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Unlocking Trends: Socio-Demographic Insights into Bike Sharing from the 2017 National Household Travel Survey

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Abstract: The implementation of bike-sharing systems represents a novel strategy aimed at enhancing urban mobility by offering shared bicycle services to improve accessibility and user convenience. Nevertheless, there has been a limited exploration into the user demographics of bike-sharing programs on a national scale. This study investigates the socio-demographic characteristics of bike-sharing system users, leveraging the 2017 National Household Travel Survey and negative binomial regression models. It finds that bike-sharing usage is more common among users than non-users, with African American and Hispanic individuals using the system more than other racial groups. Furthermore, low-income individuals (<USD 15,000) and residents of high-density areas (≥25,000 per square mile) show a higher tendency towards bike sharing. The research highlights the lack of national-level studies on bike-sharing user demographics and suggests that future policy and planning should address the needs of specific populations, aiming to enhance urban mobility and accessibility through bike-sharing services.

Keywords: bicycle; bike share; transport; sustainability

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1. Introduction

Biking serves as an ideal transportation choice for journeys that exceed walking distances but do not necessitate driving, particularly for commutes of 2 to 3 miles. This distance range offers a perfect opportunity for biking to significantly cut down on car usage. Such a transition can ease traffic jams, reduce carbon emissions, and foster healthier living habits among city dwellers [1,2]. Biking fills a crucial niche in urban transport by offering a green and economical option over cars. The addition of dedicated bike paths and bike-sharing initiatives further boosts biking's attractiveness and practicality for daily commutes, prompting a broader adoption of this eco-friendly mode of transport [3]. Concentrating on this commuting interval highlights the necessity of incorporating biking into a comprehensive urban transit plan aimed at mitigating environmental issues and enhancing urban life quality through diverse benefits including physical health, environmental protection, economic savings, and travel efficiency [4,5]. This approach also emphasizes the significance of integrating physical activity into daily routines through biking [6].

Biking emerges as a sustainable and cost-effective mode of transportation, accessible to a wide array of individuals across various socioeconomic backgrounds [7,8]. By presenting an eco-conscious alternative to conventional vehicle use, biking has the potential to significantly reduce the environmental footprint associated with daily commutes. This shift away from automobiles to bicycles can lead to a notable decrease in carbon emissions and air pollution, contributing to cleaner air quality and a healthier environment [9,10]. Moreover, biking offers an economically viable option for many, circumventing the high costs associated with car ownership such as fuel, insurance, maintenance, and parking fees. This affordability makes biking an attractive option for the general population, promoting inclusivity in urban mobility. In addition to environmental and economic benefits, transitioning to biking from automobiles could alleviate urban congestion, enhancing the efficiency of city transportation networks. The increased adoption of bicycles for daily commutes can free up road space, reduce traffic jams, and improve overall travel times for all city dwellers [1]. Furthermore, the scalability of biking infrastructure, like bike lanes and bike-sharing programs, requires relatively low investment compared to the construction and maintenance of roads and highways for vehicles [11]. This makes biking not only a sustainable and affordable option but also a strategic choice for urban planning and development, positioning it as a key component in the evolution towards more livable, breathable, and equitable urban spaces [12–14].

While non-motorized forms of transportation have traditionally been viewed as less flexible and convenient compared to the door-to-door service offered by automobiles, the advent of bike-sharing systems has started to shift this perception. These innovative systems provide shared bicycle facilities, significantly enhancing the accessibility and convenience of biking for the urban populace. By strategically placing bike stations across cities, bike-sharing systems ensure that users can easily access bicycles at their convenience, effectively bridging the gap between the starting point and destination with minimal effort [7,15].

Furthermore, the flexibility of bike-sharing systems has led to a notable increase in biking populations. Users can spontaneously decide to bike for various reasons—whether for a quick errand, commuting to work, or enjoying a leisurely ride—without the prior need to own a bicycle. This flexibility has also facilitated the integration of biking into the multi-modal transportation network, allowing users to combine biking with public transit for longer commutes, thereby expanding the reach and efficiency of urban transportation systems [16,17]. The success of bike-sharing systems underscores the potential of innovative transportation solutions to transform urban mobility. By addressing the key barriers of flexibility and convenience traditionally associated with non-motorized travel, bike-sharing systems have not only increased the biking population but have also played a significant role in encouraging a more sustainable, active, and connected urban lifestyle [18].

In the United States, numerous cities have embarked on initiatives to encourage bike sharing, integrating zoning regulations that mandate the provision of bike parking and related facilities in close proximity to office buildings. Such regulatory measures are part of a broader strategy to integrate biking as a core component of urban mobility, acknowledging its benefits for reducing traffic congestion, improving air quality, and promoting physical activity among the population [1]. Since their inception around 2008, bike share programs have seen widespread adoption across various urban and academic settings, reflecting a growing recognition of their utility in enhancing urban transport networks. These programs vary significantly in terms of size and scope, tailored to meet the specific needs and capacities of each locale. For instance, New York City's Citi Bike program, launched in May 2013, has made a substantial impact by providing 6000 bicycles for public use, demonstrating the scale at which bike sharing can operate in a metropolis with dense urban fabric and high demand for flexible transportation options. Similarly, the Capital Bikeshare program in the Washington, D.C. area, offering over 3000 bicycles, exemplifies how bike sharing systems can serve as vital components of the transportation ecosystem in both cities and surrounding regions [19].

Despite numerous studies focusing on the motivations behind the utilization of bike share systems, there remains a scarcity of research into the demographic and socioeconomic characteristics of bike share users [7]. Understanding these characteristics is crucial for crafting targeted policies aimed at increasing bike share usage among less represented groups, thereby addressing underutilization [20]. Additionally, analyzing user characteristics can shed light on equity concerns related to the geographical distribution of bike share stations, guiding efforts to ensure equitable access to these services [21,22]. Furthermore, much of the existing research is confined to local or regional contexts, limiting the applicability of its findings. This study seeks to bridge this gap by conducting a national-level analysis, aiming to provide a more generalized understanding of bike share program usage and its implications for urban mobility and accessibility.

Previous research underscores the impact of historical physical activity behaviors on the current utilization of bicycles and bike share programs [23]. Fishman, Washington [24] identified that an individual's riding activity in the preceding month significantly predicts their use of bike share programs. Similarly, Rixey [25] supports this finding, indicating that individuals who habitually walked or cycled for commuting purposes were more inclined to participate in riding activities. These studies collectively suggest that individuals with a history of higher physical activity levels may have a different perception of—and potentially lower barriers to—using bikes and bike share programs compared to those with more sedentary lifestyles. This distinction underscores the need for tailored approaches in promoting bike and bike share usage, considering individuals' previous physical activity patterns.

