsafe Heavy traffic with too many cars Not enough lighting at night Unsafe street or heavy traffic Unsafe street or bad lighting Heavy traffic or bad lighting All above
	SCHTRN1	Mode to school	How you usually get to school?	01=Walk	Walk

			02=Bicycle 03=Car 04=SUV 05=Van 06=Pickup truck 07=Golf cart / Segway 08=Motorcycle / Moped 09=RV (motor home, ATV, snowmobile) 10=School bus 11=Public or Commuter bus 12=Paratransit / Dial-a-ride 13=Private / Charter / Tour / Shuttle bus 14=City-to-city bus (Greyhound, Megabus) 15=Amtrak / Commuter rail 16=Subway / Elevated / Light rail / Street car 17=Taxi / Limo (including Uber / Lyft) 18=Rental car (Including Zipcar / Car2Go) 19=Airplane 20=Boat / Ferry / Water taxi 97=Something Else -9=Not ascertained -8=I don't know -7=I prefer not to answer -1=Appropriate skip	Bicycle Motorized
	SCHTRN2	Mode from school	How you usually get from school?	01=Walk 02=Bicycle 03=Car 04=SUV 05=Van 06=Pickup truck 07=Golf cart / Segway 08=Motorcycle / Moped 09=RV (motor home, ATV, snowmobile) 10=School bus 11=Public or Commuter bus 12=Paratransit / Dial-a-ride 13=Private / Charter / Tour / Shuttle bus	Walk Bicycle Others

			14=City-to-city bus (Greyhound, Megabus) 15=Amtrak / Commuter rail 16=Subway / Elevated / Light rail / Street car 17=Taxi / Limo (including Uber / Lyft) 18=Rental car (Including Zipcar / Car2Go) 19=Airplane 20=Boat / Ferry / Water taxi 97=Something Else -9=Not ascertained -8=I don't know -7=I prefer not to answer -1=Appropriate skip	
Household	BIKE	Frequency of bicycle use for travel	01=Daily 02=A few times a week 03=A few times a month 04=A few times a year 05=Never -9=Not ascertained -8=I don't know -7=I prefer not to answer	Daily A few times a week A few times a month A few times a year Never
	BIKE2SAVE	Bicycle to reduce financial burden of travel	01=Strongly agree 02=Agree 03=Neither Agree or Disagree 04=Disagree 05=Strongly disagree -9=Not ascertained -8=I don't know -7=I prefer not to answer	Strongly agree Agree Neither Agree or Disagree Disagree Strongly disagree

TABLE 4 Walking-Related Variables

Dataset	Variable Name	Description	Question Asked from the Participants	Levels	Aggregated levels
Person	NWALKTRP	Count of walk trips	In the past 7 days, how many times did you take a walk outside including walks to exercise, go somewhere, or to walk the dog (e.g., walk to a friend's house, walk around the neighborhood, walk to the store, etc.)?	0-200 -9=Not ascertained -8=I don't know -7=I prefer not to answer	0-200
	WALK4EX	Count of walk trips for exercise	How many of these above walks were strictly for exercise?	0-99 -9=Not ascertained -8=I don't know -7=I prefer not to answer -1=Appropriate skip	0-99
	SCHTRN1	Mode to school	How you usually get to school?	01=Walk 02=Bicycle 03=Car 04=SUV 05=Van 06=Pickup truck 07=Golf cart / Segway 08=Motorcycle / Moped 09=RV (motor home, ATV, snowmobile) 10=School bus 11=Public or Commuter bus 12=Paratransit / Dial-a-ride 13=Private / Charter / Tour / Shuttle bus 14=City-to-city bus (Greyhound, Megabus) 15=Amtrak / Commuter rail 16=Subway / Elevated / Light rail / Street car	Walk Bicycle Motorized

				17=Taxi / Limo (including Uber / Lyft) 18=Rental car (Including Zipcar / Car2Go) 19=Airplane 20=Boat / Ferry / Water taxi 97=Something Else -9=Not ascertained -8=I don't know -7=I prefer not to answer -1=Appropriate skip	
	SCHTRN2	Mode from school	How you usually get from school?	01=Walk 02=Bicycle 03=Car 04=SUV 05=Van 06=Pickup truck 07=Golf cart / Segway 08=Motorcycle / Moped 09=RV (motor home, ATV, snowmobile) 10=School bus 11=Public or Commuter bus 12=Paratransit / Dial-a-ride 13=Private / Charter / Tour / Shuttle bus 14=City-to-city bus (Greyhound, Megabus) 15=Amtrak / Commuter rail 16=Subway / Elevated / Light rail / Street car 17=Taxi / Limo (including Uber / Lyft) 18=Rental car (Including Zipcar / Car2Go) 19=Airplane	Walk Bicycle Motorized

				20=Boat / Ferry / Water taxi 97=Something Else -9=Not ascertained -8=I don't know -7=I prefer not to answer -1=Appropriate skip	
	WRKTRANS	Mode to work	How did you usually get to job last week? If you used more than one mode of transportation, please select the one used for most of the distance	01=Walk 02=Bicycle 03=Car 04=SUV 05=Van 06=Pickup truck 07=Golf cart / Segway 08=Motorcycle / Moped 09=RV (motor home, ATV, snowmobile) 10=School bus 11=Public or Commuter bus 12=Paratransit / Dial-a-ride 13=Private / Charter / Tour / Shuttle bus 14=City-to-city bus (Greyhound, Megabus) 15=Amtrak / Commuter rail 16=Subway / Elevated / Light rail / Street car 17=Taxi / Limo (including Uber / Lyft) 18=Rental car (Including Zipcar / Car2Go) 19=Airplane 20=Boat / Ferry / Water taxi 97=Something Else -9=Not ascertained -8=I don't know	Walk Bicycle Motorized

			-7=I prefer not to answer -1=Appropriate skip	
	ALT_45	Alternative Mode of Transportation: Bicycle or Walk	01=Bicycle 02=Walk 03=Both 01 and 02 04=Neither item selected -9=Not ascertained -1=Appropriate skip	Bicycle Walk Both Neither
	WALK_DEF	Reason for not walking more: Infrastructure	01=No nearby paths or trails 02=No nearby parks 03=No sidewalks or sidewalks are in poor condition 04=01 and 02 05=01 and 03 06=02 and 03 07=01, 02, and 03 -9=Not ascertained -1=Appropriate skip	No nearby paths or trails No nearby parks No sidewalks or sidewalks are in poor No path or parks No paths and sidewalk No sidewalks or parks All above
	WALK_GKQ	Reason for not walking more: Safety	01=Street crossings are unsafe 02=Heavy traffic with too many cars 03=Not enough lighting at night 04=01 and 02 05=01 and 03 06=02 and 03 07=01, 02, and 03 -9=Not ascertained -1=Appropriate skip	Street crossings are unsafe Heavy traffic with too many cars Not enough lighting at night Unsafe street or heavy traffic Unsafe street or bad lighting Heavy traffic or bad lighting All above

Household	WALK	Frequency of walking for travel	01=Daily 02=A few times a week 03=A few times a month 04=A few times a year 05=Never -9=Not ascertained -8=I don't know -7=I prefer not to answer	Daily A few times a week A few times a month A few times a year Never Unknown
	WALK2SAVE	Walk to reduce financial burden of travel	01=Strongly agree 02=Agree 03=Neither Agree or Disagree 04=Disagree 05=Strongly disagree -9=Not ascertained -8=I don't know -7=I prefer not to answer	Strongly agree Agree Neither Agree or Disagree Disagree Strongly disagree Unknown
TRIP	TRACC_WLK	Walk as mode used to get to public transit?	01=Yes 02=No -9=Not ascertained -1=Appropriate skip	Yes No
	TREGR_WLK	Walk as mode used to get from public transit?	01=Yes 02=No -9=Not ascertained -1=Appropriate skip	Yes No

3.1.5. Methodology

Analyses were conducted in R, a free software environment for statistical computing and graphics (*71*). Analyses included reading and cleaning the dataset, creating charts and plots from the descriptive statistics, using ANOVA with post-hoc Tukey HSD test, and developing walking and biking models for low-income African Americans using Binary Logistic Regression models.

The charts shown in this study were produced using the "Plotly" package (*72*). A one-way analysis of variance (ANOVA) with post-hoc Tukey HSD (Honestly Significant Difference) test was used to compare the means of different variables (such as count of bike or walk trips per week) among different races or among different income groups in the African American Population, and whether the means are statistically different (*73*).

Lastly, a binomial logistic regression model was developed using "bike or walk to reduce the financial burden of travel" as the dependent variable and socio-economic information of participants as independent variables. A binomial logistic regression (often referred to simply as logistic regression) was developed to predict the probability that an observation falls into one of two categories of a dichotomous dependent variable based on one or more independent variables that can be either continuous or categorical (*74*).

4. ANALYSES AND RESULTS

In this section, several analyses are conducted to analyze walking and biking behavior among low-income African Americans.

4.1. Biking and Walking Variables among All Racial Groups

Before analyzing the behavior of low-income African Americans, we look into the variables mentioned in the previous section among all races to compare African Americans with other races.

4.1.1. Biking Related Variables

4.1.1.1. Count of Bike Trips in a Week

A total of 262,577 participants answered the question for this variable. After weighting the data, 299,095,912 people were considered for this variable. The variable reflects the number of times that a participant rode a bicycle outside in the last week. The results show that the average use of a bicycle in the past week for all participants is 0.46. However, as shown in **Figure 3**, the average use of bicycle trips among African Americans is 0.409 per week, which is below the total average and less than the White population.

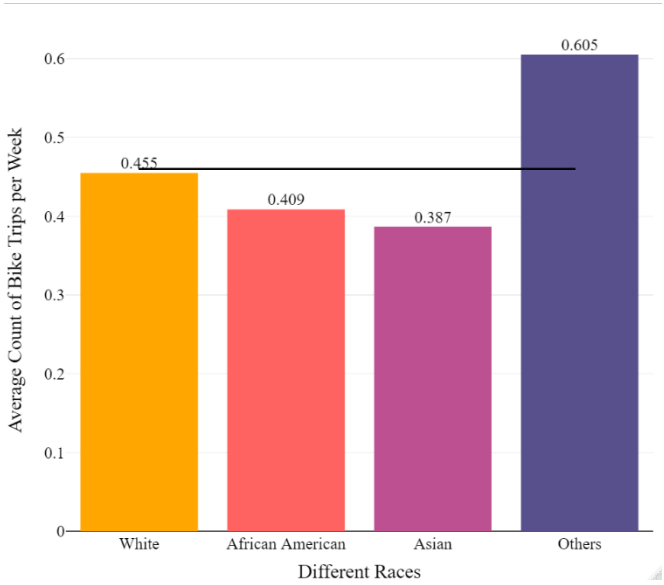

FIGURE 3 Average Count of Bike Trips per Week Among Different Racial Groups

4.1.1.2. Count of Bike Trips for Exercise in a Week

This variable shows the number of bike trips (from the previous variable) that were specifically for exercise. A total of 28,165 participants answered this question. After weighting the data, 36,853,907 people were considered for this variable. The average use of bicycle trips for exercise among all participants is 1.87 per week. As shown in **Figure 4**, African Americans have a greater average number of bicycle trips for exercise per week than the White or Asian population.

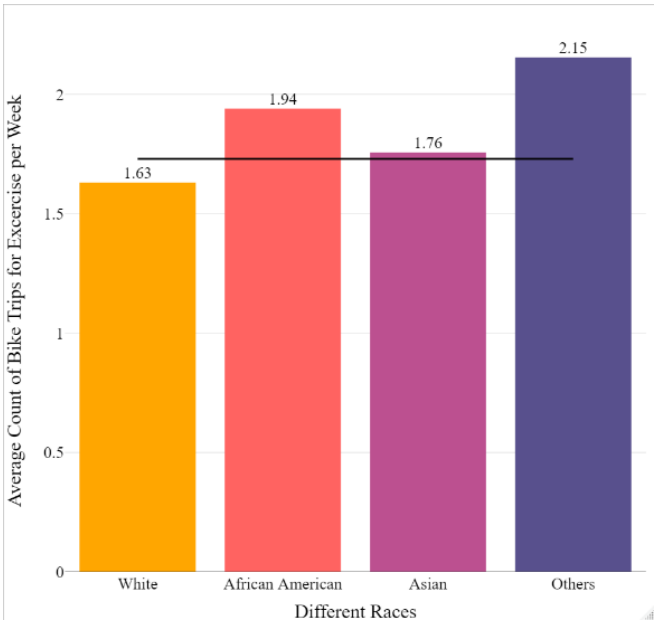

FIGURE 4 Average Count of Bike Trips for Exercise Among Different Racial Groups

4.1.1.3. Count of Bikeshare Program Usage per Month

This variable is associated with the use of bikeshare programs in the last month. A total of 28,237 participants answered this question. After weighting the data, 36,880,311 people were considered. The average number of bikeshare trips among all participants is 0.615 per month. As shown in **Figure 5**, on average, African Americans use bikeshare programs less frequently than Asians but more often than White respondents on a monthly basis.

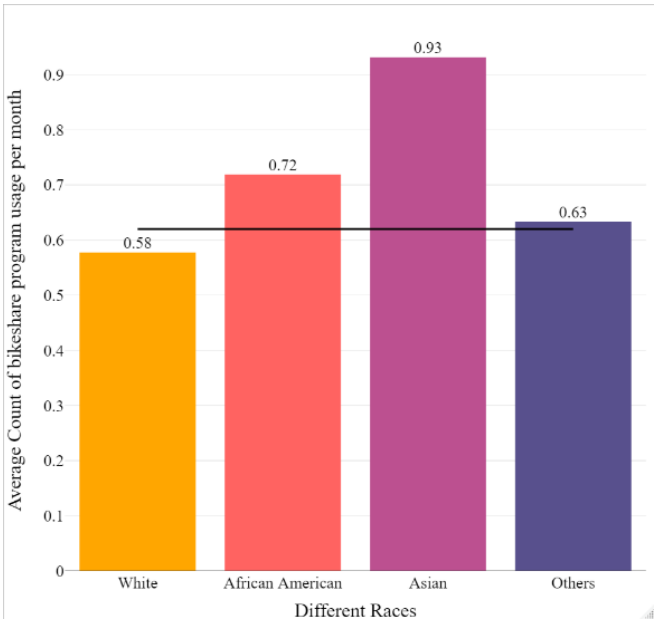

FIGURE 5 Average Count of Bikeshare Program Usage Among Different Racial Groups

4.1.1.4. Bicycle as an Alternative Mode of Transportation

This variable is associated with using a bicycle or walking as an alternative mode of transportation. A total of 187,124 participants answered this question. After weighting the data, 195,627,776 people were considered for this variable. This data shows that only 2.41% of respondents used a bicycle as an alternative mode of transportation, while 15.06% chose walking, 12.79% engaged in both, and 69.74% did not choose either biking or walking. As shown in **Figure 6**, among all of the racial groups, African Americans have the lowest percentage (0.91%) of bicycle usage as an alternative mode of transportation, and the White population (2.69%) has the most usage.

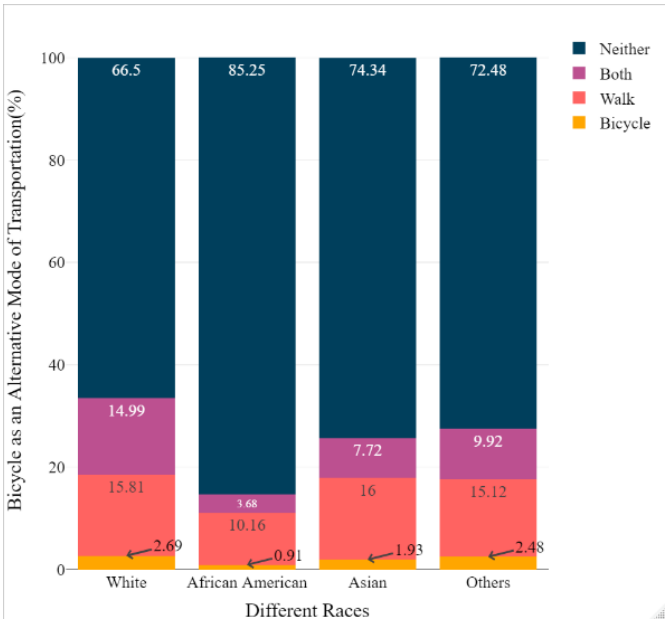

FIGURE 6 Bicycle as an Alternative Mode of Transportation Among Different Racial Groups

4.1.1.5. Mode to Work

This variable refers to participants' mode choice to get to work. For the purpose of this study, we aggregated this variable into Walk, Bicycle, and Motorized (which includes other modes such as public transportation and car). A total of 106,126 participants answered this question. After weighting the data, 132,400,439 people were considered for this variable. On average, 2.85% of respondents used a bicycle to get to work at least once a week. As shown in **Figure 7**, African Americans use bicycles to get to work less than other racial groups (2.7%).