The aim of this research is to delineate the socio-demographic profiles of individuals engaging in bicycle trips and utilizing bike share programs, leveraging data from the 2017 National Household Travel Survey (NHTS) in the United States. Furthermore, this study seeks to ascertain how these relationships are modulated by participants' historical levels of physical activity. Negative binomial regression models are employed to investigate the postulated associations, providing a nuanced understanding of the factors influencing bike and bike share usage. This study contributes to the existing literature by offering a comprehensive analysis of the socio-demographic and physical activity determinants of bike share program utilization at a national scale, a perspective that remains underexplored. By integrating the dimension of past physical activity, the research provides novel insights into how habitual exercise behaviors may influence current transportation choices. This dual focus not only enhances our understanding of the user base of bike share systems but also informs policy and program design aimed at increasing the adoption of biking as a sustainable mode of transport among diverse populations.

2. Materials and Methods

2.1. Data Source and Population

This study utilized data from the 2017 National Household Travel Survey (NHTS), conducted by the U.S. Department of Transportation, to examine the socio-demographic attributes of individuals who utilize bicycles and participate in bike sharing programs. The NHTS aims to gather detailed information on travel behavior, including the modes of transportation used, purposes of trips, and challenges encountered in adopting various travel modes, during a designated 24 h period starting at 4:00 a.m. and concluding at 3:59 a.m. the subsequent day. Acknowledging the variability in travel patterns across different days of the week, the study employed a sophisticated weighting methodology. This approach adjusted for both the day of the week and the month of travel, ensuring that the analysis could accurately represent typical travel behaviors and make the findings generalizable across different time periods [26].

The dataset employed in this analysis originates from a national representative random sample of households, collected between April 2016 and April 2017. It aimed to capture the civilian, non-institutionalized population of the United States, deliberately excluding individuals residing in prisons, rest homes, medical institutions, and living quarters housing 10 or more unrelated individuals. To qualify for inclusion in the survey, each household was required to have at least one resident aged 18 years or older. This selection criterion ensured that the survey responses would accurately reflect the travel behaviors and preferences of the adult population, excluding minors who, by law, might have different travel patterns and autonomy regarding travel decisions [26].

The 2017 National Household Travel Survey (NHTS) adopted an address-based sampling methodology alongside a self-administered web-based survey, intentionally including households with landline telephones. This approach was designed to broaden the demographic coverage of households across the United States and to minimize respondent burden and coverage bias. To facilitate participation, the survey administrators dispatched mailings to the sampled households containing detailed information about the survey, access instructions for the survey website, and a financial incentive to bolster response rates. Respondents were given the choice to either complete the survey online by logging into the designated website or return the filled-out survey form via mail [26].

The survey achieved substantial participation, with a total of 264,234 respondents. Among these respondents, 28,500 reported engaging in bike trips, and a smaller subset of 1276 individuals reported both participating in bike trips and using bike share programs. This extensive dataset provides a rich source of information for analyzing travel behaviors, specifically focusing on biking and bike share program utilization within the U.S. civilian, non-institutionalized population [26].

2.2. Variables and Measurements

In this study, the dependent variables were the count of bike trips and the count of bike share program usages, both of which are quantitative count measures. To select an appropriate statistical model for the analysis, initial steps involved calculating descriptive statistics for these two variables. This preliminary analysis revealed high ratios of variance to the mean, specifically 8.97 for the count of bike trips and 21.28 for the count of bike share program usage (Table 1). Such high ratios indicate a significant level of overdispersion in the data, which is a common characteristic in count data where the variance exceeds the mean.

Table 1. Tests for the negative binomial distribution for dependent variables.

	Count of Bike Trips	**Count of Bike Share Program Usage**
Test of a negative binomial distribution (H0: No over-dispersed issue)		
Ratio of variance to mean	8.97	21.28
Alpha	0.42	39.46
Likelihood-ratio test of alpha	2680.95	6196.26
p-value	<0.001	<0.001

To further validate the observed overdispersion, this study performed tests for a negative binomial distribution, a statistical method often employed in the analysis of count data that are over-dispersed. The results confirmed that both dependent variables exhibited over-dispersion. This finding is critical for model selection, as it suggests that standard Poisson regression models, which assume the mean and variance of the distribution to be equal, would not be appropriate for the data at hand. Instead, the evidence of overdispersion led to the selection of negative binomial regression models, which are better suited for analyzing count data when there is a significant discrepancy between the mean and variance, providing a more accurate and reliable analysis of factors influencing bike trip counts and bike share program usage.

In this analysis, a comprehensive set of independent variables was employed to investigate their impact on the count of bike trips and bike share program usage. These variables encompassed a range of socio-demographic factors, which include the following:

- Race: Categorized as White, African American, Asian, and Other.
- Ethnicity: Specifically identifying Hispanic individuals.
- Gender: Male or Female.
- Age: Considered as a continuous variable.
- Education Level: Segmented into four categories—less than high school, high school graduate, undergraduate degree, and graduate degree.
- Household Income: Segmented into four ranges—less than USD 15,000, USD 15,000 to USD 34,999, USD 35,000 to USD 74,999, and greater than USD 75,000.
- Population Density: Divided into four levels—less than 4000 per square mile, 4000 to 9999 per square mile, 10,000 to 24,999 per square mile, and 25,000 or more per square mile.
- Vehicle Ownership: The presence or absence of vehicles in the household.
- Household Size: The total number of individuals residing within the household.

- Past Level of Physical Activity: Quantified by the number of times participants engaged in light or moderate physical activity in the previous week.

Additionally, the study evaluated six potential barriers to bicycle use, including the absence of nearby paths or trails, poor sidewalk conditions or a complete lack of sidewalks, the absence of nearby parks, unsafe street crossings, heavy traffic, and inadequate nighttime lighting. These barriers were assessed using a binary (0 or 1) approach, indicating the presence or absence of each factor.

By incorporating these variables, the study aimed to provide a nuanced understanding of the various factors that influence individuals' decisions to use bikes and participate in bike-sharing programs. This approach allows for the identification of key demographic groups and barriers that could be addressed to increase cycling participation, offering valuable insights for policymakers and urban planners aiming to promote sustainable transportation.

Table 2 delineates the demographic and socioeconomic profiles of the survey respondents, distinguishing between the entire respondent pool, those who have taken bike trips, and those who have engaged in both bike trips and bike share program usage. A detailed analysis reveals significant disparities in several categories, including race, age, household income, and population density, while showing no substantial differences in education level or perceived barriers to cycling. White respondents showed a lesser inclination (69.94%, 95% Confidence Interval [CI]: 67.41–72.47) towards engaging in bike trips and bike share usage when compared to the overall demographics of the survey. This contrasts with African American (12.10%, 95% CI: 10.30–13.91) and Hispanic (18.45%, 95% CI: 16.31–20.58) participants, who were found to be more likely to utilize bike share programs than their counterparts from the general survey population. In terms of age, this study reveals that those individuals partaking in bike trips (average age 34.60, 95% CI: 34.33–34.86) and those using both bike trips and bike share services (average age 38.27, 95% CI: 37.12–39.43) are generally younger than the aggregate of survey respondents. However, the examination of education levels across the different groups did not showcase any significant disparities, indicating that educational attainment may not play a pivotal role in determining bike usage patterns.

Household income also emerged as a crucial factor. Respondents with a household income below USD 15,000 were more engaged in bike trips and bike share program usage (14.52%, 95% CI: 12.58–16.47) compared to the wider respondent pool. Furthermore, individuals living in areas with a population density greater than 25,000 per square mile exhibited a higher propensity (10.04%, 95% CI: 8.39–11.69) for such activities than the overall survey participants.

When it came to barriers preventing the use of bikes, the study found no significant differences among the various groups. This suggests that while certain socio-demographic factors such as race, age, income, and urban density influence biking behavior, perceived barriers to cycling might uniformly affect all groups without distinction.

2.3. Statistical Analyses

This research delved into the socio-demographic profiles and perceived barriers to cycling among various groups: the entire respondent pool, those who reported biking trips, and those who both cycled and utilized bike share programs. A key objective was to determine if significant differences existed among these subsets (Table 2).

To assess these differences, weighted t-tests were employed, specifically comparing individuals who reported biking trips against those who engaged in both biking trips and bike share program usage. Additionally, the study segmented respondents based on their level of physical activity, categorizing them as sufficiently active (engaging in moderate physical activity $\geq$5 times per week) or sufficiently inactive (engaging in moderate physical activity <5 times per week), using the past level of physical activity as the dividing metric. The investigation extended to examining differences in socio-demographic characteristics and cycling barriers between the sufficiently active and inactive groups through weighted t-tests, the results of which are summarized in Table 3.

Table 2. Characteristics of all respondents, respondents with bike trips, and respondents with bike trips and bike share program usage.

	All Respondents (N = 162,728)		Respondents with Biking Trips (N = 17,542)		Respondents with Biking Trips and Bike Share Program Usage (N = 785)		
	Weighted % or Mean (SD)	**95% CI ***	**Weighted % or Mean (SD)**	**95% CI**	**Weighted % or Mean (SD)**	**95% CI**	***p*-Value**
Race							
White	81.53	81.38–81.67	81.09	80.64–81.55	69.94	67.41–72.47	0.002
African American	7.39	7.29–7.49	6.23	5.95–6.51	12.10	10.30–13.91	0.012
Asian	4.59	4.51–4.67	4.38	4.14–4.62	7.83	6.35–9.32	0.015
Hispanic	9.12	9.01–9.23	10.21	9.86–10.56	18.45	16.31–20.58	0.007
Other	6.49	6.40–6.58	8.30	7.98–8.62	10.13	8.46–11.79	0.068
Gender							
Male	52.77	52.58–52.96	59.51	58.94–60.08	56.32	53.60–59.05	0.075
Female	47.23	47.04–47.42	40.49	39.92–41.06	43.68	40.95–46.40	0.066
Age	48.65 (0.04)	48.57–48.73	34.60 (0.14)	34.33–34.86	38.27	37.12–39.43	0.041
Education							
Less than high school	8.17	8.06–8.28	10.20	9.78–10.63	8.21	6.55–9.88	0.121
High school	19.74	19.58–19.90	11.61	11.16–12.06	17.10	14.81–19.38	0.045
Undergraduate	51.79	51.59–51.99	50.02	49.32–50.72	48.71	45.68–51.74	0.782
Graduate	20.30	20.14–20.46	28.17	27.54–28.80	25.98	23.32–28.64	0.856
Household income							
<USD 15,000	7.97	7.87–8.08	7.33	7.03–7.64	14.52	12.58–16.47	0.011
USD 15,000–USD 34,999	15.93	15.79–16.07	11.94	11.55–12.32	16.98	14.91–19.06	0.042
USD 35,000–USD 74,999	29.18	29.01–29.36	24.48	23.97–24.98	25.16	22.76–27.56	0.986
>USD 75,000	46.92	46.72–47.11	56.26	55.67–56.84	43.33	40.59–46.07	0.025
Population density							
<4000	70.09	69.91–70.26	65.72	65.17–66.27	55.29	52.56–58.03	0.032

Table 2. *Cont.*

	All Respondents (N = 162,728)		Respondents with Biking Trips (N = 17,542)		Respondents with Biking Trips and Bike Share Program Usage (N = 785)		
	Weighted % or Mean (SD)	**95% CI ***	**Weighted % or Mean (SD)**	**95% CI**	**Weighted % or Mean (SD)**	**95% CI**	***p*-Value**
4000–9999	22.76	22.60–22.92	25.33	24.83–25.84	24.94	22.56–27.32	0.622
10,000–24,999	5.46	5.37–5.54	6.73	6.43–7.02	9.73	8.10–11.35	0.235
>=25,000	1.70	1.65–1.75	2.22	2.05–2.39	10.04	8.39–11.69	0.002
Number of vehicles owned	2.24 (0.01)	2.23–2.25	2.22 (0.01)	2.21–2.23	1.93	1.86–1.99	0.023
Number of household members	2.70 (0.01)	2.69–2.71	3.20 (0.01)	3.18–3.22	2.91 (0.04)	2.82–2.99	0.025
No nearby paths or trails	75.17	73.84–76.49	75.15	73.82–76.47	70.77	65.45–76.10	0.862
No sidewalks or sidewalks are in poor condition	53.09	51.56–54.62	53.11	51.58–54.64	53.52	47.69–59.36	0.845
No nearby parks	32.27	30.83–33.70	32.27	30.84–33.71	35.92	30.30–41.53	0.953
Street crossings are unsafe	41.81	40.55–43.07	41.79	40.53–43.05	46.32	41.20–51.45	0.684
Heavy traffic with too many cars	76.68	75.60–77.75	76.69	75.61–77.77	74.66	70.19–79.13	0.725
Not enough lighting at night	43.18	41.92–44.44	43.17	41.90–44.43	43.60	38.50–48.69	0.858

* CI: Confidence interval.

Table 3. Characteristics of respondents who were insufficiently active and sufficiently active.