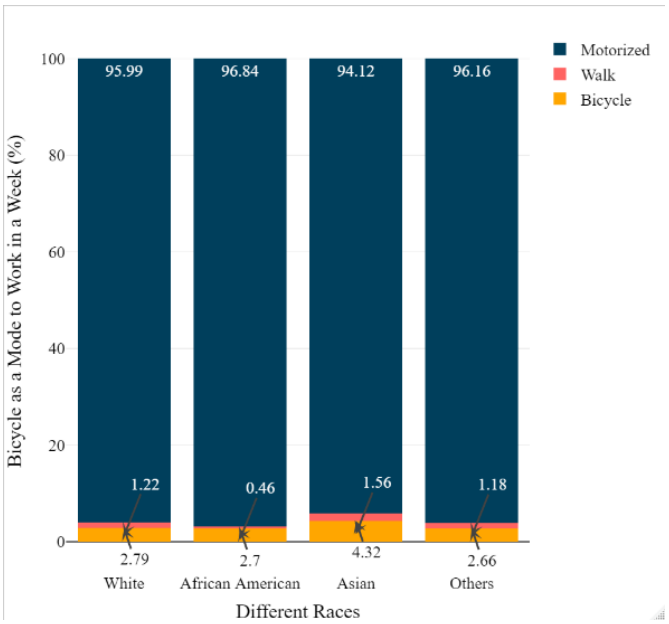

FIGURE 7 Bicycle as a Mode to Work Among Different Racial groups

4.1.1.6. Mode to School

A total of 30,745 participants answered this question. After weighting the data, 49,702,677 people were considered for this variable. Overall, 9.45% of all participants used a bicycle to get to school most of the time. As shown in **Figure 8**, African Americans use a bicycle to get to school more than other racial groups (13.45%).

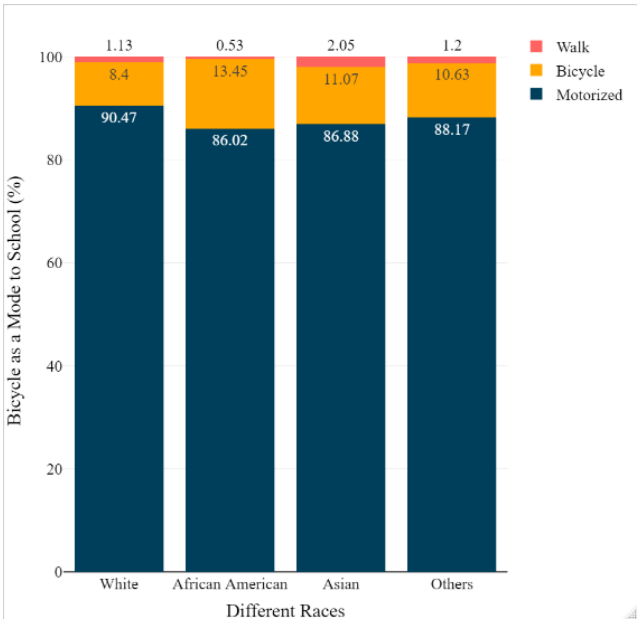

FIGURE 8 Bicycle as a Mode to School Among Different Racial Groups

4.1.1.7. Mode from School

A total of 30,746 participants answered this question. After weighting the data, 49,703,780 people were considered for this variable. Overall, 11.5% of all participants usually used a bicycle as a transportation mode from school. As can be seen from **Figure 9**, African Americans use a bicycle more than other races as a mode to school (15.54%).

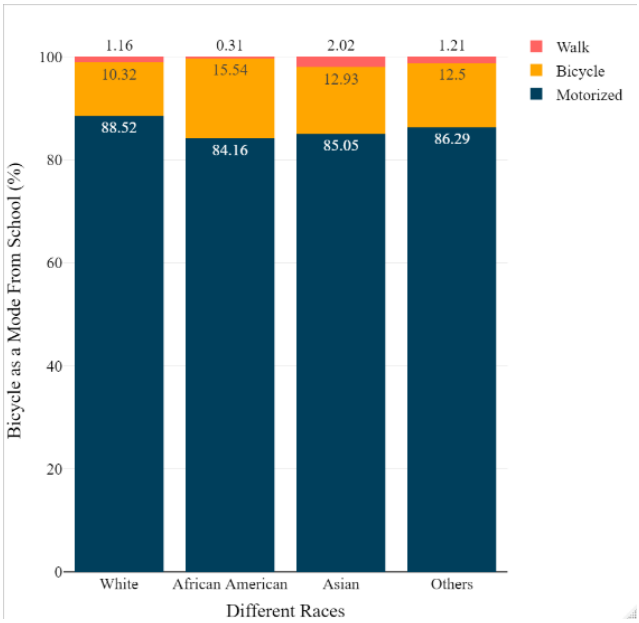

FIGURE 9 Bicycle as a Mode from School Among Different Racial Groups

4.1.1.8. Frequency of Bicycle Use for Travel

A total of 114,419 households answered this question. After weighting the data, 103,727,022 households were considered for this variable. Overall, 1.89% of all households use a bike for travel on a daily basis, and **Figure 10** demonstrates that this number is 1.45% for African Americans. Moreover, the percentage of households that never use the bike for travel is higher for African Americans than other racial groups.

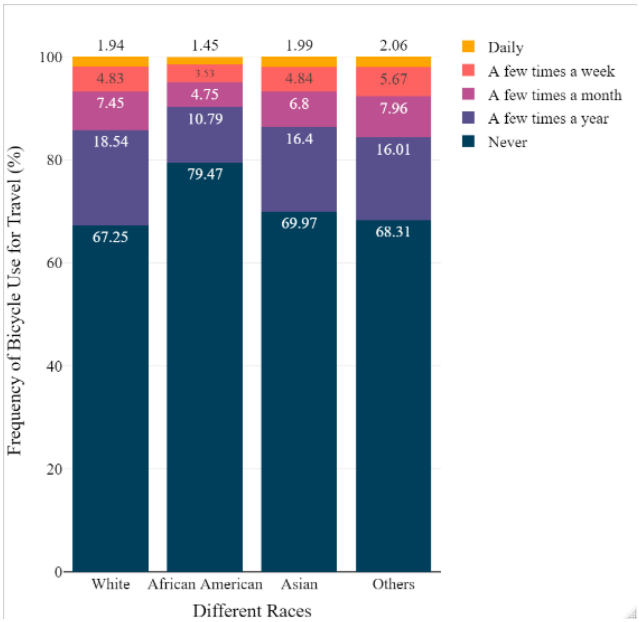

FIGURE 10 Frequency of Bicycle Use for Travel Among Different Racial Groups

4.1.1.9. Bicycle to Reduce Financial Burden of Travel

A total of 129,012 households answered this question. After weighting the data, 111,566,117 households were considered for this variable. Of all the households, 9.17% use bicycles to reduce their travel costs. Moreover, as can be seen from **Figure 11**, African Americans use bicycle more than White Americans to reduce the financial burden of travel.

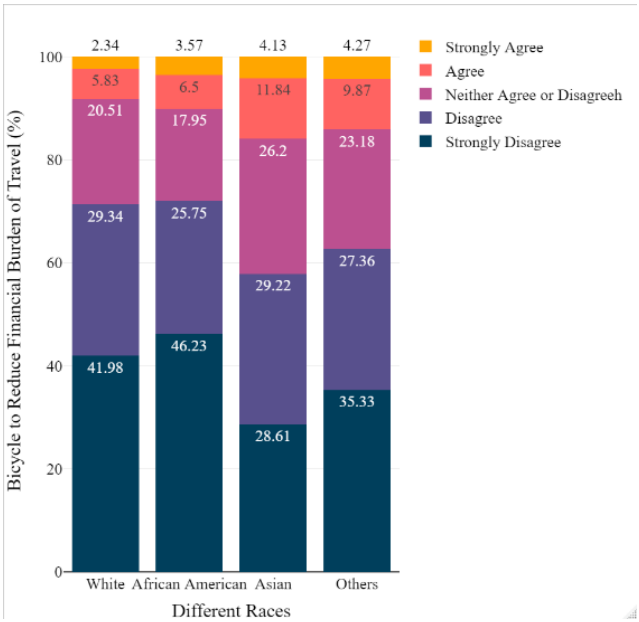

FIGURE 11 Bicycle to Reduce Financial Burden of Travel Among Different Racial Groups

4.1.2. Walking Related Variables

4.1.2.1. Count of Walk Trips

A total of 261,973 participants answered the question. Moreover, after weighting the data, 299,095,912 people were considered for this variable. The average number of walking trips per week for all groups is 5.2 per week. As can be seen from **Figure 12**, African Americans take the highest number of walking trips per week out of all racial groups

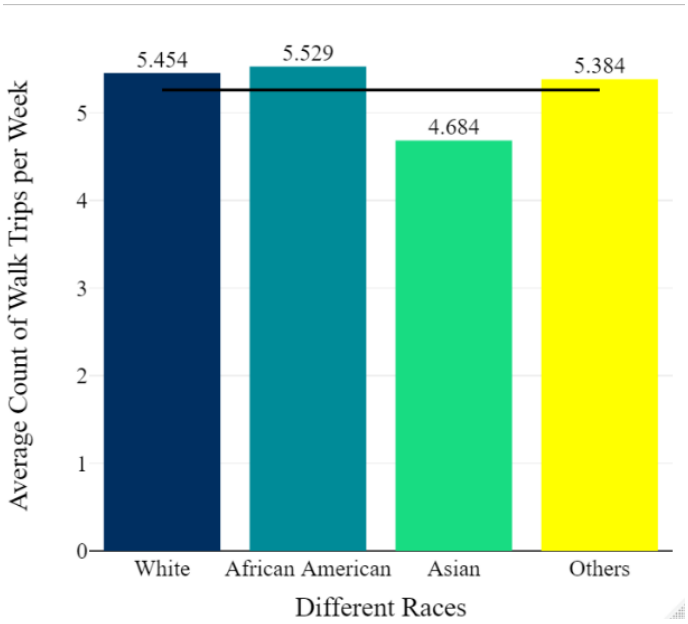

FIGURE 12 Average Count of Walk Trips per Week Among Different Racial Groups

4.1.2.2. Count of Walk Trips for Exercise

A total of 190,319 participants answered the question. Moreover, after weighting the data, 217,052,633 people were considered for this variable. As can be seen from **Figure 13**, on average, participants walk 2.812 times per week for exercise. Among all racial groups, African Americans have the highest average number of walk trips for exercise per week.

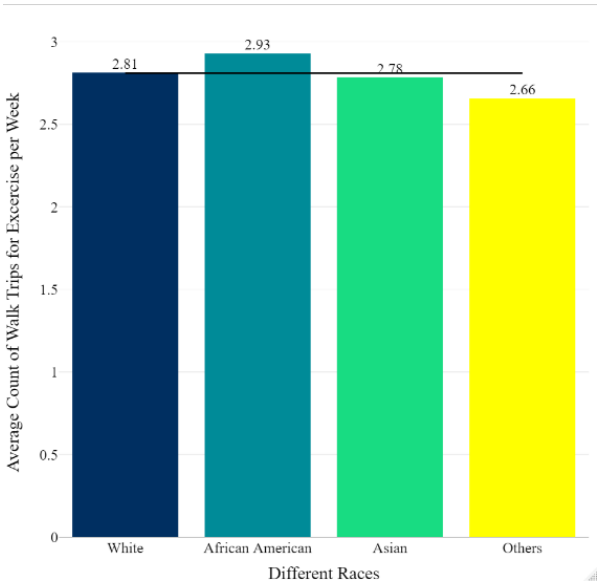

FIGURE 13 Average Count of Walk Trips for Exercise per Week Among Different Racial

4.1.2.3. Walk as an Alternative Mode of Transportation

This variable is associated with walking as an alternative mode of transportation. A total of 187,124 participants answered this question. Moreover, after weighting the data, 195,627,776 people were considered for this variable. From this, 15.06% use walking as an alternative mode of transportation. As shown in **Figure 14**, among all racial groups, African Americans have the lowest percentage (10.16%) walking as an alternative mode of transportation, and Asian Americans (16%) have the most usage among different races.

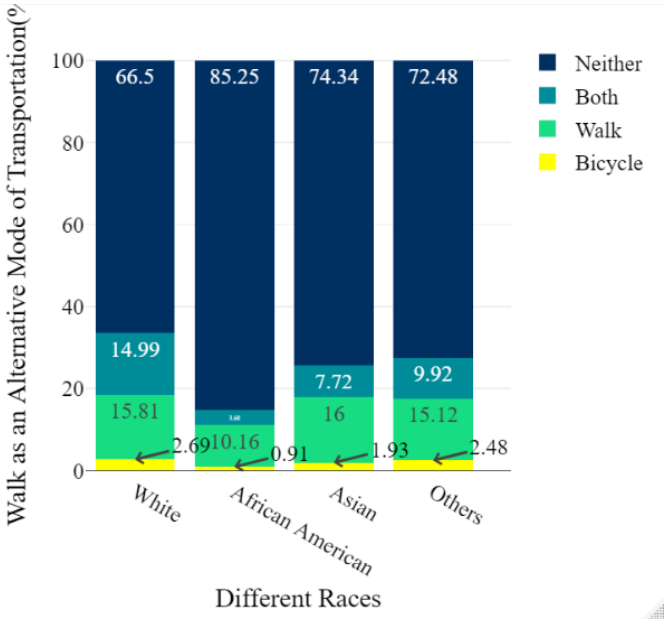

FIGURE 14 Walk as an Alternative Mode of Transportation Among Different Racial Groups

4.1.2.4. Mode to Work

This variable refers to participants' preferred travel mode to work. For the purpose of this study, we aggregated this variable into Walk, Bicycle, and Others (which includes other modes such as public transportation and car). A total of 106,126 participants answered this question. After weighting the data, 132,400,439 people were considered for this variable. On average, walking was used by 1.15% as a mode to work. As shown in **Figure 15**, African Americans walked to work less than other racial groups (0.46%).

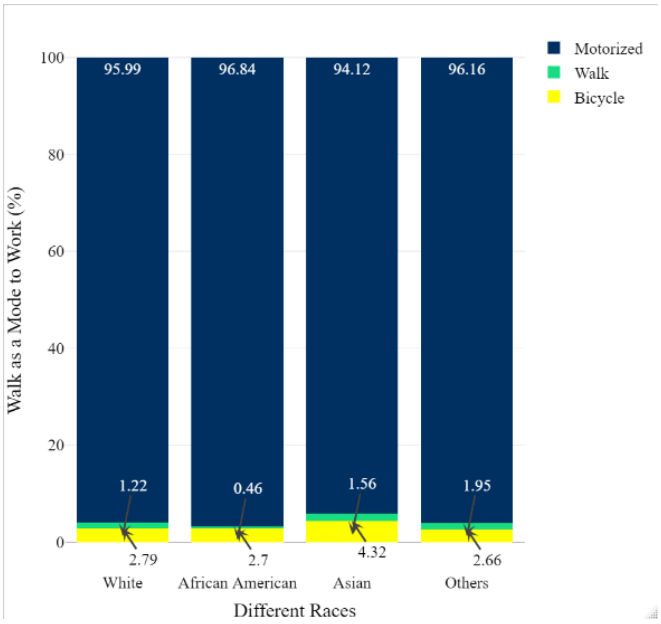

FIGURE 15 Walk as a Mode to Work Among Different Racial Groups

4.1.2.5. Mode to School

A total of 30,745 participants answered this question. After weighting the data, 49,702,677 people were considered for this variable. Overall, 1.1% walked to school, and 89.34% used a motorized transportation as a mode to school. As shown in **Figure 16**, African Americans walked to school (0.53%) less than all other racial groups.

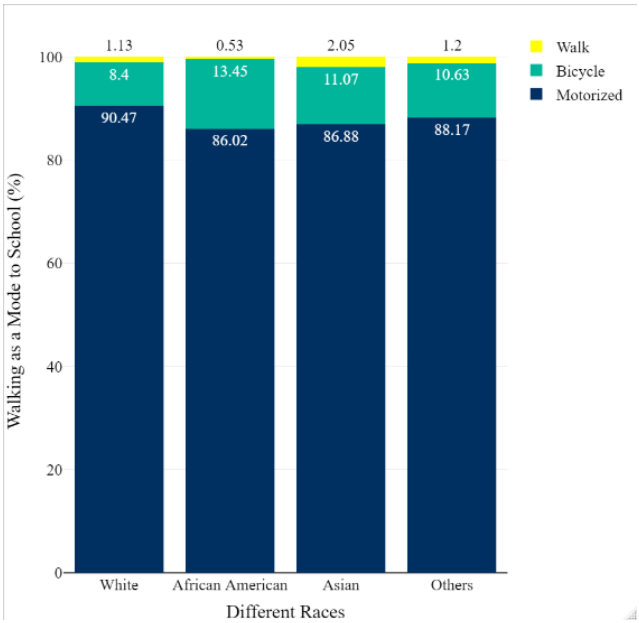

FIGURE 16 Walking as a Mode to School Among Different Racial Groups

4.1.2.6. Mode from School

A total of 30,746 participants answered this question. After weighting the data, 49,703,780 people were considered for this variable. Overall, 11.5% of all racial groups used a bicycle as a transportation mode to school, 1.09% walked to school, and 87.42% used motorized transportation as a mode to school. As shown in **Figure 17**, African Americans walked home from school (0. 31%) less than all other racial groups.

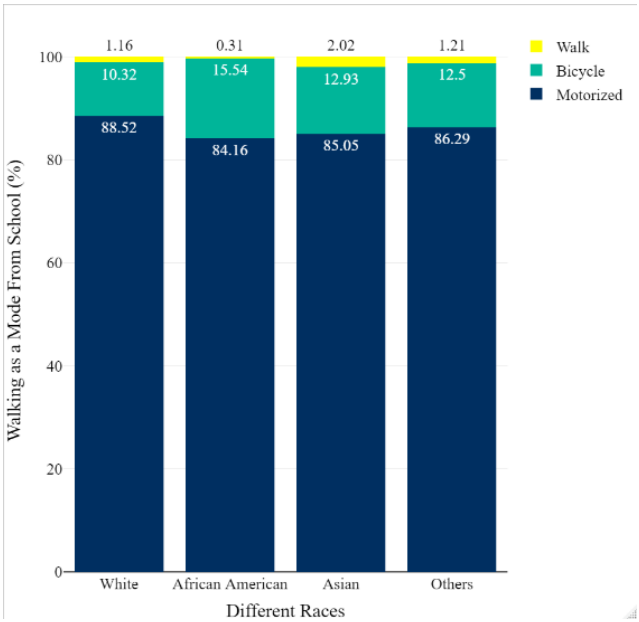

FIGURE 17 Walking as a Mode from School Among Different Racial Groups

4.1.2.7. Walking to Reduce Financial Burden of Travel

A total of 124,301 households answered this question. After weighting the data, 112,881,966 households were considered for this variable. Out of all of the households, 20.8% walk to reduce their travel costs. Moreover, as shown in **Figure 18**, this percentage for African Americans is 29.58%.

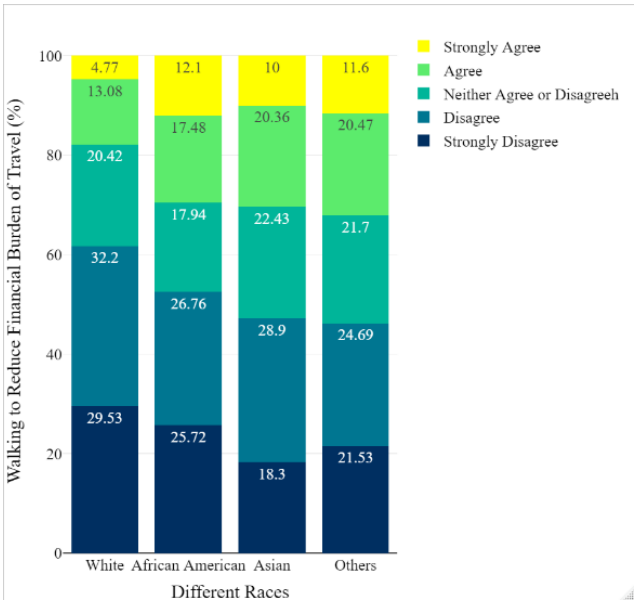

FIGURE 18 Walking to Reduce Financial Burden of Travel Among Different Racial Groups

4.1.2.8. Frequency of Walking for Travel

A total of 117,643 households answered this question. After weighting the data, 107,086,999 households were considered for this variable. Overall, 21.71% of all households walk for travel on a daily basis, and this percentage is 26.31% for African Americans (seen **Figure 19**).

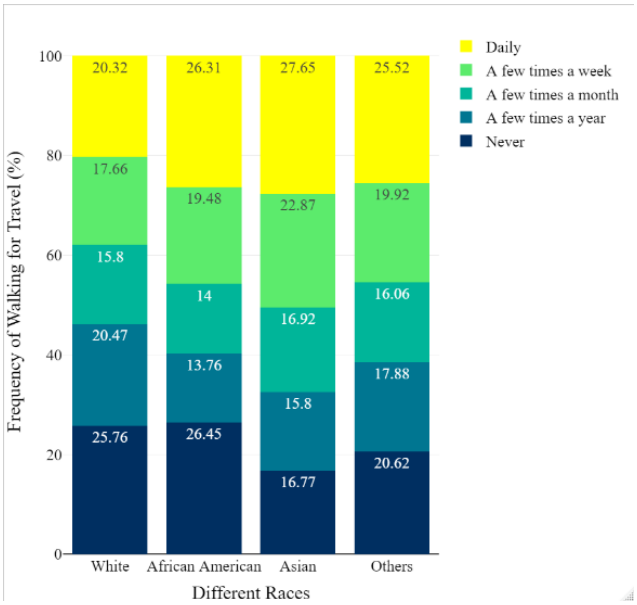

FIGURE 19 Frequency of Walking for Travel Among Different Racial Groups

4.1.2.9. Walk as Mode Used to Get to Public Transit

A total of 10,951 participants were asked whether they walk to get to public transit. Among all the participants, more than 79% answered that they would walk to get to public transit. As shown in **Figure 20**, this value is 81% for African Americans, which is above average.

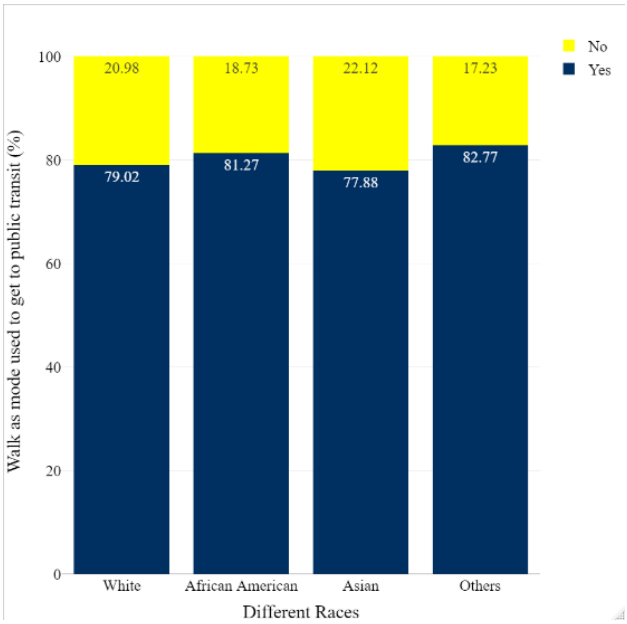

FIGURE 20 Walk as a Mode Used to Get to Public Transit Among Different Racial Groups

4.1.2.10. Walk as Mode Used to Get from Public Transit

A total of 10,951 participants were asked whether they walk to get from public transit. Among all the participants, more than 76% answered that they walk from public transit. As shown in **Figure 21**, this value is 78% for African Americans, which is above average.

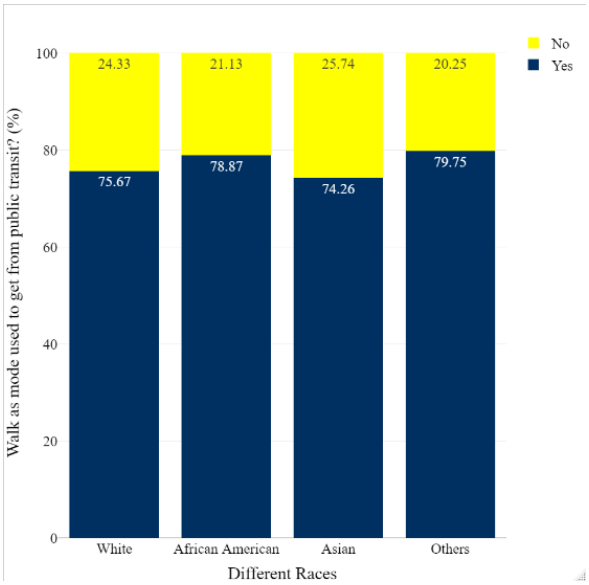

FIGURE 21 Walk as a Mode Used to Get from Public Transit Among Different Racial Groups

4.1.3. Variables Only Focusing on the State of California

Some of the variables in the NHTS 2017 dataset were only asked in the state of California (2017 California-NHTS database). Four of these variables are related to biking and walking and will be analyzed in the next sections.

4.1.3.1. Reason for Not Biking more: Infrastructure

A total of 4,066 participants answered this question. After weighting the data, 4,786,423 people were considered for this variable. As shown in **Figure 22**, the most common reason for not biking in the infrastructure section is no path, both for African American (20.3%) populations and all racial groups (31.57%).

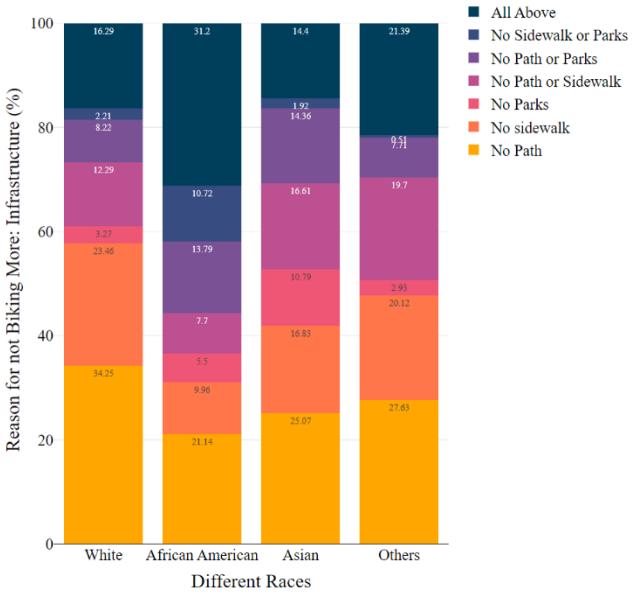

FIGURE 22 Reason for Not Biking More: Infrastructure, Among Different Racial Groups

4.1.3.2. Reason for Not Biking More: Safety

A total of 5,864 participants answered this question. After weighting the data, 6,751,667 people were considered for this variable. The most common reason for not biking in the safety section is heavy traffic (30.12%). As shown in **Figure 23**, for the African American population, the reason for not biking is bad lighting.

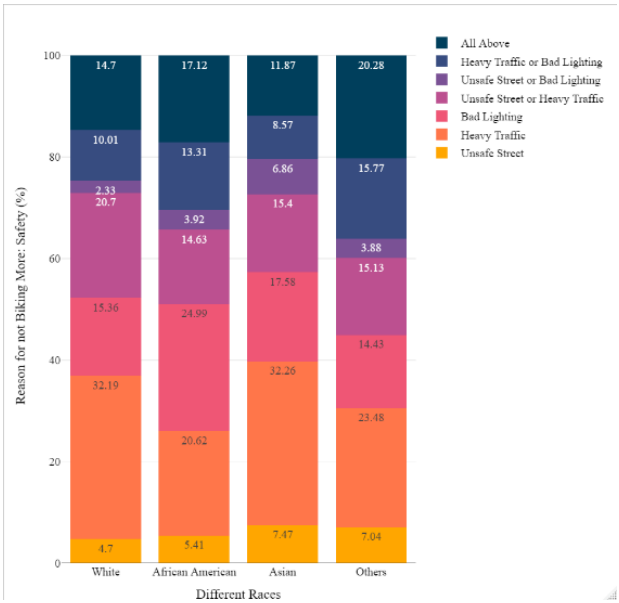

FIGURE 23 Reason for Not Biking More: Safety, Among Different Racial Groups

4.1.3.1. Reason for not walking more: Infrastructure

A total of 38,491 participants answered this question. After weighting the data, 41,448,690 people were considered for this variable. As shown in **Figure 24**, the most common reason for not walking in the infrastructure section is no parks (29.98%), both for African Americans and other racial groups.

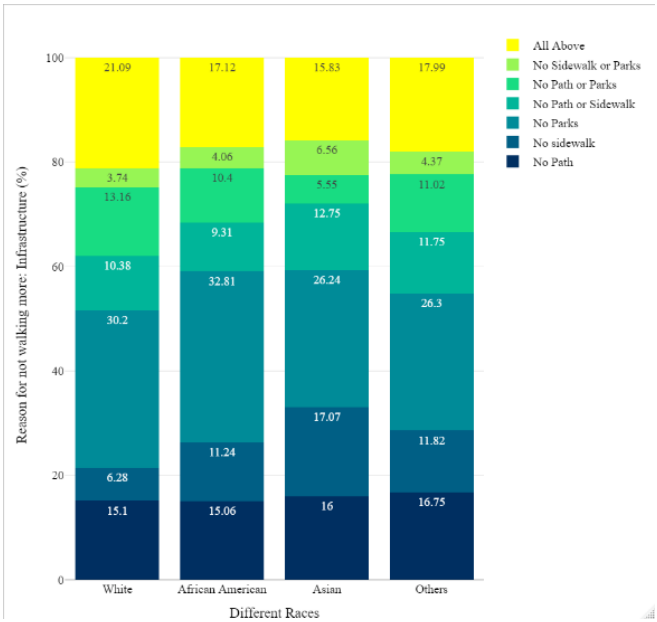

FIGURE 24 Reason for Not Walking More: Infrastructure, Among Different Racial Groups

4.1.3.2. Reason for not walking more: Safety

A total of 39,826 participants answered this question. After weighting the data, 45,275,543 people were considered for this variable. The most common reason (36.56%) for not walking in the safety section for all racial groups is bad lighting, as shown in **Figure 25**.

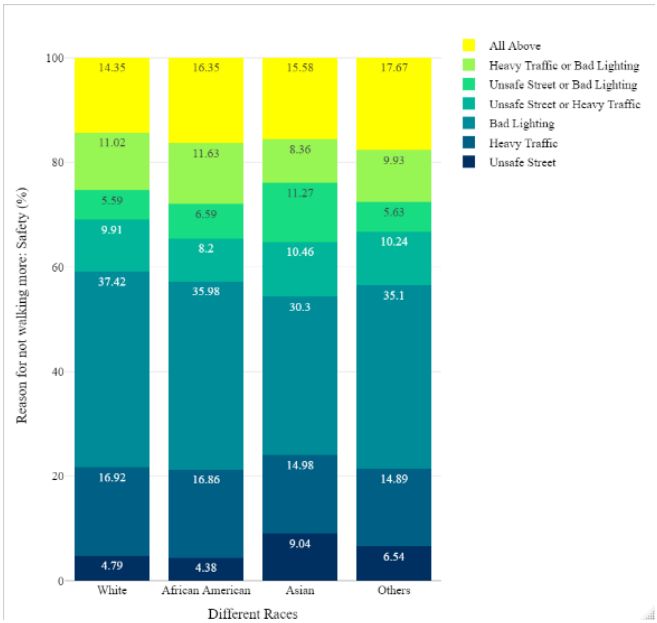

FIGURE 25 Reason for Not Walking More: Safety, Among Different Racial Groups

4.1.4. ANOVA Test for Walking and Biking Among All Racial Groups

To determine which groups significantly differ from each other, we used an ANOVA with post-hoc Tukey HSD test. **Table 5** and **Table 6** present the results of the Tukey test for the count of bike trips, count of bike trips for exercise, count of bikeshare trips, count of walk trips, and count of walk trips for exercise in detail. From **Table 5,** we can conclude that there are no significant differences among African Americans and White Americans regarding the frequency of bike trips. In terms of bike trips for exercise, it can be concluded that African Americans take more bicycle trips for exercise per week compared to White and Asian populations and that the difference is significant. Moreover, Bikeshare usage among African Americans is statistically greater than that of the White population but less that of the Asian population.

TABLE 5 ANOVA with post-hoc Tukey HSD Test for Biking Among Racial Groups

	Estimate	Std. Error	t value	Pr(>|t|)	Sig Code
Count of Bike Trips					
African American - White == 0	0.008207	0.013832	0.593	0.929	
Asian - White == 0	-0.00682	0.017279	-0.395	0.977	
Others - White == 0	0.177008	0.014692	12.048	<1e-05	***
Asian - African American == 0	-0.01502	0.021402	-0.702	0.889	
Others - African American == 0	0.168801	0.019374	8.713	<1e-05	***
Others - Asian == 0	0.183825	0.021968	8.368	<1e-05	***
Count of bike trips for exercise					
African American - White == 0	0.55676	0.07423	7.5	<0.001	***
Asian - White == 0	0.01608	0.08815	0.182	0.9977	
Others - White == 0	0.15515	0.06509	2.384	0.0743	.
Asian - African American == 0	-0.54069	0.11178	-4.837	<0.001	***

Others - African American == 0	-0.40161	0.09466	-4.243	<0.001	***
Others - Asian == 0	0.13907	0.10593	1.313	0.5358	
Count of Bike Share Program Usage					
African American - White == 0	0.53837	0.07095	7.588	< 0.001	***
Asian - White == 0	0.26135	0.08386	3.116	0.00908	**
Others - White == 0	0.13736	0.06207	2.213	0.11139	
Asian - African American == 0	0.27702	0.10654	2.6	0.04256	*
Others - African American == 0	-0.40101	0.09039	-4.436	< 0.001	***
Others - Asian == 0	-0.12398	0.10085	-1.229	0.58983	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p values reported -- single-step method)**					

From **Table 6,** we can conclude that there are no significant differences between African Americans and White population regarding the frequency of walk trips. However, there is a statistically significant difference between African American and Asian populations in the number of walk trips taken per week. In terms of walk trips for exercise, we can conclude that African Americans have the highest use of the bicycle for exercise per week compared to White and Asian populations and that the difference is significant.

TABLE 6 ANOVA with post-hoc Tukey HSD Test for Walking Among Racial Groups

Count of Walk Trips					
	Estimate	Std. Error	t value	Pr(>|t|)	
African American - White == 0	0.07538	0.06253	1.206	0.606	
Asian - White == 0	-0.76914	0.07801	-9.86	<1e-04	***
Others - White == 0	-0.07	0.06636	-1.055	0.702	
Asian - African American == 0	-0.84451	0.09667	-8.736	<1e-04	***
Others - African American == 0	-0.14538	0.08754	-1.661	0.328	
Others - Asian == 0	0.69913	0.09919	7.048	<1e-04	***
Count of walk trips for exercise					
African American - White == 0	0.12578	0.03893	3.231	0.00603	**
Asian - White == 0	-0.06526	0.04873	-1.339	0.51923	
Others - White == 0	-0.08582	0.04124	-2.081	0.14916	
Asian - African American == 0	-0.19104	0.06035	-3.166	0.00764	**
Others - African American == 0	-0.2116	0.05448	-3.884	< 0.001	***
Others - Asian == 0	-0.02056	0.06186	-0.332	0.98629	
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p values reported -- single-step method)					

4.2. Biking and Walking Variables Among Low-income African Americans

In the next step of this study, we only focused on African Americans. In the person dataset, there were 19,426 African American participants. We aggregated the income levels of African Americans into five categories: low-income class (less than $25k), lower-middle class (between $25k to $49.9), middle class (between $50k to $99.9), upper-middle class ($100k to $149.9), and

wealthy (more than $150k). We have removed the participants who did not answer the question about their income. Therefore, after cleaning the data, 18,868 African American participants were considered for this variable. After weighting the data, 36,995,972 people were considered for African Americans (see **Table 7**).