	Insufficiently Active (N = 103,276)		Sufficiently Active (N = 59,452)		
	Weighted % or Mean (SD)	95% CI	Weighted % or Mean (SD)	95% CI	p-Value
Race					
White	80.32	80.08–80.56	82.91	82.60–83.21	0.035
African American	8.24	8.08–8.41	6.26	6.06–6.45	0.021
Asian	5.24	5.11–5.38	4.53	4.37–4.70	0.022
Hispanic	9.23	9.06–9.41	8.49	8.26–8.71	0.019
Other	6.19	6.04–6.34	6.31	6.11–6.50	0.215
Gender					
Male	43.17	42.87–43.47	45.10	44.70–45.50	0.042
Female	56.83	56.53–57.13	54.90	54.50–55.30	0.045
Age	50.41	50.28–50.54	50.88	50.70–51.06	0.714
Education					
Less than high school	6.83	6.67–6.99	6.90	6.68–7.11	0.965
High school	19.56	19.32–19.81	22.04	21.69–22.39	0.032
Undergraduate	53.58	53.27–53.90	52.67	52.24–53.09	0.049
Graduate	20.02	19.77–20.28	18.40	18.07–18.72	0.036
Household income					
<USD 15,000	8.68	8.51–8.86	8.34	8.11–8.56	0.068
USD 15,000–USD 34,999	16.57	16.34–16.80	18.01	17.69–18.32	0.035
USD 35,000–USD 74,999	29.39	29.11–29.68	32.12	31.74–32.50	0.038
>USD 75,000	45.35	45.04–45.66	41.53	41.13–41.93	0.025
Population density					
<4000	69.20	68.92–69.49	72.23	71.87–72.59	0.034
4000–9999	23.44	23.18–23.69	21.37	21.04–21.70	0.021
10,000–24,999	5.63	5.49–5.77	4.97	4.79–5.14	0.042
>=25,000	1.73	1.65–1.81	1.44	1.34–1.53	0.038
Number of vehicles owned	2.16	2.15–2.17	2.22	2.21–2.23	0.043
Number of household members	2.61	2.59–2.62	2.63	2.61–2.64	0.071
No nearby paths or trails	72.90	70.53–75.26	75.21	72.26–78.17	0.108
No sidewalks or sidewalks are in poor condition	54.73	52.07–57.38	56.01	52.62–59.41	0.815
No nearby parks	34.64	32.10–37.17	35.97	32.68–39.25	0.766
Street crossings are unsafe	43.27	41.03–45.50	42.47	39.50–45.44	0.882
Heavy traffic with too many cars	73.75	71.77–75.74	73.34	70.69–75.99	0.806
Not enough lighting at night	45.97	42.72–49.22	51.45	48.45–54.49	0.624

CI: Confidential interval.

Given the observed over-dispersion in the dependent variables—specifically, the counts of bike trips and bike share program usage—this study used negative binomial regression models as the analytical tool. Negative binomial models were employed to analyze bike sharing count data for several reasons. First, the bike sharing data analyzed in this study (Table 1) exhibited significant over-dispersion. This finding is crucial as it indicates that the count data's variability cannot be accurately captured by Poisson regression models. Negative binomial models, however, are designed to accommodate over-dispersion by introducing an additional parameter to account for the extra variance, thus providing a more flexible and accurate modeling approach. Second, the primary research objectives of this study are to identify and analyze the factors influencing bike trip counts and bike share program usage. By using negative binomial models, the study aims to achieve accurate parameter estimates and reliable statistical inferences, which are critical for understanding these influencing factors. The model's robustness in handling over-dispersed data ensures that the conclusions drawn about the determinants of bike sharing activity are valid and reflective of the underlying patterns in the data. Third, the selection of negative binomial models is supported by previous studies on bike sharing that have demonstrated its superiority in analyzing count data [27,28]. These studies have shown that negative binomial models outperform Poisson models by providing a better fit and more reliable parameter estimates in the presence of over-dispersion. The analysis aimed to dissect how these factors correlate with the frequency of bike trips and bike share utilization, and further, how these relationships differ between individuals classified as sufficiently active and those deemed inactive based on their level of physical activity.

Tables 4 and 5 present the findings from these negative binomial regression analyses, which also integrated the weighting scheme from the National Household Travel Survey (NHTS) to ensure that the results are representative of national estimates. By applying this weight scheme, the study's findings offer insights with broader applicability, reflecting the diversity of the U.S. population and their travel behaviors.

Table 4. Model results for the count of bike trips.

	All Respondents			Insufficiently Active			Sufficiently Active		
	Coefficient	95% CI	*p*-Value	Coefficient	95% CI	*p*-Value	Coefficient	95% CI	*p*-Value
Race									
White	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
African American	−0.13	−0.26–0.01	0.052	−0.06	−0.25–0.12	0.512	0.24	−0.08–0.57	0.142
Asian	−0.14	−0.28–0.01	0.065	−0.04	−0.25–0.18	0.727	−0.16	−0.48–0.16	0.330
Hispanic	0.04	−0.08–0.15	0.547	−0.24 *	−0.43–0.06	0.011	0.37 **	0.09–0.65	0.009
Other	0.13	−0.01–0.25	0.062	0.15	−0.02–0.32	0.058	−0.16	−0.45–0.13	0.279
Gender									
Male	0.18 ***	0.11–0.24	<0.001	0.17 **	0.06–0.28	0.002	0.01	−0.14–0.16	0.884
Female	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
Age	−0.01 **	−0.02–0.01	0.001	0.01	−0.03–0.04	0.796	−0.01	−0.02–0.01	0.075
Education									
Less than high school	−0.05	−0.21–0.11	0.558	0.22	−0.03–0.46	0.087	−0.38	−0.77–0.02	0.064
High school	0.10	−0.02–0.22	0.110	0.19	−0.03–0.42	0.076	−0.15	−0.43–0.12	0.274
Undergraduate	−0.03	−0.11–0.04	0.374	0.12	−0.01–0.24	0.074	0.03	−0.15–0.21	0.743
Graduate	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
Household income									
<USD 15,000	0.45 ***	0.33–0.57	<0.001	0.25 *	0.06–0.45	0.010	0.36 **	0.11–0.62	0.005
USD 15,000–USD 34,999	0.07	−0.03–0.17	0.182	0.07	−0.09–0.24	0.375	0.09	−0.13–0.31	0.421
USD 35,000–USD 74,999	−0.02	−0.09–0.06	0.695	−0.01	−0.13–0.13	0.995	−0.08	−0.27–0.11	0.426
>USD 75,000	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.

Table 4. *Cont.*

	All Respondents			Insufficiently Active			Sufficiently Active		
	Coefficient	**95% CI**	***p*-Value**	**Coefficient**	**95% CI**	***p*-Value**	**Coefficient**	**95% CI**	***p*-Value**
Population density									
<4000	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
4000–9999	0.14 **	0.06–0.21	0.001	0.03	−0.09–0.16	0.642	0.25 **	0.07–0.43	0.005
10,000–24,999	0.12 *	0.01–0.24	0.048	0.37 ***	0.18–0.55	<0.001	0.12	−0.16–0.41	0.397
>=25,000	0.28 **	0.11–0.46	0.001	−0.01	−0.36–0.35	0.999	0.11	−0.39–0.62	0.667
Number of vehicles owned	−0.06 ***	−0.08−0.03	<0.001	−0.08 **	−0.13−0.03	0.003	−0.06 *	−0.13−0.01	0.037
Number of household members	−0.01	−0.04–0.01	0.303	0.01	−0.03–0.06	0.613	0.04	−0.03–0.10	0.297
No nearby paths or trails	0.01	−0.07–0.09	0.796	−0.16 *	−0.29–0.03	0.018	−0.08	−0.27–0.12	0.440
No sidewalks or sidewalks are in poor condition	−0.01	−0.09–0.07	0.790	−0.01	−0.12–0.11	0.903	−0.06	−0.24–0.12	0.508
No nearby parks	−0.01	−0.08–0.07	0.925	−0.04	−0.16–0.07	0.449	0.04	−0.12–0.21	0.610
Street crossings are unsafe	0.09	−0.02–0.15	0.059	0.07	−0.04–0.18	0.221	0.06	−0.09–0.22	0.415
Heavy traffic with too many cars	0.11	−0.03–0.20	0.058	−0.14 *	−0.27−0.01	0.048	−0.09	−0.27–0.10	0.360
Not enough lighting at night	0.06	−0.01–0.14	0.078	0.07	−0.05–0.19	0.236	−0.05	−0.22–0.12	0.549
Pseudo R^2		0.02		0.02			0.03		
N		2904		955			559		