TABLE 7 Percentage of Different Income Groups of African Americans in Person Dataset

Income Groups	Range	Unweighted	Weighted
Low-income Class	Less than $25K	34.5%	38.7%
Lower-middle Class	$25K – $49.9K	24.7%	25.8%
Middle Class	$50k - $99.9K	25.8%	22.7%
Upper-middle Class	$100K - $149.9K	9.8%	8.6%
Wealthy	More than $150K	5.1%	4.3%

In the household dataset, there were 9,894 African American households. We aggregated the income levels into five categories: low-income class (less than $25k), lower-middle class (between $25k to $49.9), middle class (between $50k to $99.9), upper-middle class ($100k to $149.9), and wealthy (more than $150k). We have removed the households who did not answer the question about their income. Therefore, after cleaning the data, 9,543 African American households were considered for this variable. After weighting the data, 13,944,685 people were considered African Americans (see **Table 8**).

TABLE 8 Percentage of Different Income Groups of African Americans in Household Dataset

Income Groups	Range	Unweighted	Weighted
Low-income Class	Less than $25K	40.46%	44.68%
Lower-middle Class	$25K – $49.9K	25.10%	25.87%
Middle Class	$50k - $99.9K	23.20%	20.02%
Upper-middle Class	$100K - $149.9K	7.69%	6.41%
Wealthy	More than $150K	3.55%	3.02%

4.2.1. Biking Related Variables

4.2.1.1. Count of Bike Trips in a Week

A total of 18,860 answered the question. After weighting the data, 36,969,670 people were considered for this variable. As shown in **Figure 26**, low-income African Americans have more bike trips per week compared to those in other income groups.

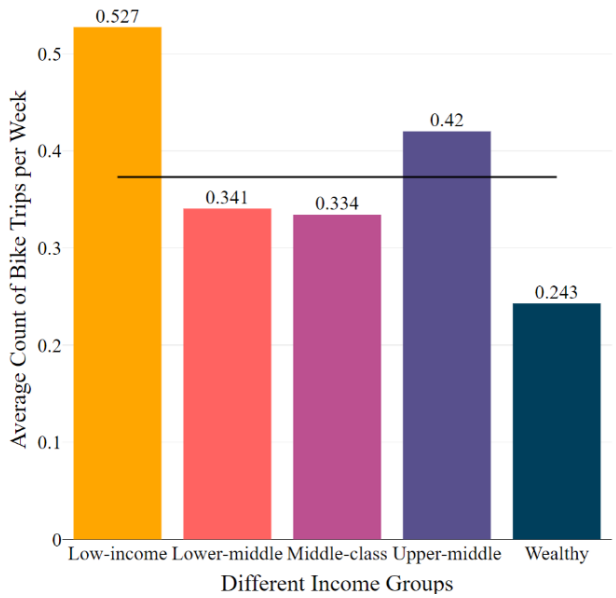

FIGURE 26 Average Count of Bike Trips per Week Among Different Income Groups

4.2.1.2. Count of bike trips for exercise in a Week

A total of 1,734 participants answered the question. After weighting the data, 4,128,770 people were considered for this variable. According to **Figure 27**, low-income African Americans use the bike for exercise more than those in other income groups.

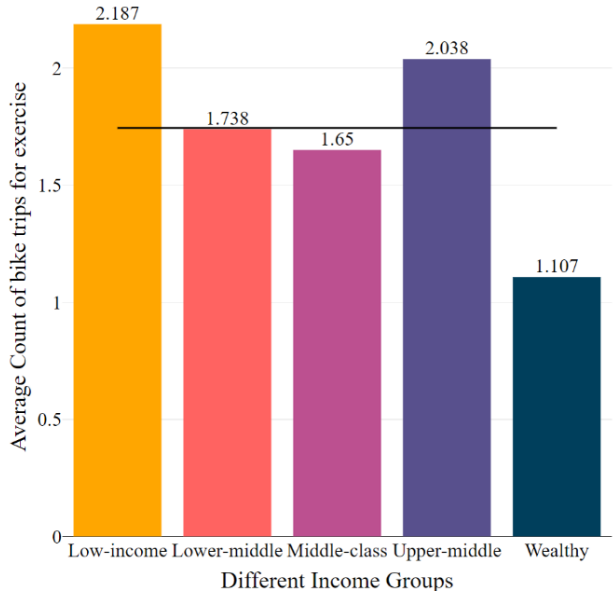

FIGURE 27 Count of Bike Trips for Exercise per Week Among Different Income Groups

4.2.1.3. Count of Bikeshare Trips per Month

Some 1,731 participants answered the question. The weighted population for this variable is 4,095,807. According to **Figure 28**, low-income African Americans use bikeshare only 0.407 times per month, while those in the upper-middle class have the highest number of trips.

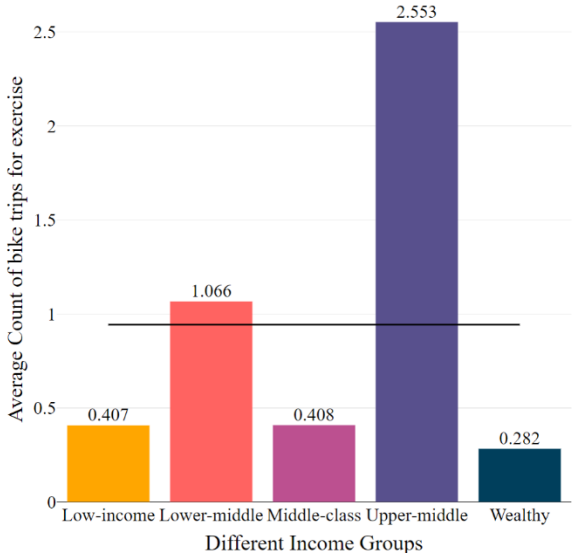

FIGURE 28 Count of Bike Trips for Exercise per Week Among Different Income Groups

4.2.1.4. Bicycle as an Alternative Mode of Transportation

For this variable, 12,806 participants answered the question. The weighted data includes 23,738,575 people. On average, 0.93% of all used the bicycle as an alternative mode of transportation. As shown in **Figure 29**, low-income African Americans use the bicycle as an alternative mode of transportation less than other income groups.

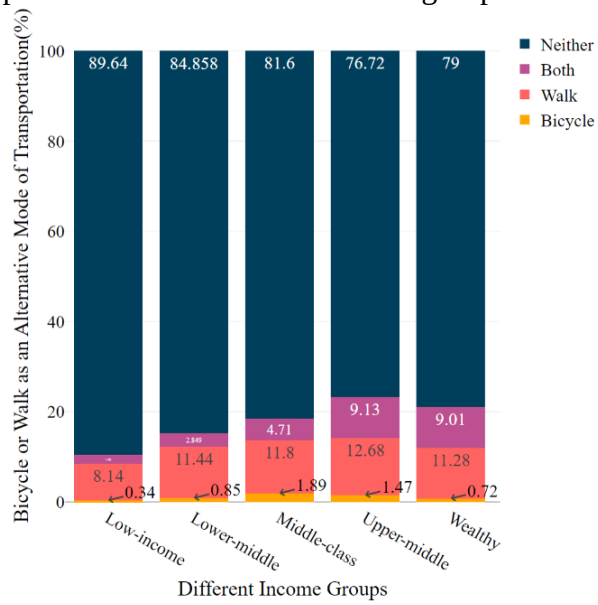

FIGURE 29 Bicycle as Alternative Mode of Transportation Among Different Income Groups

4.2.1.5. Mode to Work

A total of 7,393 answered the question about the mode to work variable. After weighting the data, 14,979,915 African Americans were considered for this variable. On average, 2.71% of African Americans use the bicycle to go to work. As shown in **Figure 30**, this percentage for low-income African Americans is 5.17, which is above other income groups.

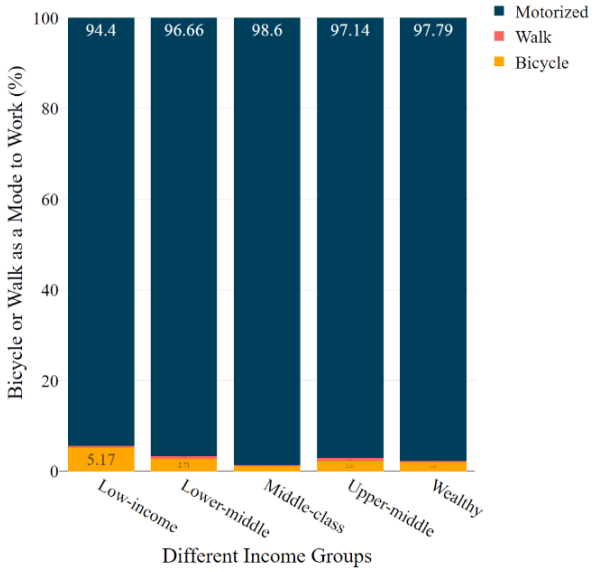

FIGURE 30 Bicycle as a Mode to Work Among Different Income Groups

4.2.1.6. Mode to School

A total of 2,835 participants answered the question. After weighting the data, 6,927,082 African Americans were considered for this variable. On average, 13.69% of African Americans use a bicycle as a transportation mode to school. As shown in **Figure 31**, low-income African Americans use a bicycle as a mode to school more often than other income groups.

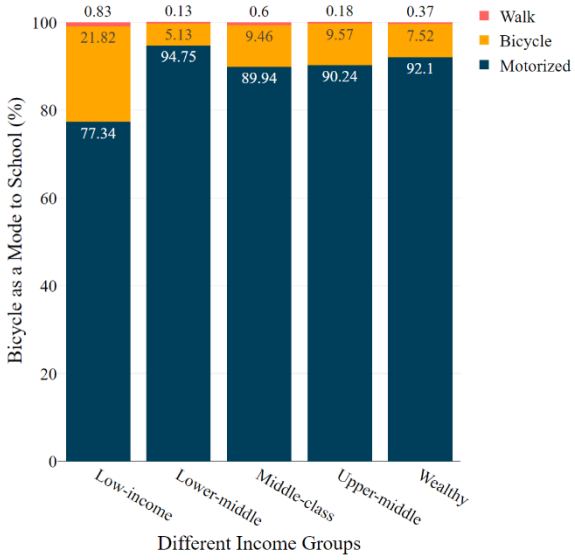

FIGURE 31 Bicycle as a Mode to School Among Different Income Groups

4.2.1.7. Mode from School

A total of 2,835 participants answered the question. After weighting the data, 6,927,082 African Americans were considered for this variable. On average, 15.82% of African Americans use the bicycle as a transportation mode from school, and as shown in **Figure 32,** they use a bicycle more often than other income groups.

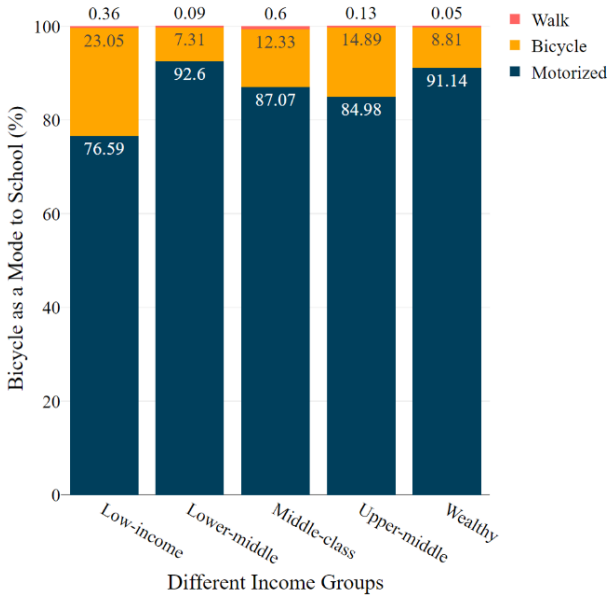

FIGURE 32 Bicycle as a Mode from School Among Different Income Groups

4.2.1.8. Frequency of Bicycle Use for Travel

A total of 7,877 answered the question. After weighting the data, the dataset included 11,361,152 African Americans. As shown in **Figure 33**, daily bicycle use among low-income African Americans is greater than that of other income groups.

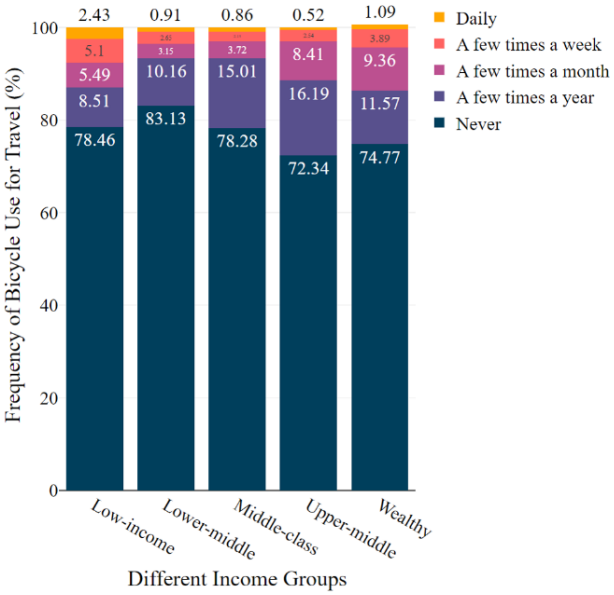

FIGURE 33 Frequency of Bicycle Use for Travel Among Different Income Groups

4.2.1.9. Bicycle to Reduce Financial Burden of Travel

A total of 8,683 answered the question. A total of 12,569,758 African Americans were included in the weighted dataset. As shown in **Figure 34**, low-income African American households use the bike to reduce their financial burden of travel more than other income groups.

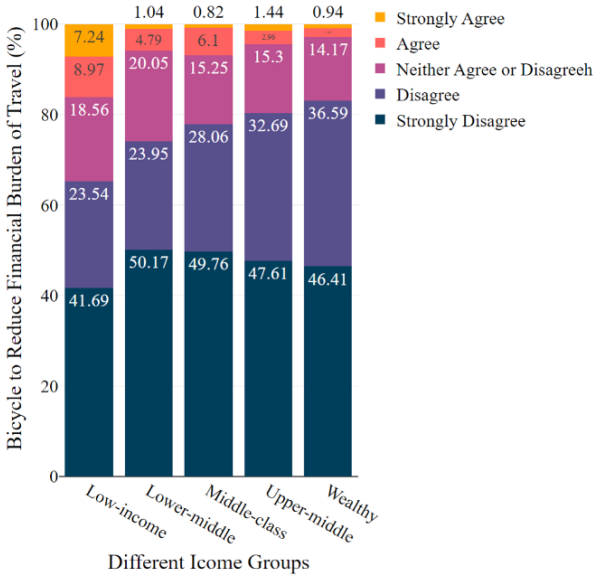

FIGURE 34 Bicycle to Reduce Financial Burden of Travel Among Different Income Groups

4.2.2. Walking Related Variables

4.2.2.1. Count of Walk Trips per Week

A total of 18,788 participants answered the question. The weighted data included 36,860,571 participants. As shown in **Figure 35**, on average, African Americans have 5.5 trips per week. Low-income African Americans have a greater number of average walk trips per week than other income groups.

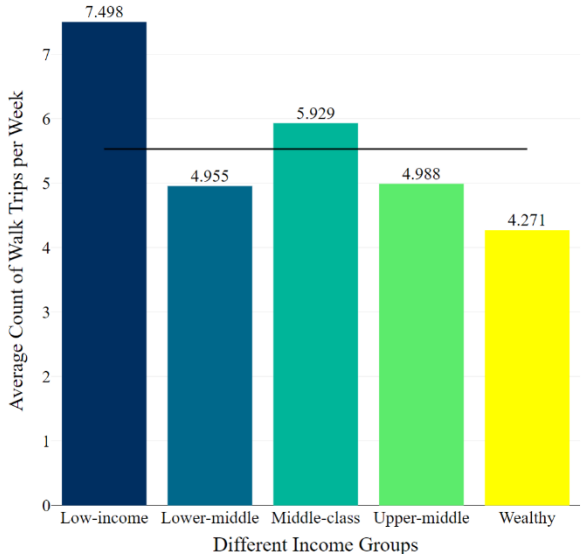

FIGURE 35 Average Count of Walk Trips per Week Among Different Income Groups

4.2.2.2. Count of Walk Trips for Exercise

A total of 1,734 participants answered this question. The weighted data included 4,128,770 African Americans. As shown in **Figure 36**, on average, all African Americans make 1.7 walk trips for exercise per week. Moreover, low-income African Americans take more walking trips for exercise than other income groups.