CI: Confidence interval. Ref: Reference group. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 5. Model results for the count of bike share program usage.

	All Respondents			Insufficiently Active			Sufficiently Active		
	Coefficient	**95% CI**	***p*-Value**	**Coefficient**	**95% CI**	***p*-Value**	**Coefficient**	**95% CI**	***p*-Value**
Race									
White	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
African American	1.35 *	0.29–2.42	0.013	1.70	−0.29–3.68	0.094	1.47	−0.99–3.94	0.242
Asian	0.89	−0.25–2.02	0.125	1.66	−0.53–3.78	0.074	2.37	−0.31–5.04	0.083
Hispanic	1.65 **	0.66–2.64	0.001	1.76	−0.50–4.03	0.127	3.46 **	1.02–5.90	0.005
Other	0.63	−0.37–1.64	0.217	1.20	−1.10–3.50	0.308	0.78	−1.74–3.31	0.544
Gender									
Male	0.44	−0.11–0.99	0.120	0.06	−1.23–1.35	0.931	0.88	−0.38–2.15	0.171
Female	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
Age	−0.01	−0.02–0.01	0.535	−0.01	−0.06–0.03	0.563	−0.02	−0.09–0.05	0.096
Education									
Less than high school	−1.06	−2.55–0.44	0.165	−0.69	−3.69–2.31	0.652	0.24	−2.71–3.19	0.873
High school	1.10 *	0.17–2.02	0.020	3.40 **	0.97–5.83	0.006	1.60	−0.51–3.72	0.138
Undergraduate	0.34	−0.31–0.99	0.305	1.67 *	0.18–3.16	0.028	0.84	−0.84–2.51	0.327
Graduate	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
Household income									
<USD15,000	1.39 *	0.31–2.46	0.012	0.28	−2.07–2.64	0.814	1.09	−1.26–3.43	0.363

Table 5. *Cont.*

	All Respondents			Insufficiently Active			Sufficiently Active		
	Coefficient	**95% CI**	***p*-Value**	**Coefficient**	**95% CI**	***p*-Value**	**Coefficient**	**95% CI**	***p*-Value**
USD 15,000–USD 34,999	−0.26	−1.10–0.58	0.540	0.26	−1.42–1.94	0.759	0.01	−1.84–1.86	0.992
USD 35,000–USD 74,999	0.18	−0.47–0.82	0.591	0.32	−1.26–1.90	0.691	0.11	−1.31–1.53	0.882
>USD 75,000	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
Population density									
<4000	Ref.		Ref.	Ref.		Ref.	Ref.		Ref.
4000–9999	0.20	−0.53–0.94	0.587	0.88	−0.74–2.50	0.287	−1.62	−3.33–0.09	0.064
10,000–24,999	0.26	−0.80–1.32	0.636	0.17	−1.65–1.99	0.858	−1.12	−3.62–1.39	0.382
>=25,000	1.89 *	0.36–3.42	0.016	0.65	−2.60–3.90	0.694	2.67	−0.95–6.28	0.148
Number of vehicles owned	−0.01	−0.29–0.29	0.998	0.40	−0.35–1.16	0.292	0.01	−0.67–0.67	0.999
Number of household members	0.19	−0.07–0.46	0.156	−0.13	−0.65–0.39	0.629	−0.32	−1.06–0.42	0.397
No nearby paths or trails	−0.02	−0.71–0.67	0.961	0.50	−0.98–1.98	0.511	−1.31	−2.94–0.31	0.114
No sidewalks or sidewalks are in poor condition	−0.11	−0.79–0.58	0.760	0.13	−1.29–1.55	0.856	0.29	−1.12–1.70	0.684
No nearby parks	−0.26	−0.86–0.33	0.385	0.46	−0.82–1.74	0.481	0.18	−1.20–1.56	0.795
Street crossings are unsafe	0.28	−0.27–0.83	0.324	−0.78	−1.95–0.39	0.190	−0.38	−1.73–0.97	0.581
Heavy traffic with too many cars	−0.20	−0.86–0.47	0.564	0.65	−0.83–2.12	0.390	0.79	−0.91–2.48	0.363
Not enough lighting at night	−0.20	−0.79–0.39	0.503	−0.42	−1.68–0.83	0.510	−0.24	−1.71–1.23	0.751
Pseudo R^2		0.03		0.04			0.07		
N		2891		947			558		

CI: Confidence interval. Ref.: Reference group. * $p < 0.05$; ** $p < 0.01$.

The statistical software Stata was employed for all analyses, facilitating the application of complex model specifications and the interpretation of the interactions between numerous independent variables and the dependent variables of interest. Through this rigorous approach, the research provides a detailed examination of the factors that promote or hinder bike and bike share program usage, contributing valuable perspectives to the field of transportation and urban planning, especially regarding the promotion of active transportation modes within varied demographic segments.

3. Results

Out of the 162,728 survey respondents, 10.78%, equivalent to 17,542 individuals, reported engaging in bike trips. Within this subgroup of cyclists, a smaller fraction, 4.48% or 785 respondents, had participated in bike share programs. Among those who utilized bike share services, the average number of bike trips stood at 3.79. This average is statistically higher, with a t-value of 2.30 and a significance level of $p < 0.05$, compared to those who cycled but did not use bike share programs, who had an average of 3.50 bike trips. This significant difference suggests that bike share program users tend to engage in bicycling more frequently than those who do not use such programs, indicating that access to bike share services may encourage more frequent cycling activities.

Table 3 elucidates the characteristics of respondents categorized by their level of physical activity, distinguishing between those deemed insufficiently active and those sufficiently active, across various socio-demographic dimensions such as race, gender, age, education level, household income, population density, vehicle ownership, household size, and perceived barriers to cycling.

Although the differences were not substantial, the analysis revealed racial disparities in physical activity levels, with a higher percentage of White respondents reported as being sufficiently active (82.91%, 95% CI: 82.60–83.21) compared to those insufficiently active (80.32%, 95% CI: 80.08–80.56). Conversely, the proportions of African Americans, Asians, and Hispanics who were sufficiently active were found to be lower than their counterparts in the insufficiently active category. Gender differences were also observed, although they were not substantial, with a greater percentage of males being classified as sufficiently active (45.10%, 95% CI: 44.70–45.50) in contrast to those insufficiently active (43.17%, 95% CI: 42.87–43.47).

When examining the influence of education level, no clear pattern emerged, suggesting that educational attainment might not significantly correlate with physical activity levels. However, income levels showed a different picture, where individuals in higher income brackets (USD 15,000–USD 34,999 and USD 35,000–USD 74,999) were more likely to be sufficiently active compared to their lower-income peers.

Population density also played a role, with those living in less densely populated areas (<4000 per square mile) reporting higher levels of sufficient activity (72.23%, 95% CI: 71.87–72.59) than those in the insufficiently active group (69.20%, 95% CI: 68.92–69.49). Interestingly, vehicle ownership was higher among the sufficiently active (2.22, 95% CI: 2.21–2.23) than in the insufficiently active group (2.16, 95% CI: 2.15–2.17), indicating that access to more vehicles did not deter physical activity. Lastly, no significant disparities were found in terms of barriers to biking between the sufficiently and insufficiently active groups, suggesting that perceived obstacles to cycling affect both groups similarly.

Table 4 presents the outcomes of negative binomial regression analyses focused on the count of bike trips among all respondents. The analysis reveals nuanced insights into how various factors correlate with the likelihood and frequency of engaging in biking activities. For all respondents, racial demographics did not emerge as a significant determinant of bike trip frequencies, indicating that within the scope of this study, race alone does not materially affect the number of bike trips taken by individuals. However, gender showed a significant influence, with males being more likely to undertake more bike trips than females, as evidenced by a positive coefficient of 0.18 ($p < 0.001$).

Age played a notable role, with a negative coefficient of -0.01 ($p < 0.01$) suggesting that younger individuals tend to have more bike trips compared to their older counterparts, highlighting a demographic tilt towards younger bikers in terms of biking frequency. Education levels did not significantly impact the number of bike trips, suggesting that educational attainment is not directly correlated with biking activity levels. Income levels, however, were a significant predictor, with individuals from lower income brackets (<USD 15,000) engaging in significantly more bike trips than those in the highest income category (>USD 75,000), as indicated by a coefficient of 0.45 ($p < 0.001$). This may reflect economic incentives or necessities driving lower-income individuals to opt for biking as a cost-effective mode of transportation.

Urban density also influenced biking behaviors, with respondents residing in areas of moderate (4000–9999 per square mile; coefficient = 0.14, $p < 0.01$) and high (10,000–24,999 per square mile; coefficient = 0.12, $p < 0.05$, and >=25,000 per square mile; coefficient = 0.28, $p < 0.01$) population densities reporting more bike trips than those in the least dense areas (<4000 per square mile). This trend underscores the role of urban environments in facilitating or encouraging biking as a viable and preferred mode of transport. Vehicle ownership presented a negative association with biking frequency (coefficient = -0.06, $p < 0.001$), indicating that households with more vehicles tended to have fewer bike trips. This could suggest that greater access to vehicles may reduce the reliance on or preference for biking as a mode of transportation.

The subgroup analysis based on the level of physical activity reveals intriguing patterns in biking behavior among different demographic and socioeconomic segments. This analysis specifically differentiates between respondents who were insufficiently active and those who were sufficiently active, offering a nuanced understanding of how physical activity levels intersect with other factors to influence biking habits. For racial demographics, activity level played a critical role. Among the insufficiently active, Hispanics had significantly fewer bike trips (coefficient = −0.24, $p < 0.05$) compared to their White counterparts. Conversely, sufficiently active Hispanics were more likely to engage in biking (coefficient = 0.37, $p < 0.01$) than sufficiently active Whites, highlighting how physical activity levels can accentuate or reverse racial disparities in biking engagement.

Gender differences were pronounced within the context of physical activity. Insufficiently active males were notably more likely to have more bike trips (coefficient = 0.17, $p < 0.01$) compared to insufficiently active females, pointing to gendered patterns in how biking is adopted among those with lower levels of overall physical activity. Income levels consistently influenced biking frequency across both activity levels. Low-income individuals (<USD 15,000) in both the sufficiently (coefficient = 0.25, $p < 0.05$) and insufficiently active (coefficient = 0.36, $p < 0.01$) cohorts undertook more biking trips than those from high-income backgrounds (>USD 75,000), underscoring the economic dimension of biking as an affordable transportation option.

Urban density emerged as a significant factor, with individuals living in moderately and highly dense areas engaging in more biking trips than those in less dense environments, irrespective of their physical activity level. This trend was particularly strong among insufficiently active individuals living in areas with 10,000–24,999 people per square mile (coefficient = 0.37, $p < 0.001$) and sufficiently active individuals in areas with 4000–9999 per square mile (coefficient = 0.25, $p < 0.01$). Vehicle ownership was inversely related to biking frequency in both physical activity groups, with more vehicles leading to fewer bike trips (insufficiently active: coefficient = 0.08, $p < 0.01$; sufficiently active: coefficient = −0.06, $p < 0.05$), suggesting that access to alternative forms of transportation reduces the reliance on biking.

Interestingly, the perception of barriers to biking, such as the absence of nearby paths or trails and heavy traffic, significantly deterred biking trips among the insufficiently active group (no nearby paths or trails: coefficient = −0.16, $p < 0.05$; heavy traffic: coefficient = −0.14, $p < 0.05$), indicating that environmental and infrastructure barriers can have a more pronounced impact on those less engaged in regular physical activity. This insight highlights the importance of addressing physical and perceived barriers to encourage biking across different levels of physical activity.

Table 5 details the outcomes from negative binomial regression analyses focusing on the frequency of bike share program usage among different demographic and socioeconomic groups. These results provide insights into the characteristics of individuals who are more inclined to use bike share programs.

Significantly, the analysis shows that racial and ethnic minorities, specifically African Americans (coefficient = 1.35, $p < 0.05$) and Hispanics (coefficient = 1.65, $p < 0.01$), are more likely to frequently use bike share programs compared to White respondents. This finding suggests that bike share programs may be particularly appealing or accessible to these groups, possibly due to their locations or the targeted outreach of these programs.

Educational attainment also plays a role in bike share usage, with individuals holding a high school degree (coefficient = 1.10, $p < 0.05$) being more likely to use these programs than those with a graduate degree. This could reflect a variety of factors, including differences in commuting needs, preferences, or the distribution of bike share stations relative to educational institutions and residential areas.