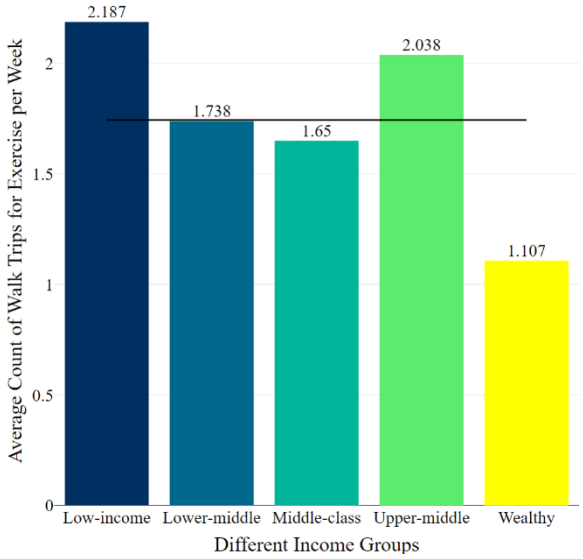

FIGURE 36 Count of Walk Trips for Exercise per Week Among Different Income Groups

4.2.2.3. Walk as an Alternative Mode of Transportation

A total of 12,806 participants answered the question. The weighted dataset contains 23,738,575 African Americans. As shown in **Figure 37**, low-income African Americans report the lowest use of walking as an alternative mode of transportation.

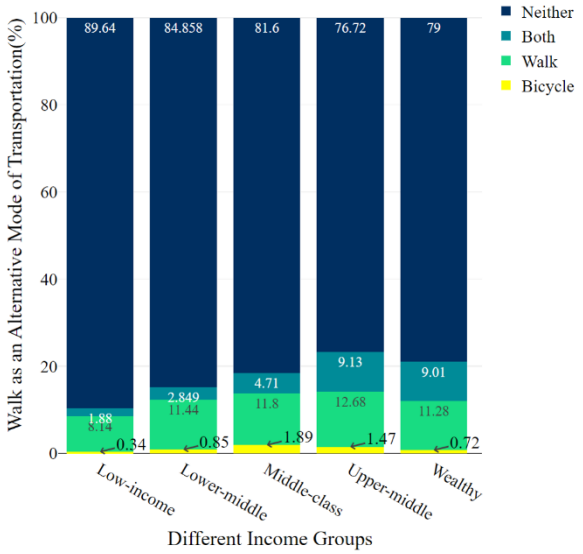

FIGURE 37 Walk as an Alternative Mode of Transportation Among Different Income Groups

4.2.2.4. Mode to Work

A total of 7,393 participants answered this question. The weighted data contained 14,979,915 African Americans. As shown in **Figure 38**, walking as a mode to work is higher among lower-middle income groups.

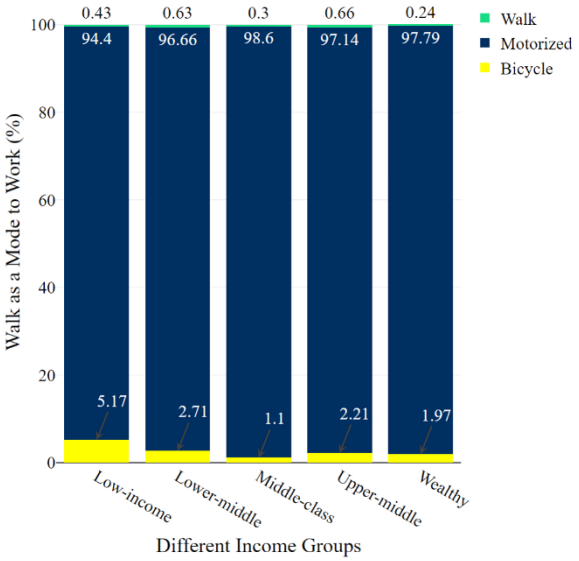

FIGURE 38 Walk as a Mode to Work Among Different Income Groups

4.2.2.5. Mode to School

A total of 2,835 answered this question. The weighted data contained 6,927,082 African Americans. **Figure 39** shows that low-income African Americans use walking as a mode to school more than other income groups.

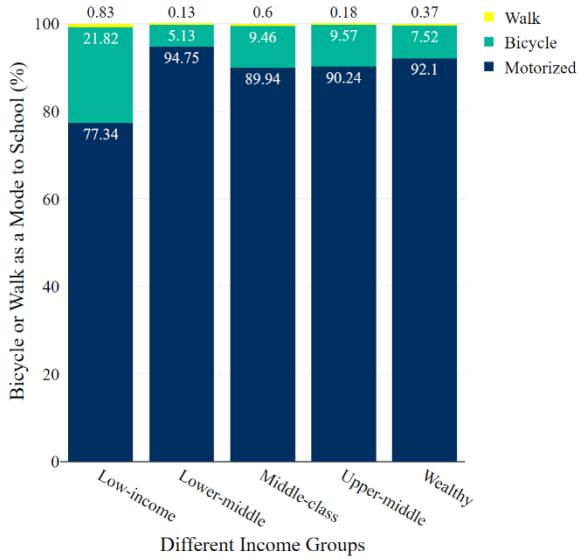

FIGURE 39 Bicycle as a Mode to School Among Different Income Groups

4.2.2.6. Mode from School

A total of 2,835 participants answered the question. The weighted dataset contained 6,927,082 African Americans. **Figure 40** shows that low-income African Americans use walking as a mode from school more than other income groups.

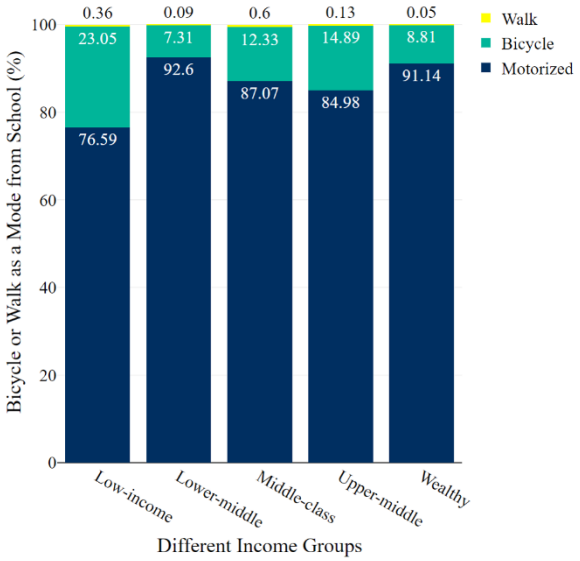

FIGURE 40 Bicycle as a Mode from School Among Different Income Groups

4.2.2.7. Walk to Reduce Financial Burden of Travel

A total of 8,827 households answered this question. The weighted data includes 12,794,513 African American households. As shown in **Figure 41**, low-income African Americans walk to reduce their financial burden of travel more than any other income groups.

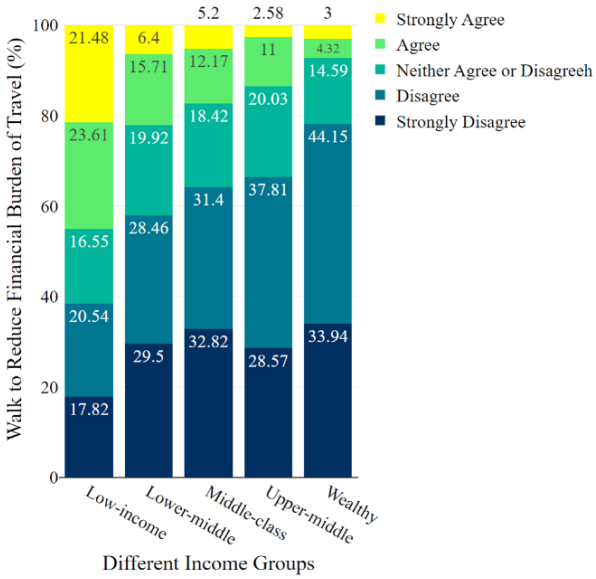

FIGURE 41 Walk to Reduce Financial Burden of Travel Among Different Income Groups

4.2.2.8. Frequency of Walking for Travel

A total of 8,241 households answered the question and weighted data includes 11,957,478 households. **Figure 42** shows low-income African Americans walk for travel purposes the most.

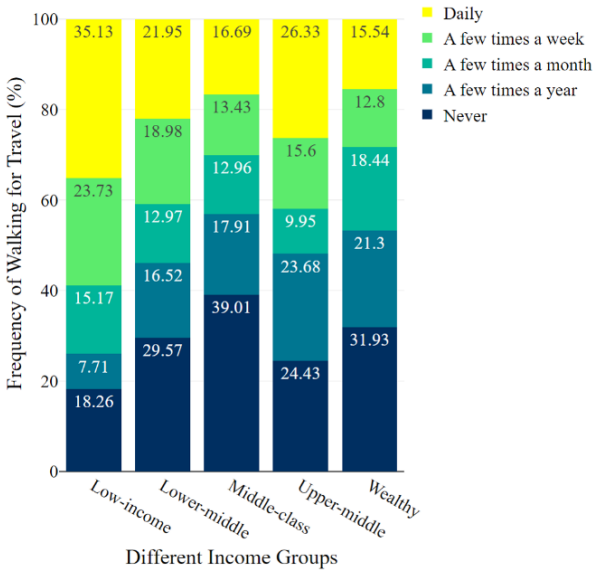

FIGURE 42 Frequency of Walking for Travel Among Different Income Groups

4.2.2.9. Walk as Mode Used to Get to Public Transit

A total of 2,169 participants were asked whether they walk to get to public transit. Among all African Americans, more than 81% answered that they would walk to get to public transit. As shown in **Figure 43**, this number for low-income African Americans is 84.6%, which is above the average and all other income groups.

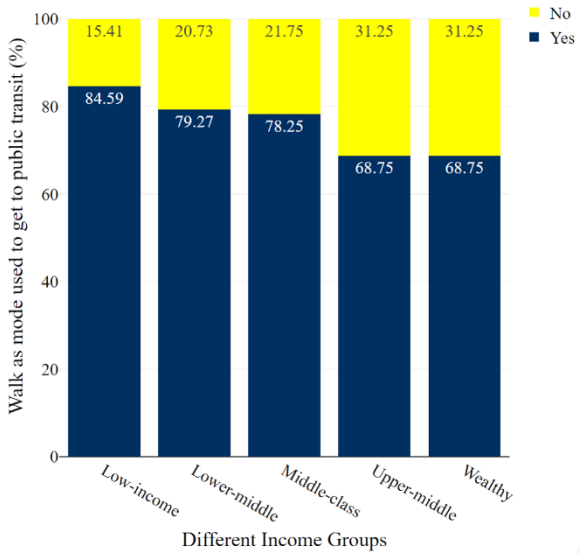

FIGURE 43 Walk as a Mode Used to Get to Public Transit Among Different Income Groups

4.2.2.10. Walk as Mode Used to Get from Public Transit

A total of 2,168 participants were asked whether they walk to get from public transit. Among all the African Americans, more than 78% answered that they would walk as a mode to get from public transit. As shown in **Figure 44**, this number for low-income African Americans is 81.8%, which is above the average and all other income groups.

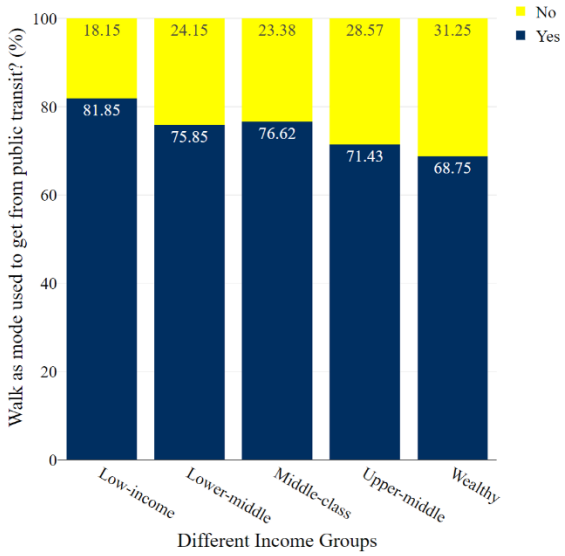

FIGURE 44 Walk as a Mode Used to Get from Public Transit Among Different Incomes

4.2.3. Variables Only Focusing on the State of California

Some of the variables in the NHTS 2017 dataset were only included in the state of California (2017 California-NHTS database). Four of these variables are related to biking and walking and are analyzed in the next sections.

4.2.3.1. Reason for not biking more: Infrastructure

For this variable, 266 participants answered the question. The weighted data included 580,049 African Americans. As shown in **Figure 45**, the most frequent response given for not biking among low-income African Americans was not having a path.

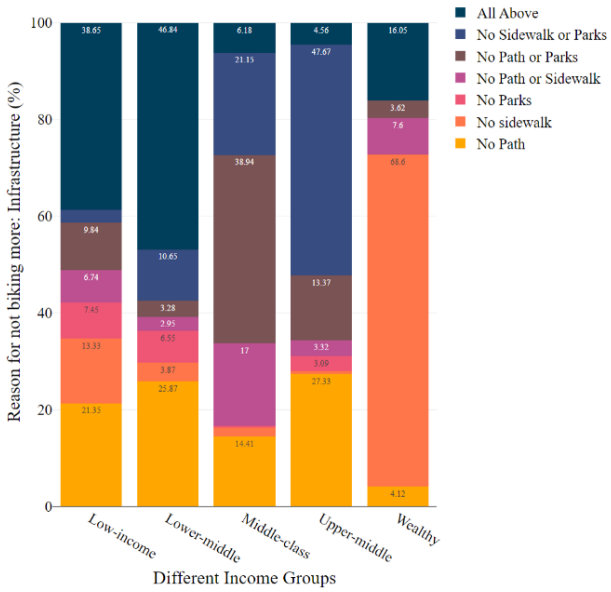

FIGURE 45 Reason for Not Biking More: Infrastructure Among Different Income Groups

4.2.3.2. Reason for not biking more: Safety

For this variable, 349 participants answered the question. The weighted data included 747,647 African Americans. As shown in **Figure 46**, the most frequent response given for not biking among low-income African Americans was bad lighting.

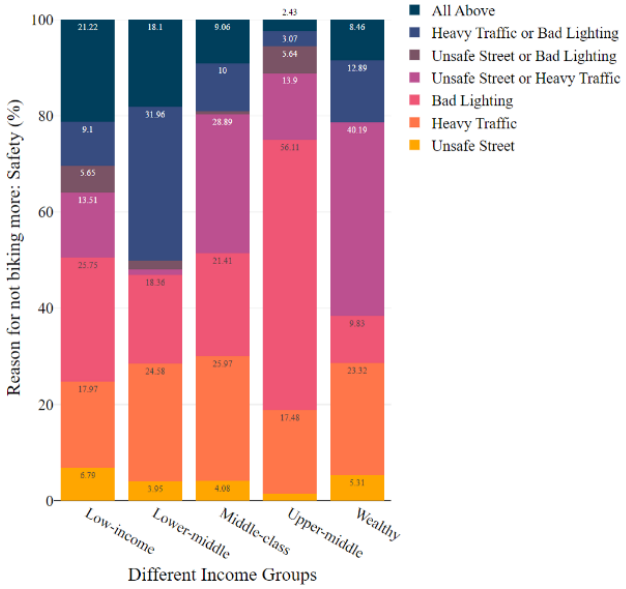

FIGURE 46 Reason for Not Biking More: Safety Among Different Income Groups

4.2.3.3. Reason for not walking more: Infrastructure

A total of 3,139 participants answered this question. The weighted data contained 5,392,199 African Americans. As shown in **Figure 47**, the most common reasons for not walking more among low-income African Americans with respect to infrastructure was no parks followed by no paths.

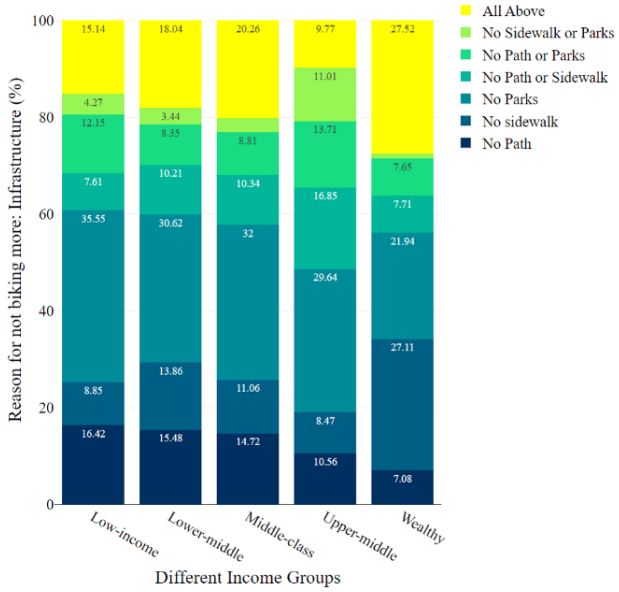

FIGURE 47 Reason for Not Walking More: Infrastructure Among Different Income Groups

4.2.3.4. Reason for not walking more: Safety

A total of 3,551 answered the question. The weighted data contained 6,343,410 African Americans. As shown in **Figure 48**, the most common reasons for not walking more among low-income African Americans with respect to safety is bad lighting followed by heavy traffic.