Income levels were another significant determinant of bike share program usage. Individuals with lower incomes (<USD 15,000) (coefficient = 1.39, $p < 0.05$) showed a higher likelihood of using bike share programs than those in the highest income bracket (>USD 75,000). This trend might indicate the cost-effectiveness and accessibility of bike share programs as an alternative mode of transportation for lower-income populations. Moreover, urban density emerged as an important factor influencing bike share program usage. Residents of highly dense areas (>=25,000 per square mile) (coefficient = 1.89, $p < 0.05$) were significantly more likely to use bike share programs than those living in less densely populated areas (<4000 per square mile). This pattern underscores the importance of location and urban infrastructure in facilitating access to and utilization of bike share programs, reflecting the role of urban planning and density in promoting sustainable transportation options.

The subgroup analyses of bike share program usage offer further insights, particularly highlighting differences in usage patterns based on physical activity levels, ethnicity, age, and education. Sufficiently active Hispanics demonstrated a significantly higher frequency of bike share program usage (coefficient = 3.46, $p < 0.01$) compared to their White counterparts who were also sufficiently active. This indicates that among those who are physically active, ethnic and cultural factors may influence the choice to use bike share programs, with Hispanics showing a stronger inclination towards these services. Age emerged as a factor among sufficiently active individuals, with older participants being less likely to use bike share programs (coefficient = −0.04, $p < 0.05$) compared to younger users. This suggests that younger, physically active individuals are more drawn to or able to integrate bike sharing into their mobility habits, possibly due to varying lifestyle needs or preferences between age groups. Education level influenced bike share usage differently across activity levels. Among the insufficiently active, those with lower education levels (high school: coefficient = 3.40, $p < 0.01$; undergraduate: coefficient = 1.67, $p < 0.05$) were more likely to utilize bike share programs than those with a graduate degree. This pattern could reflect socioeconomic factors where individuals with lower educational attainment, and potentially lower income, find bike sharing a more accessible or appealing transportation option compared to more highly educated individuals.

4. Discussion

This research utilized the 2017 National Household Travel Survey (NHTS) to conduct a comprehensive examination of the socio-demographic characteristics of users of bikes and bike share programs on a national scale, further distinguishing the behaviors between individuals classified as sufficiently active and those deemed inactive. Consistent with the existing literature, the study identified that male and younger participants were more engaged in biking activities compared to their female and older counterparts. This aligns with previous findings that suggest gender and age not only reflect physical ability but also significantly influence the propensity and frequency of cycling [7].

The subgroup analysis revealed nuanced differences in biking behavior related to physical activity levels. Specifically, among the insufficiently active, males reported more bike trips than females, a disparity not observed within the sufficiently active group. This pattern underscores the potential for biking to serve as a crucial avenue for enhancing physical activity, particularly among women [29]. The difference in the average number of biking trips between active (0.30, 95% CI: 0.28–0.32) and inactive (0.15, 95% CI: 0.14–0.16) females highlights an opportunity for increasing physical activity through cycling among women. Therefore, this study suggests that barriers to cycling among females warrant further investigation beyond the simplistic attribution to lower cycling ability. Identifying and addressing these barriers could significantly contribute to promoting biking as an accessible form of physical activity for women, potentially narrowing the gender gap in cycling participation [30]. The implications of these findings are crucial for urban planners, policymakers, and public health officials aiming to design more inclusive and supportive environments for cycling, thereby enhancing the overall health and mobility of the population.

This study found that households owning more vehicles reported fewer bike trips, a trend that persisted across different levels of physical activity. This observation suggests that the availability of private cars, which offer a direct, safer, and more convenient form of transportation, especially in auto-centric environments, may disincentivize bike use [31]. The convenience and perceived safety of door-to-door service by private vehicles can overshadow the benefits of cycling, such as cost savings, physical activity, and environmental friendliness, particularly in urban settings designed to prioritize car travel. This finding aligns with research by Fishman, Washington [32], which highlighted the reciprocal relationship between cycling and vehicle use. Their study suggested that an increase in biking trips and bike share program usage could lead to a decrease in the reliance on personal vehicles, thereby reducing overall vehicle miles traveled. This potential reduction in vehicle usage not only contributes to lower transportation costs for individuals but also has broader societal benefits, including decreased traffic congestion, reduced greenhouse gas emissions, and improved air quality. Therefore, the evidence suggests that encouraging bike and bike share program use could serve as a strategic component of sustainable urban mobility plans [33]. By providing safe, convenient, and accessible cycling infrastructure and programs, cities can potentially shift travel behavior away from private vehicle dependency towards more sustainable modes of transport, aligning with goals for healthier communities and environmental sustainability.

The findings of this study illuminate a distinct pattern within the Hispanic community regarding biking behavior and its correlation with physical activity levels. Hispanics who were categorized as insufficiently active demonstrated a lower likelihood of engaging in biking trips. Conversely, those who were sufficiently active not only participated in more biking trips but also utilized bike share programs more frequently. This contrast underscores the significance of past physical activity levels as a pivotal factor influencing biking habits among Hispanics. This result suggests that physical activity predisposition plays a crucial role in determining the propensity towards biking and bike share usage within this demographic. Given this relationship, there appears to be a substantial opportunity for targeted programs aimed at promoting physical activity among Hispanics. Such initiatives could play a vital role in encouraging biking as a regular mode of transportation and recreation within this community. Developing programs specifically designed to increase the level of physical activity among Hispanics could, therefore, significantly enhance bike and bike share usage. These programs could focus on addressing barriers to physical activity, such as providing culturally sensitive resources, ensuring access to safe biking infrastructure, and creating community-based initiatives that promote cycling as an enjoyable and beneficial form of exercise. By fostering a greater engagement with physical activity, these targeted efforts have the potential to elevate biking as a preferred and frequent mode of transport among Hispanics, contributing to healthier lifestyles and more sustainable urban mobility.

The findings of this study highlight the pronounced usage of bike share programs among minority populations, such as African Americans and Hispanics, compared to White populations. Additionally, individuals with lower income and those who have only attained a high school education were found to use bike share programs more frequently than their higher-income and more highly educated counterparts. These patterns clearly indicate a significant reliance on and need for bike share systems among minority and low-income communities, underscoring the importance of making these services accessible to underserved populations. However, research conducted by Ursaki and Aultman-Hall [19] on the accessibility of bike share systems in major U.S. cities, including Chicago, Denver, Seattle, and New York City, revealed an inequitable distribution of bike share stations. Their study found that the placement of these bike share facilities often does not align with the demographics that most frequently use them, particularly concerning race, income, and education level. This discrepancy suggests that despite the apparent need for and reliance on bike share systems by certain demographic groups, the infrastructure does not adequately cater to their accessibility needs. Therefore, it becomes imperative to align the deployment of bike share systems with the actual demand from these critical user groups. By strategically locating bike share stations in neighborhoods that are predominantly inhabited by minority and low-income populations, cities can ensure that the benefits of bike sharing—such as affordable transportation, reduced traffic congestion, and lower greenhouse gas emissions—are equitably distributed. This approach not only addresses the mobility needs of underserved communities but also contributes to the broader objectives of social equity and environmental sustainability in urban transportation planning. Addressing these disparities in bike share system distribution is essential for creating more inclusive cities that support the mobility and well-being of all residents.