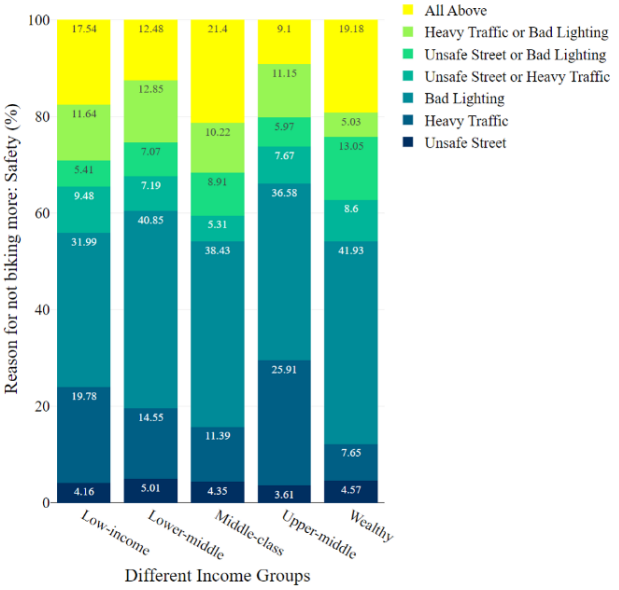

FIGURE 48 Reason for Not Walking More: Safety Among Different Income Groups

4.2.4. ANOVA Test for Walking and Biking Among Different Income Groups

To determine which groups significantly differ from each other, we used an ANOVA with post-hoc Tukey HSD test. **Table 9** and **Table 10** present the results of the Tukey test for the count of bike trips, bike trips for exercise, bikeshare program usage, walk trips, and walk trips for exercise in detail. **Table 9** demonstrates that low-income African Americans have a significantly higher use of bikes compared to other income groups. In terms of bike trips for exercise, low-income African Americans also have significantly higher use of bikes compared to other income groups except for the wealthy group.

TABLE 9 ANOVA with post-hoc Tukey HSD Test for Biking Among Different Incomes

	Count of Bike Trips				
	Estimate	Std. Error	t value	Pr(>|t|)	
Lower-middle - Low-income == 0	-0.16853	0.04248	-3.967	0.000661	***
Middle-class - Low-income == 0	-0.24251	0.04193	-5.784	< 1e-04	***
Upper-middle - Low-income == 0	-0.1815	0.05836	-3.11	0.014722	*
Wealthy - Low-income == 0	-0.22484	0.07634	-2.945	0.024522	*
Middle-class - Lower-middle == 0	-0.07399	0.04536	-1.631	0.461088	
Upper-middle - Lower-middle == 0	-0.01297	0.06087	-0.213	0.999507	
Wealthy - Lower-middle == 0	-0.05631	0.07828	-0.719	0.948984	
Upper-middle - Middle-class == 0	0.06101	0.06049	1.009	0.843226	
Wealthy - Middle-class == 0	0.01768	0.07798	0.227	0.999372	
Wealthy - Upper-middle == 0	-0.04334	0.08792	-0.493	0.987186	
Count of Bike Trips for Exercise					
Lower-middle - Low-income == 0	-0.11636	0.029697	-3.918	0.000764	***
Middle-class - Low-income == 0	-0.1518	0.029313	-5.178	< 1e-04	***
Upper-middle - Low-income == 0	-0.1372	0.0408	-3.363	0.006345	**
Wealthy - Low-income == 0	-0.12593	0.053374	-2.359	0.11833	
Middle-class - Lower-middle == 0	-0.03544	0.031713	-1.118	0.786893	
Upper-middle - Lower-middle == 0	-0.02084	0.042557	-0.49	0.987499	
Wealthy - Lower-middle == 0	-0.00957	0.054728	-0.175	0.999775	
Upper-middle - Middle-class == 0	0.014601	0.042289	0.345	0.996727	
Wealthy - Middle-class == 0	0.02587	0.054521	0.475	0.988904	
Wealthy - Upper-middle == 0	0.01127	0.061464	0.183	0.999729	

From **Table 10,** it can be concluded that there are significant differences between low-income African Americans and other income groups in terms of the frequency of walk trips and walk trips for exercise. All low-income African Americans have significantly more walk trips and walk trips for exercise.

TABLE 10 ANOVA with post-hoc Tukey HSD Test for Walking Among Different Incomes

	Count of Walk Trips				
	Estimate	Std. Error	t value	Pr(>|t|)	
Lower-middle - Low-income == 0	-1.39317	0.16976	-8.207	<1e-04	***
Middle-class - Low-income == 0	-1.55305	0.16757	-9.268	<1e-04	***
Upper-middle - Low-income == 0	-1.61226	0.23323	-6.913	<1e-04	***
Wealthy - Low-income == 0	-1.96392	0.3051	-6.437	<1e-04	***
Middle-class - Lower-middle == 0	-0.15988	0.18128	-0.882	0.898	
Upper-middle - Lower-middle == 0	-0.21909	0.24327	-0.901	0.891	
Wealthy - Lower-middle == 0	-0.57075	0.31285	-1.824	0.344	
Upper-middle - Middle-class == 0	-0.05921	0.24174	-0.245	0.999	
Wealthy - Middle-class == 0	-0.41088	0.31166	-1.318	0.666	
Wealthy - Upper-middle == 0	-0.35166	0.35135	-1.001	0.847	
	Count of Walk Trips for Exercise				
Lower-middle - Low-income == 0	-0.71784	0.09059	-7.924	< 1e-05	***
Middle-class - Low-income == 0	-0.73199	0.08941	-8.187	< 1e-05	***
Upper-middle - Low-income == 0	-0.67064	0.12445	-5.389	< 1e-05	***
Wealthy - Low-income == 0	-0.76776	0.1628	-4.716	2.06E-05	***
Middle-class - Lower-middle == 0	-0.01414	0.09673	-0.146	0.999	
Upper-middle - Lower-middle == 0	0.0472	0.12981	0.364	0.996	
Wealthy - Lower-middle == 0	-0.04992	0.16694	-0.299	0.998	
Upper-middle - Middle-class == 0	0.06135	0.12899	0.476	0.989	
Wealthy - Middle-class == 0	-0.03577	0.1663	-0.215	0.999	

4.3. Socio-demographic Information of Low-Income African Americans

This section discusses the socio-demographic information of low-income African Americans in the U.S. As mentioned in the previous section, African Americans with income less than $25K were considered to be a low-income class. A total of 6,517 African Americans were considered low-income in the NHTS person dataset. After weighting the data, 14,312,806 African Americans were considered as a low-income class.

4.3.1. Low-income African Americans Distribution in the U.S.

The distribution of low-income African Americans in the U.S. is shown in **Figure 49**. As the map demonstrates, there are no low-income African Americans respondents in the NHTS person dataset who live in the states of Montana, Idaho, Wyoming, South Dakota, Utah, New Mexico, New Hampshire, Vermont, and Hawaii.

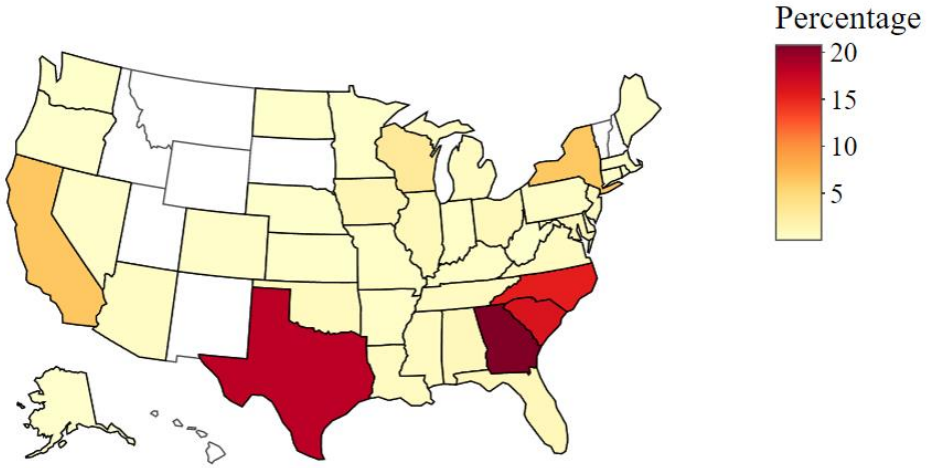

FIGURE 49 Distribution of Low-income African American Participants in NHTS Dataset

Furthermore, **Figure 50,** which shows the distribution of the weighted dataset, shows that most of the U.S. low-income African American population is dispersed across the nation's Eastern and Southern regions.

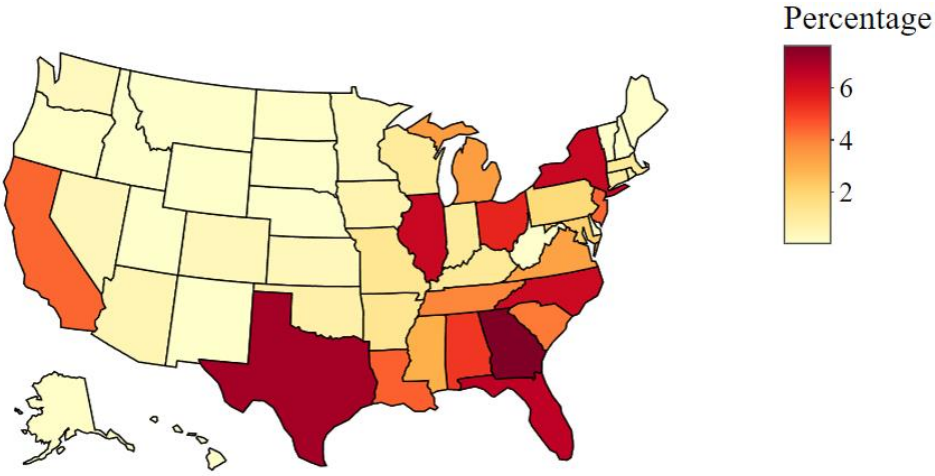

FIGURE 50 Distribution of Low-income African Americans in the U.S.

4.3.2. Age

As shown in **Table 11**, those aged 55 and older constituted the largest group of low-income African American respondents.

TABLE 11 Age Groups Among Low-income African Americans

Levels	Unweighted	Weighted
5-12	9.95	13.83
13-17	5.96	7.88
18-24	6.37	10.01
25-34	10.70	11.99
35-44	13.44	11.09
45-54	13.32	13.16
55-64	20.38	15.35
65 and more	23.65	16.69

4.3.3. Gender

Table 12 shows the gender distribution among low-income African American respondents. The table shows that more than half of the population (59.43%) is female.

TABLE 12 Gender Among Low-income African Americans

Levels	Unweighted	Weighted
Male	37.64	40.57
Female	62.36	59.43

4.3.4. Educational Attainment

It can be seen from **Table 13** that a high school graduate or GED is the most common level of educational attainment among low-income African Americans, followed by some college or associates degree.

TABLE 13 Educational Attainment levels Among Low-income African Americans

Levels	Unweighted	Weighted
Less than a high school graduate	21.13	23.37
High school graduate or GED	37.38	37.14
Some college or associates degree	30.90	29.28
Bachelor's degree	6.98	6.13
Graduate degree or professional degree	3.61	4.08

4.3.5. Number of drivers in the household

As shown in **Table 14**, almost half of the low-income African Americans (46.59%) have only one driver in their household, followed by no drivers (24.37%).

TABLE 14 Number of Household Drivers Among Low-income African Americans

Levels	Unweighted	Weighted
0	20.73	24.37
1	49.92	46.59
2	23.08	22.59
3	4.54	3.70
4	1.01	1.13
5	0.52	1.49
6	0.20	0.12

4.3.6. Count of Household Vehicles

Table 15 shows almost half of the low-income African Americans (45.40%) have only one vehicle in their household followed by no vehicle (34.76%).

TABLE 15 Household Vehicles Among Low-income African Americans

Levels	Unweighted	Weighted
0	29.49	34.76
1	46.16	45.40
2	17.81	14.32
3	4.71	3.35
4	1.06	1.18
5 and more	0.77	0.87

4.3.7. Home Ownership

Table 16 shows that most of the low-income African Americans (80%) rent their home.

TABLE 16 Home Ownership Among Low-income African Americans

Levels	Unweighted	Weighted
Own	30.74	17.93
Rent	67.52	80.92
Some other arrangement	1.73	1.14

4.3.8. Households in urban/rural areas

Table 17 shows the distribution of low-income African Americans in urban or rural areas. The table shows that most of this population lives in urban areas (91.79%).

TABLE 17 Home Ownership Among Low-income African Americans

Levels	Unweighted	Weighted
Urban	84.26	91.79
Rural	15.74	8.21

4.3.9. Average of Bike Trips and Walk Trips in a Week in the U.S.

It can be seen from **Figure 51** that the average number of bike trips for low-income African Americans in the U.S. is higher on the East Coast. Rhode Island had the highest average for bike trips.

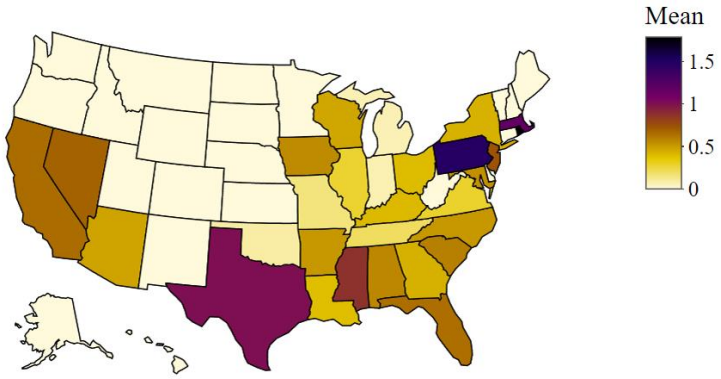

FIGURE 51 Average of Bike Trips per Week of Low-income African Americans in the U.S.

4.3.10. Average Walk Trips per Week in the U.S.

Figure 52 shows the average walk trips for low-income African Americans in the U.S.

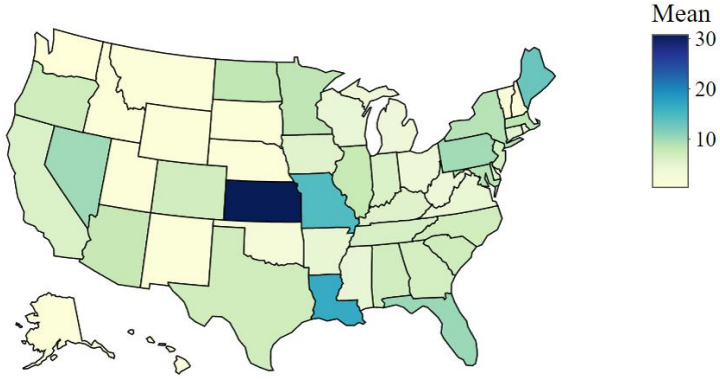

FIGURE 52 Average of Walk Trips per Week of Low-income African Americans in the U.S.

4.3.11. Average of Bikeshare ridership in a Month in the U.S.

Figure 53 shows that the average bikeshare ridership for low-income African Americans in the U.S. is higher on the East Coast. Texas and New York have the highest average for bikeshare trips.

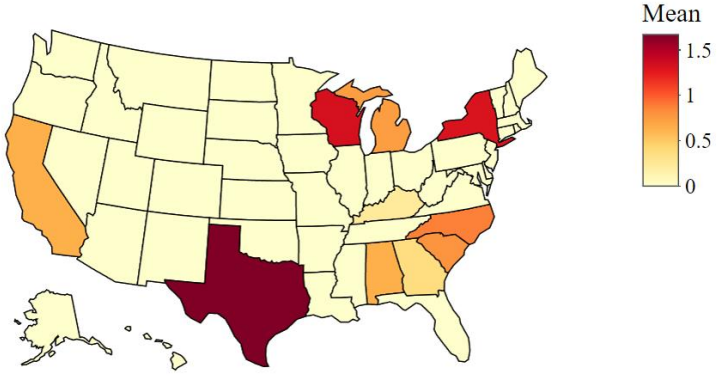

FIGURE 53 Bikeshare Use per Month of Low-income African Americans in the U.S.

4.3.12. Households Using Bike to Reduce the Financial Burden of Travel

Figure 54 shows the percentage of low-income African Americans that use a bike to reduce the financial burden of travel. Florida, New York, and Chicago had the highest percentage.

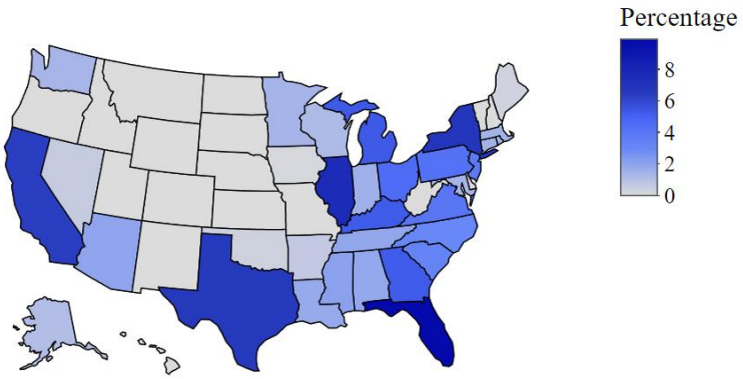

FIGURE 54 Bike to Reduce Financial Burden of Travel of Low-income African Americans

4.3.13. Percentage of Households Using Walk to Save Financial Burden of Travel

Figure 55 shows the percentage of low-income African Americans that walk to reduce the financial burden of travel. Florida, New York, and Chicago had the highest percentage.

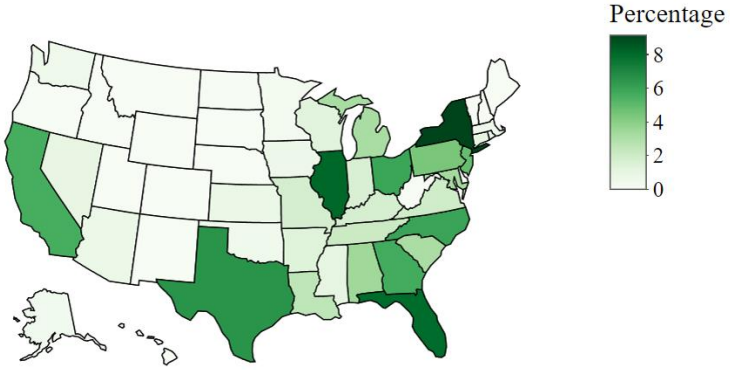

FIGURE 55 Walk to Reduce Financial Burden of Travel of Low-income African Americans

4.4. Modeling Analysis

Many studies have used statistical models to develop policies to improve traffic safety, investigate and forecast travel behavior, and pinpoint deficiencies in equity and transportation policy (*75–89*). Therefore, in this study, a Binary logistic Regression was developed to investigate the relationship between using a bicycle and walking to reduce the financial burden of travel and socio-demographic variables. The dependent variables are BIKE2SAVE and WALK2SAVE (bike or walk to reduce the financial burden of travel). Levels of these two variables were aggregated into "yes" if they used bike/walk to reduce their financial burden of travel and "no" if they did not. All

other types of socio-demographic information were considered independent variables. **Tables 18** and **19** present the results of the final models.

TABLE 18 Binary Logistic Regression Model of Bike to Reduce Financial Burden of Travel

	Estimate	Std. Error	z value	Pr(>|z|)	Sig Code
(Intercept)	0.41086	0.31087	1.322	0.18629	
Number of drivers in household	0.24876	0.11105	2.24	0.02508	*
Household Size	-0.13258	0.04681	-2.832	0.00462	**
Count of household vehicles	0.39325	0.0997	3.944	8.00E-05	***
Hispanic status of household respondent (No)	0.91555	0.2976	3.076	0.00209	**
Household in urban/rural area (Rural)	0.14287	0.17137	0.834	0.40444	

TABLE 19 Binary Logistic Regression Model of Walk to Reduce Financial Burden of Travel

	Estimate	Std. Error	z value	Pr(>|z|)	Sig Code
(Intercept)	-0.76533	0.29123	-2.628	0.00859	**
Number of drivers in household	0.32641	0.08282	3.941	8.10E-05	***
Household Size	-0.2082	0.03747	-5.556	2.76E-08	***
Count of household vehicles	0.59273	0.07197	8.236	< 2e-16	***
Hispanic status of household respondent (No)	0.44593	0.28381	1.571	0.11613	
Household in urban/rural area (Rural)	0.36004	0.12298	2.928	0.00342	**

5. DISCUSSION

Based on the systematic review explained in section 2 of this report, demographic factors, such as age, gender, education level, income, race, etc. affect biking and walking activities. Studies showed that bikeshare stations were built in areas where residents have higher incomes and socio-demographic status. The built environment can also affect active transportation use. For instance, low-income and minority neighborhoods in the U.S. have disproportionately limited access to bike lanes. We also reviewed papers that investigated the impact of the COVID-19 pandemic on active transportation. The results showed that bikeshare is more resilient than other types of transportation modes, making it one of the best choices during the COVID-19 pandemic. This shows that more people are shifting from public transportation to bikeshare as a substitute for their transit trips. Therefore, addressing the equity impact of bikeshare ridership and increasing access to bikeshare stations for disadvantaged groups is needed to diversify the transit system. Policymakers may consider providing safer services like bikeshare to keep communities connected during health emergencies. Future research is required to better understand and evaluate walking and biking activities and to address the gaps in the existing methods and the challenges.

We used the NHTS 2017 dataset to investigate walking and biking behaviors. The 2017 NHTS data used complex strategies to ensure that the collected data represents the U.S. population so that disproportionate sampling across a region does not artificially inflate the response rate. Accordingly, the applied weight provided in the dataset was to ensure that the results represent the U.S. population. The results of the analyses show that, in general, African Americans typically use the bicycle as a way to exercise rather than as a mode to travel. African Americans also use active transportation to reduce the financial burden of travel more than other racial groups. Moreover, African American students tend to use active transportation (walking and biking) as a mode of transportation to and from school more than other racial groups. The results showed that low-income African Americans have the highest number of active transportation trips for exercise per week and the highest number of active transportation modes (walking and biking) per day but have the lowest rate of bikeshare usage among all income groups. African Americans have the highest rates of active transportation use to and from work and school as well. Moreover, low-income African American households use active transportation to reduce their financial burden of travel more than other income groups. In the 2017 California-NHTS database we concluded that the most common reasons given for not walking or biking among low-income African Americans was no path and bad lighting.

The results of the regression model indicate that the number of drivers in household, the number of household vehicles, not being Hispanic, and living in rural areas are all positively correlated with the use of active transportation to reduce the financial burden of travel among low-income African Americans.

6. SUMMARY AND CONCLUSION

The goal of this study was to investigate walking and biking activities among low-income African Americans. To reach this goal, first, we conducted a systematic review of all the studies related to this subject. We used PRISMA guidelines to systematically review relevant publications using different keywords. After screening and reviewing the literature, some 60 articles were included in the review. The most frequent results when reviewing the literature indicated that bicycling was more popular among males, white people, and well-educated individuals, whereas walking was more popular among females. Bike usage was found to be low among minorities and those with lower incomes. Furthermore, communities with poor accessibility to bike infrastructure had a larger concentration of African Americans, low-wage employees, and the elderly.

To explore walking and biking behavior, we used NHTS 2017 datasets. The NHTS is the main national source of data on the relationship between demographic, economic, and cultural variables and the travel behavior of the American public. The NHTS dataset contains different datasets, including person-, household-, trip-, and vehicle-level data. We conducted a comprehensive analysis of all walking and biking-related variables in the NHTS 2017 datasets. In total, 11 variables related to biking and 12 variables related to walking were considered in the analysis. Moreover, to ensure the collected data represents the U.S. population the applied weight provided in the NHTS dataset was used to ensure that the results represent the U.S. population. The variables were analyzed first among all racial groups, and then among different income groups of African Americans (low-income, lower-middle, middle-class, upper-middle, and wealthy). We first removed the 0.55% of participants who did not respond to the question about their race (unknown) in the analysis section. We then aggregated the racial groups into four categories: White, African American, Asian, and Other (which includes American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and Multiple responses selected). As a result, the new sample data in the person dataset includes 262,782 participants, and the weighted dataset includes 299,366,245 people (12.71% of the weighted dataset were African Americans). The same process was conducted for the household dataset. the sample dataset includes 129,012 households, and the weighted dataset includes 117,448,239 Households. The weighted dataset shows that 12.3% of household respondents were African American.

The results of our analysis showed that, on average, African Americans fewer bike trips per week compared to the White population, which is in line with the results of the previous studies. However, African Americans use the bicycle for exercise and to get to and from work and school more often than other racial groups. Based on the household dataset, we also concluded that African Americans use bicycles to reduce the financial burden of travel more often than White Americans. These results show that, in general, African Americans tend to use the bicycle as a way to exercise rather than as a mode to travel. In terms of walking, on average, African Americans have the highest number walk trip and walk trips for exercise per week among all racial groups. African American households also walk to reduce financial burden of travel more than other racial groups, and African American students use active transportation (walking and biking) to get to and from school more than any other racial group. From the 2017 California-NHTS database, we concluded that the most common reasons given for not biking more among African Americans are

no path and bad lighting, whereas for other racial groups the reason is heavy traffic. The most common reason given for not walking more were no parks and bad lighting for African Americans and other racial groups. After exploring the variables among all racial groups, we aggregated the income levels into five categories: low-income class (less than $25k), lower-middle class (between $25k to $49.9), middle class (between $50k to $99.9), upper-middle class ($100k to $149.9), and wealthy (more than $150k) and investigated all the variables among these income groups, focusing only on African Americans. After cleaning the data, 18,868 African American participants were considered for the income variable. After weighting the data, 36,995,972 people were considered African Americans.

The results also showed that low-income African Americans have the highest active transportation trips for exercise per week, and daily use of active transportation modes (walking and biking), but the lowest use of bikeshare programs among all income groups. African Americans use active transportation to get to and from work and school more than other racial groups. Moreover, low-income African American households use active transportation to reduce their financial burden of travel more than other income groups. From the 2017 California-NHTS database, we concluded that the most repetitive response for low-income African Americans as a response for not biking and walking more is no path and bad lighting. In the next step, we only focused on low-income African Americans. Data showed that most of the low-income African American population lives in urban areas (91.79%). Most of them also rent their homes, have only one vehicle in their household and have a high school graduate or GED is the most common level of educational attainment. We also visualized low-income African American participants' distribution in the U.S. for the NHTS 2017 dataset. The visualized data showed that most of the low-income African Americans live in the nation's Eastern and Southern regions. The data also showed that average bike trips and bikeshare ridership for low-income African Americans in the U.S. are higher on the East Coast. Florida, New York, and Chicago had the highest percentage of low-income African Americans that use active transportation to reduce the financial burden of travel. Finally, we developed a model for biking and walking to reduce the financial burden of travel. We used a binary regression model to investigate the relationship between using a bicycle to reduce the financial burden of travel and socio-demographic variables. The results showed that the number of drivers in households, of the number of household vehicles, Not being Hispanic, and rural residency are all positively correlated with the use of active transportation to reduce the financial burden of travel.

In summary, although various data related to active transportation are available, to the best knowledge of the authors, few related studies investigated the low-income African American walking and biking activities across the U.S. There is still a need to investigate these factors through comprehensive data. This study is novel in that it explores the bike and walk-related attributes in the 2017 NHTS and focuses on different household and personal characteristics. Furthermore, this research contributes to shaping the future of mobility by providing a deeper understanding of active travel behavior among low-income African Americans in the U.S. and developing methodologies for identifying and prioritizing communities for appropriately planned active transportation infrastructure development, which can help transportation planners and authorities prioritize infrastructure investment. This study serves as an initial exploration into the

use of walking or biking to reduce the financial burden of travel using the weighted 2017 NHTS data as well. The analyses of this study on the NHTS data show that different socio-demographic groups are not using active transportation equally or for the same purpose. Due to their relatively low cost and convenience, active transportation can promote mobility for users with diverse socio-demographic profiles, including low-income racial minorities. The main limitation of this study is that the latest NHTS data dates back to the year 2017. The newer version of the NHTS was postponed due to the COVID-19 pandemic. Future studies should also include the new data and compare it to the socio-demographic data of households from the 2017 data to identify any similarities or changes that happened during the time period between 2017 and the new dataset. Additionally, future studies can focus on the geographic disparities between specific households using data integration for NHTS data and bike share stations.

TABLE 20 Summary of Previous Studies on Active Transportation

Authors	Goal	Data and Methodology	Results	Gap/[Note]
(*1*) Acheampong and Siiba (2018)	• Using a socio-ecological model to better understand the factors that influence biking infrastructure in northern Ghana.	• Case study: Tamale metropolis • A cross-sectional survey (n=455) • Statistical Analysis (Binary Logistic Regression)	• Being female was shown to be negatively connected with commuting by bicycle in the city; males were about two-and-a-half times more likely than females to bike. When compared to people with greater levels of education, those with the equivalent of a high school education were 2.5 times more likely to cycle for utility purposes.	•
(*2*) Auchincloss et al. (2020)	• Presenting the design, methods, and baseline characteristics of a bikeshare assessment aimed at assessing within-person variations in physical activity levels (PA), with an emphasis on those from lower socioeconomic backgrounds.	• A sample of new bikeshare members in the Drexel neighborhood in Philadelphia (n=1,206) • Statistical Analysis	• Relative to others, those who were insufficiently active were disproportionately older, female, non-Hispanic Black and disadvantaged.	• This study had to rely on self-reports to derive an estimate of total activity.
(*3*) Aziz et al. (2018)	• Developing an agent-based model (ABM) that can assist the transportation investment decision makers to examine the impact of changes in walk-bike infrastructures at a high spatial resolution (e.g., block group level).	• High performance Agent-Based Model (ABM) • GIS-based maps are developed at block group level • Case study: New York City	• Infrastructure expenditures such as sidewalk expansion and bike lane expansion can have a favorable impact on active transportation mode choices.	• More features at a finer resolution can be added (e.g., the route choice for walk and bike modes) and the results can be improved.

(*4*) Barajas (2021)	• Examining whether deficiencies in transportation are associated with disproportionate policing in Chicago	• Dataset of citations issued by the Chicago Police Department (CPD) from 2017 to 2019. • Socio-demographic data from ACS, employment density from the Longitudinal Employer–Household Dynamics program and policing and safety data from city sources. • Case study: Chicago • Multilevel negative binomial regression model	• Tickets were issued 8 times more often per capita in majority Black tracts and 3 times more often in majority Latino tracts compared to majority White tracts.	•
(*5*) Barajas and Braun (2021)	• Examining the relationship between cycling or walking and self-reported health.	• 2017 NHTS • Adults who lived in central cities (n = 91,541) • Weighted logistic regression models	• Cyclists of color had smaller health effects from cycling for utilitarian trips, while race and ethnicity had only a marginal moderating effect on the association between walking and health.	• The use of self-reported health as the dependent variable. • Relying on a single definition of neighborhood change.
(*6*) Beck and Nguyen (2017)	• Investigating how children (5–18 years) travel to and from school and among those living ≤1 mile of the school.	• Porter Novelli's 2012 ConsumerStyles database (n= 4,170) • The multivariable regression model	• Passenger vehicles were a frequent mode of transportation regardless of distance from school. The role of school bus service eligibility in walking or biking for students who reside near school warrants additional research.	• Did not capture driver characteristics (e.g., driver age) • Walking and bicycling were combined in the study
(*7*) Bongiorno et al. (2019)	• Investigating and comparing pedestrian and cyclist behaviors.	• Case study: Boston Greater Area (2014–2015) • Data from activity tracking mobile phone application of 260,000 pedestrian trips • Open data from the Hubway system (or Bluebikes) • Detailed quantitative analysis	• Pedestrian and bike mobility are affected by temperature, precipitation and time of day. • Severe weather (especially precipitation) has a greater impact on biking journeys than on walking. Cycling as a mode of transportation may be hampered during specific periods of inclement weather.	• Using bikesharing trips as a proxy to the overall use of bicycles in the urban space. • Does not consider socio-demographic information

(*8*) Branion-Calles et al. (2021)	• Investigating available national sources to count the number of people who walk or ride their bikes, and looking at trends in mortality risk.	• Case study: Canada • CCHS for Canadians walking or bicycling for leisure (2000–2014) and to work or school (2008–2014) • Database data on the number of pedestrian and bicyclist fatalities (1999–2017) • Descriptive Analysis	• Bicycling was more popular among males, whereas walking was more popular among females. • Men are at more risk than women. • In Canada, a national household travel survey should be a top priority for public health reasons.	• Due to the lack of a nationwide household travel survey in Canada, there is a data gap for walking and bicycling. • Lack of details regarding amount of use for bicycle and walking.
(*9*) Braun et al. (2019)	• Analyzing cross-sectional relationships between bike lanes and sociodemographic factors at the block group level.	• Case study: 22 large U.S. cities (n = 21,843 block groups) at the block group level • The 2011–2015 American Community Survey • Data for bike lanes from local and regional administrative data sources • Linear and Logistic Multilevel Mixed-effects Regression Models (MLME)	• Disadvantaged block groups (i.e., lower SES, higher proportions of minority residents) had significantly lower access to bike lanes.	• Due to the difficulties of getting bike lane data, the study was limited to 22 cities.
(*10*) Caspi and Noland (2019)	• Examining bikeshare travel patterns in low-income neighborhoods in Philadelphia.	• Data for Philadelphia's Indego bikeshare system between April 2017 and March 2018. • Multivariate Regression Models	• Bikeshare trips taken from docking stations in lower-income areas are for work commute trips. • Lower-income areas generate fewer trips.	• Only the location of the docking station is included in the data, not the persons who utilized the bikeshare.
(*11*) Child et al. (2019)	• Investigating people's views of the advantages of neighborhood-based physical activity (PA) and the factors that influence them.	• Case Study: Greenville, South Carolina. • Eight focus groups were conducted in low-income, predominantly Black neighborhoods.	• Residents (low-income African American) reported walking inside their neighborhoods as part of a healthy lifestyle, despite a variety of environmental obstacles.	• The income, education, and race/ethnicity homogeneity of the eight focus group communities.

(*12*) Crossa et al. (2021)	• Whether Citi Bike members represent the sociodemographic profile of bikers in New York City.	• Case study: New York City • NYC Community Health Survey data	• Citi Bike users were more likely to be women, ages 24 to 45, and were white, college graduates, and from a family with an income greater than 400% of the poverty threshold compared to NYC bikers. • Citi Bike users have more inequalities in race/ethnicity and socioeconomic position (not gender) than NYC bikers.	• The Citi Bike footprint has changed throughout the five years covered by this survey, and hence the characteristics of Citi Bike members may have changed as well.
(*13*) Cusack (2021)	• Investigating the commute mode choices of essential workers.	• Case study: Philadelphia, Pennsylvania • Online survey (N = 213) • Bivariate analyses and logistic regression models	• Nearly half of respondents changed their commute mode during the pandemic.	• Minority respondents were underrepresented
(*14*) de Sousa et al. (2014)	• Assessing the perception of barriers that may hinder the use of bicycles for commuting.	• Case study: three Brazilian cities • Survey of 380 college students	• The lack of specialized bicycle infrastructure is the most significant perceived obstacle in all three cities.	• The sample was too small compared to students in these three cities.
(*15*) Dill and McNeil (2020)	• A comprehensive review, focusing on race/ethnicity, income, gender, age, and disability in studies on equality and car sharing.	• Systematic review article	• They discovered evidence of disparities in the usage of shared vehicles, which can only be explained in part by distance. Additional barriers to usage, notably for bikesharing, have been discovered in several research studies.	•

(*16*) Du et al. (2020)	• Investigating the travel characteristics and factors affecting travel mode choice for healthcare activity by the elderly in core area and suburb.	• Descriptive Analysis • Multinational Logistic Regression	• Bus and walking are main modes for the elderly to seek medical treatment.	• Discussion on the differences between urban and rural area.
(*17*) Ermagun and Tilahun (2020)	• Investigating the equity of transit accessibility in the City of Chicago.	• The Metropolitan Chicago Accessibility Explorer • Generalized linear model	• Areas of low accessibility have a higher percentage of African Americans, Hispanics, Asians, low-income workers, low-educated citizens, and the elderly.	•
(*18*) Faghih-Imani and Eluru (2015)	• Exploring bikesharing systems behavior at the trip level to analyze bicyclists' destination preferences.	• Case study: Chicago • 2013 data from the Chicago's Divvy system • Random utility maximization approach • Multinomial logit model	• The developed model should allow bicycle-sharing system operators to plan services more effectively by examining the impacts of travel distance, land use, built environment, and access to public transportation infrastructure on users' destination preferences.	• The study does not explicitly control for the BSS infrastructure installation process.
(*19*) Fitch et al. (2016)	• Creating a model of the variables associated with biking to schools and testing the model's efficacy in predicting bicycling to school.	• Case study: Davis, California • Observing bike rack counts at 11 public schools. • Descriptive analysis • Binomial multilevel regression models	• Comfortable bicycle routes, the racial and economic mix of the student population, and numerous daily background elements (e.g., day of week, season, weather) were all found to have an impact on rates of riding to school.	• Only for California.

(*20*) Franckle et al. (2020)	• Exploring perceived barriers and facilitators to bikeshare use among users and non-users of the Bluebikes bikeshare program in Boston, Massachusetts.	• Case study: Boston • Cross sectional Survey (n = 512)	• The most frequently cited barriers for low-income Boston neighborhoods included: safety concerns, lack of a helmet, proximity to stations, trouble with renting/returning a bike, and weather.	• Most of the sample were women, white individuals, and individuals with a university degree.
(*21*) Gehkre et al. (2021)	• Investigating systemwide travel patterns during the first 18 months of a dockless bikeshare program in the Greater Boston region.	• Case study: Boston • Lime's Application Programming Interface (API)	• Neighborhoods with a higher share of renter-occupied housing and historically disadvantaged populations had less access to dockless bikes while also exhibiting higher rates of bike usage.	Not using built environment measures of network connectivity and land development patterns
(*22*) Godwin and Price (2016)	• Examining the factors that may contribute to less bicycling and walking for transportation in the southeastern U.S.	• The U.S. Census Bureau • Descriptive statistics.	• The Southeast has a denser population in rural areas and less dense urban areas.	•
(*23*) Golub et al. (2019)	• Assessing equity issues of smart mobility in the context of lower-income areas	• Case study: Portland, Oregon • Mixture of quantitative and qualitative research • Two focus groups • Survey (n= 308)	• By lowering costs and improving service for public transit, ridesharing and active transportation, smart mobility systems could address many of the needs of transportation disadvantaged communities.	• Only in Portland.

(*24*) Griffin and Jiao (2019)	• Examining the location and equality of active transportation participation strategies in Austin, Texas, (bicycling and pedestrian).	• Case study: Austin, Texas • In-person meetings • PPGIS called ‘‘WikiMap’’ in development of the 2045 Regional Active Transportation Plan. • Bicycling Smartphone App	• Compared to in-person gatherings, smartphone applications can help reach lower-income groups in specific situations.	•
(*25*) Hochmair et al. (2019)	• Investigating which transport network measures, characteristics of the built environment, and sociodemographic factors are associated with increased or decreased bicycle ridership in census block groups.	• Case study: Miami-Dade County area • Strava tracking data • Descriptive statistics and linear regression models	• Based on the regression results, the paper presents a set of guidelines for practical design detailing which groups of cyclists would benefit most from specific bicycle infrastructure improvements.	• Regression results may change when using a different aggregation level.
(*26*) Howland et al. (2017)	• Investigating the current approaches toward serving low-income and minority populations and bikeshare systems.	• A survey of representatives from 56 U.S. bikeshare systems. • Descriptive analysis	• Nearly one-fourth of bikeshare systems have written equity policies. Many more systems, on the other hand, emphasize equity in different elements of their systems.	• Only one person from each system answered the survey.
(*27*) Hu et al. (2021)	• Examining the spatiotemporal evolution of bike-sharing usage across the pandemic and comparing it with other modes of transport.	• Case study: Chicago • Divvy bikeshare program • Generalized additive (mixed) models	• Regions with more white, Asian, and fewer African American residents are found to become less dependent on bikesharing • Stations near the city center, with more docks, or located in high-income areas go from increasing before the pandemic to decreasing during the pandemic.	• The deep socio-economic inequities deserve more attention.

(*28*) Jobe and Griffin (2021)	• Investigating the range of bikeshare systems' responses to the pandemic	• Case study: San Antonio, Texas • Survey (n= 125) • Statistical Analysis	• Results showed that 43% of survey respondents who were unemployed due to the pandemic reported increasing use of the bikeshare system, whereas 36% of employed respondents decreased ridership.	• Limited only to San Antonio
(*29*) Kaviti et al. (2019)	• Examining and modeling price preferences of bikeshare users, as well as identifying the similarities and differences between members and casual users in terms of demographics, use, and expressed preferences.	• Case study: Washington, D.C. • Survey • Logistic regression	• Registered members are more likely to be white, make more money, and live in the D.C. region than casual users. In comparison to members, casual users do fewer bikeshare rides and are less sensitive to the service (station density). Gender, age, and socioeconomic status do not appear to have an impact on casual food product selection.	• Limited to Washington, D.C., area
(*30*) Kelarestaghi et al. (2019)	• Investigating the cycling usage and frequency determinants on college campuses	• Case study: College campuses in Baltimore, Maryland • Survey (n= 780) • Factor analysis • Structural equation model (SEM)	• Males are less concerned about the risk-related indicators such as theft and road and environment-related obstacles such as poor road conditions. However, females have a positive attitude toward campus-related improvements such as pro-bike programs.	• Focusing only on students
(*31*) Knight et al. (2018)	• Examining the geographies of walkability in relation to various socioeconomic factors.	• Case study: Buffalo, New York • WalkScore data at the census block group level	• Walkable block groups are highly clustered in certain parts of the city, that housing values in walkable areas are increasing, and that individuals in poverty and members of certain minority groups live in block groups with a disproportionately low WalkScore®.	• Limited only to Buffalo.

(*32*) Kontou et al. (2020)	• Investigating the most recent and nationally representative school transportation patterns.	• 2017 NHTS • Binary logit model	• In 2017, 9.6% of students walked to school and 1.1% rode their bikes. Results showed that 77.5% of trips for children who walk to school were less than one mile. As the distance to school rose, student rates of walking to school fell, whereas rates of bicycling to school peaked when the distance was between 0.5 and 1 mile.	• Did not consider sociodemographic information of students.
(*33*) Kotval-K and Vojnovic (2015)	• Examining how socioeconomic factors influence travel patterns and environmental impacts.	• Case study: Detroit • Survey (n= 1,191) • Ordinary Least Squares Regression Model	• The analysis explores contributions to environmental burdens between poorer urban and wealthier suburban populations.	•
(*34*) Lachapelle (2015)	• Investigating access to a car and active transportation of transit riders.	• 2009 NHTS • Negative binomial models	• As income increased, the quantity of vehicle available increased as well. Transit users who did not have access to a car were more likely to take public transit, walk, or ride their bikes than fully powered drivers.	•
(*35*) Leister et al. (2018)	• Investigating the factors affecting the operation of bikeshare systems.	• Online survey (n= 23) • Descriptive statistics	• Bikeshare operators estimated that 44.13% of trips were made by women, 8.81% by children, 10.40% by older adults, 18.13% by ethnic minorities, and 12.67% by persons of low-income. Bikeshares revealed low reach among minorities and those of lower income.	• Contacting representatives via email may have limited our reach. • Employed self-report measures

(*36*) Li et al. (2019)	• Researching the influence of perceptions and attitudes on walking in Beijing's historical area.	• Case study: Beijing • Survey (n= 270) • Combination of principal component analysis (PCA) and statistical regression.	• Walking frequency is associated with income, age, and employment status.	• It was conducted in only one • walkable neighborhood
(*37*) Lowe (2016)	• Investigating the relationship between sidewalk continuity and poverty and racial composition at the census tract level.	• Case study: New Orleans, Louisiana • An audit of sidewalk continuity adjacent to bus stops	• According to the findings, minority communities and, to a lesser extent, low-income groups are substantially related to poor sidewalk connectivity.	• Limited only to New Orleans.
(*38*) MacArthur et al. (2020)	• Exploring the potential need for adaptive bikeshare options in urban locations.	• Case study: Portland, Oregon • Surveys of residents living in several low-income communities of color (n = 1,885) • A national survey of cities and bikeshare operators (n = 70) • Interviews with adaptive bikeshare participants (n = 5) in Portland, Oregon	• There is an underserved market of people who believe they are unable to use existing bikesharing systems due to physical limitations.	• Does not include direct involvement of people with disabilities and older adults.
(*39*) McAndrews and Okuyama (2017)	• Investigating the hypothesis that bicycling was primarily an urban activity.	• 2009 NHTS • Binary Logistic Regression	• Bicycling was found to be primarily, but not exclusively, an urban activity. Moreover, women and youths were more likely to bicycle in rural, small, and low-density places (RSLD) places compared to urban places.	• Under coverage of nonwhite travelers in the NHTS data

(*40*) Millward et al. (2013)	• Reporting detailed aspects of walking behavior for a medium-sized North American city	• Questionnaire data from the 2007–2008 Space–Time Activity Research (STAR) survey conducted in Halifax, Canada. • Simple linear regression	• Home is both the most common origin and destination for AT walks, and the most common purpose is travel-to-shop rather than travel-to-work. Most walks are to non-home locations, such as retail establishments and offices. Particularly important are restaurants and bars, grocery stores, shopping centers, banks, and other services.	•
(*41*) Mitra et al. (2021)	• Presenting on a study that examined potential gender gaps in mobility patterns of older adults (65 years and over) in the U.S.	• 2017 NHTS • Structural Equation Model (SEM)	• There were gender variations in the elderly's mobility habits, and the discrepancies varied among clusters. The Senior Elder with Medical Condition(s) cluster has the largest significant gender discrepancy. Females in the Low-Income Single Elder cluster, on the other hand, saw statistically significant positive mobility differences compared to their male counterparts.	• Data limitations did not allow for the exploration of mobility-related attitude-based clustering
(*42*) Mjahed et al. (2015)	• The individual characteristics and community attributes that influence biking and walking mode choices and investigating the role of childhood experience on these factors.	• Attitudinal survey (n= 254) • Structural equation model	• The findings demonstrated that there is a link between childhood travel behavior and adulthood walking behavior factors.	•
(*43*) Nuworsoo and Cooper (2013)	• The best practices are underlined, and program features linked to high levels of non-motorized mobility, with a focus on bikers and pedestrians are identified.	• Case study: California communities of Davis, Palo Alto, and San Luis Obispo, cities • Survey (n= 630)	• Acceptable biking and walking distances to desired activities, direct routes, adequate route connectivity, and separation of motorized and non-motorized transportation modes are among the criteria that matter most to stakeholders when it comes to establishing bicycle- and pedestrian-friendly settings.	• Limited only to two cities.

(*44*) Pae and Akar (2020)	• Investigating the effects of various trip purposes on individuals' self-assessed health status with a focus on walking trips.	• 2017 NHTS • The sample includes 125,885 adults between the ages of 18 and 64 • Ordered logit model	• Walking for different trip purposes has different effects on adults' self-assessed health scores. Second, a closer look indicates that walking speeds and durations vary depending on the purpose of the journey.	• The health scores are self-reported.
(*45*) Qian and Jaller (2021)	• Developing a competing destination model to analyze the spatial patterns of choice parameters of bikeshare trips.	• Case study: Chicago • Divvy bikeshare system datasets • Entropy-based CDM	• Bikeshare journeys are more likely to be attracted to areas with increased accessibility (i.e., the ability to use various mobility services and technologies, and/or the ability to reach significant destinations/opportunities).	• The dataset provides limited information about trip purposes and users.
(*46*) Quinn et al. (2016)	• Examining relationships of demographic and workplace factors with health-enhancing active transportation and commuting.	• 2009 NHTS • Multiple logistic Regressions	• Younger age, lower income, urban dwelling, and the highest and lowest education categories were all linked to increased probabilities of active commuting and transportation. • Males had a higher chance of commuting and transporting by bike, but a lower chance of walking.	•
(*47*) Ray et al. (2020)	• Understanding how communities use bicyclist and pedestrian manual counting programs data and assess the potential to use manual count data for assessment and evaluation.	• Case study: six communities in Minnesota • Semi-structured interview per community	• Counts are a feasible assessment tool for local active transportation (bicycling and walking) promotion efforts.	• Only limited to Minnesota

(*48*) Rothman et al (2018)	• Reviewing Active School Transportation (AST) correlates and discusses why school travel mode (STM) share may have changed over time.	• Systematic Review • 1990-2016	• Because of the social and environmental variety, local solutions to school transportation issues are required. Changes in AST correlations throughout time should be taken into account when evaluating current policy methods and when developing new policy, legislation, design, and program initiatives	•
(*49*) Rybarczyk and Gallagher (2014)	• Investigating what travel demand management (TDM) strategies will increase bicycling and walking activity.	• Case study: City of Flint, Michigan • Survey (n= 110) • Descriptive Analysis • Binary logit model	• All groups generally favored most bicycling interventions within a bicycling zone versus those who lived outside the zone. Accordingly, most walking facilitators were viewed positively among all groups. • Bicycle safety and education may cause faculty to bicycle, whereas higher automobile costs may cause staff to bicycle	• Limited only to one university
(*50*) Sallis et al. (2013)	• Exploring correlates of bicycle ownership and bicycling frequency	• Case study: Seattle, Washington, and Baltimore, Maryland • Survey (n= 1,780 adults aged 20–65 recruited) • Multivariable models	• About 71% of the sample owned bicycles, but 60% of those did not report cycling. Among bicycle owners, frequency of riding was greater among young, male, white, educated, and lean subgroups.	• Survey items did not distinguish bicycling for transportation vs. recreation.
(*51*) Sikder (2019)	• Investigating the socio-demographic and land use factors that affect the adoption and frequency of use of ride-hailing services in the U.S.	• 2017 NHTS • Descriptive Analysis • Ordered Logit (ORL) model	• African American individuals are less likely than others to adopt and frequently use ride-hailing services. • The tendency to adopt and frequently use these services is higher among individuals in insufficient vehicle households (i.e., households with more workers than vehicles) than other individuals.	•

(*52*) Wang and Noland (2021)	• Examining the impact of the COVID-19 pandemic on the CitiBike system and the NYC subway.	• Case study: New York City • CitiBike dataset • Estimate Prais-Winsten models	• The results show that both subway ridership and bikeshare usage plummeted initially; bikeshare usage has nearly returned to normal while subway ridership remains substantially below pre-COVID levels.	• Do not know how MTA service reductions affected ridership.
(*53*) Wang and Lindsey (2019)	• Examining the associations between bikeshare user behavior and socio-demographic characteristics at the Census block group (CBG) level	• 2017 data on trips taken by 30-day and annual members of the Nice Ride Bike Share System in Minneapolis-St. Paul • Linear mixed-effects models and multinomial logistic models	• People who live in areas with a high concentration of minorities and low socioeconomic status (SES) use bikeshare more frequently, take journeys at different times of the day and across days of the week, and have more frequently used origin-destination pairings of stations.	• Do not analyze patterns of use for casual users. • Self-selection bias
(*54*) Whitfield et al. (2015)	• Comprehensive, multiyear assessments of active transportation surveillance in the U.S.	• The American Community Survey • National Household Travel Survey (NHTS) • The American Time Use Survey • The National Health and Nutrition Examination Survey • National Health Interview Survey	• Men, younger respondents, and minority racial/ethnic groupings were more likely to use active transportation across networks. The least and most educated groups had the greatest incidence of active transportation, while densely populated, metropolitan regions had the highest prevalence of active transportation.	• Limited to the 2005–2012 single-year data releases.
(*55*) Yang and McAndrews (2020)	• Examining the link between individual exposure to diverse economic entities, such as retail stores and schools, and walking and cycling.	• Case study: Wisconsin • The 2017 Wisconsin Add-On to the National Household Travel Survey • Negative Binomial model	• Schools and local government offices might function as anchor institutions for health-promoting travel habit if active travel promotion is promoted.	• Active travel behavior was measured by the frequency of walking and cycling, rather than total minutes of walking and cycling.
(*56*) Yang et al. (2018)	• Investigating active travel and public transportation use among U.S. older adults and the built environment characteristics associated with them.	• 2009 NHTS • Linear regression models	• Active travel and daily transport trips declined from younger to older age groups. Among the older adults, the daily transport varied by a number of characteristics.	•

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