The study's findings indicate that individuals residing in areas of high population density are more frequent users of bike share programs compared to those in lower density regions. This observation aligns with the expectation that high-density areas typically boast more comprehensive non-motorized infrastructure, superior transit service networks, and a greater number of daily destinations within a reachable distance. Such characteristics foster a conducive environment for bike share usage, where the shorter distances to destinations serve as a compelling motivator for choosing bike sharing over other modes of transportation [34,35].

The convenience offered by proximity to destinations in high-density areas underscores the role of environmental and infrastructural factors in encouraging bike share program use. The motivation to use bike share systems is significantly influenced by the ease of accessing bikes, with the distance from home to bike docking stations identified as a critical determinant of bike share utilization [32,36]. Previous research has consistently highlighted the significance of this proximity, demonstrating that the closer individuals live to bike docking stations, the more likely they are to utilize bike share services [7,37]. This relationship between population density, infrastructure availability, and bike share usage emphasizes the need for urban planners and policymakers to consider the spatial distribution of bike share stations as part of broader sustainable mobility strategies [38,39]. By strategically placing bike docking stations in high-density areas and ensuring the accessibility of these services to a wide range of residents, cities can enhance the attractiveness and practicality of bike sharing. This approach not only supports the goals of increasing sustainable transportation options but also contributes to the overall livability and accessibility of urban environments.

The insignificance of barrier-related variables in influencing both bike trips and bike share program usage among all respondents suggests that the overarching importance of convenience may overshadow the impact of infrastructure-related barriers (such as the lack of paths or trails, sidewalks, and parks) and safety-associated obstacles (including unsafe street crossings, heavy traffic, and insufficient nighttime lighting). This finding aligns with insights from an Australian study [24], which highlighted that convenience-related concerns, particularly the location of docking stations, ranked significantly higher than safety concerns among bike share users. This suggests that when users perceive bike sharing as convenient, infrastructure and safety barriers may become less deterrent to usage. However, a different pattern emerges among those classified as insufficiently active, where the absence of nearby paths or trails and the presence of heavy traffic were identified as significant negative correlates of biking behavior. This indicates that individuals who engage in lower levels of physical activity are more acutely affected by the availability of supportive infrastructure and safety from traffic. For these individuals, the physical environment plays a crucial role in determining whether they choose to bike, pointing to the sensitivity of less active individuals to external barriers to biking. Given these findings, addressing infrastructure and safety concerns could be particularly effective in encouraging bike use among the insufficiently active segment of the population [40]. Improving the availability and quality of biking infrastructure, ensuring safe crossings, and reducing traffic exposure for cyclists can make biking a more attractive option for those currently leading more sedentary lifestyles. By focusing on removing these barriers, urban planners and policymakers can enhance the appeal of biking and bike sharing, potentially increasing physical activity levels and promoting healthier lifestyles among less active individuals. This approach underscores the need for targeted interventions that consider the specific needs and sensitivities of different user groups to effectively promote biking as a viable and preferred mode of transportation.

This study, while offering valuable insights into the socio-demographic characteristics of bike and bike share program users, is not without its limitations. First, the reliance on survey data introduces the potential for recall bias, as respondents may not accurately remember or report their travel activities over the past week. This limitation could affect the precision of the data regarding bike usage patterns. Second, the scope of this analysis was primarily focused on exploring the socio-demographic aspects of biking and bike share usage at a national level, which meant that the potential impact of the surrounding built environment was not considered. Factors such as the availability of bike facilities, bike parking, and amenities like showers for cyclists [41], which can significantly influence biking behavior, were outside the purview of this study. This omission suggests that future research could benefit from incorporating these environmental elements to provide a more comprehensive understanding of the determinants of bike and bike share usage [42]. Moreover, the low value of the R^2 extracted from the models may suggest that bike trips are influenced by a wide range of factors beyond socio-demographic variables, including personal preferences, environmental conditions, and situational contexts. Consequently, the model may not encompass all predictors due to data limitations. Factors such as weather conditions, bike availability, infrastructure quality, and safety perceptions are likely to significantly influence bike trip counts, yet they may not be adequately represented in the model. Last, this study's exclusive focus on biking activities presents another limitation. A more holistic approach that examines the integration of biking with other modes of travel—before or after bike trips—could yield deeper insights into multimodal travel behaviors. Understanding how biking fits into the broader context of active travel, including walking and public transit use, could offer valuable information for crafting policies that encourage sustainable and active transportation options. Future studies that investigate these trip chains and the interplay between different modes of travel could play a crucial role in informing urban mobility strategies and policy development aimed at promoting healthier, more sustainable urban environments.

5. Conclusions

Utilizing data from the 2017 National Household Travel Survey (NHTS), this study conducted a national-level exploration into the socio-demographic characteristics of bike and bike share program users. The findings reveal that certain demographic groups, particularly males and younger individuals, are more inclined towards higher rates of bike usage. Moreover, the analysis highlighted that minority and low-income populations tend to utilize bike share programs with greater frequency. Additionally, residents of high-density urban areas were found to be more frequent users of these programs.

These insights underscore the necessity for policy development and urban planning to consider the specific needs and preferences of distinct population segments in relation to biking facilities and services. Addressing the unique requirements of these groups can enhance the accessibility and appeal of bike and bike share programs, contributing to broader transportation equity and sustainability goals.

One key policy implication is the need for targeted infrastructure development. For instance, in New York City, expanding bike lanes in high-density areas has significantly increased bike usage among residents, particularly in low-income neighborhoods. Therefore, prioritizing the development of bike lanes and bike-friendly infrastructure in high-density urban areas and underserved communities can improve accessibility and safety for frequent users.

Another important policy recommendation is the implementation of subsidized bike share programs. Real-world evidence from cities like Boston, which have implemented subsidized bike share memberships for low-income residents, shows increased program usage among minority and low-income populations. Thus, implementing or expanding subsidies for bike share programs targeting low-income and minority populations can make biking more affordable and attractive.

Engaging younger populations through youth engagement programs can foster the early adoption of cycling. For example, Seattle's "Safe Routes to School" program has successfully increased biking rates among younger individuals by providing safe and accessible biking routes to educational institutions. Developing similar programs focused on engaging younger populations, such as safe biking routes to schools and recreational areas, can further encourage biking. Furthermore, integrating bike share stations with public transportation networks provides seamless multimodal transport options. In San Francisco, the integration of bike share stations with public transit hubs has facilitated multimodal transportation, increasing overall bike usage. Integrating bike share stations with public transportation networks can make it easier for residents to incorporate biking into their daily commutes.

Given the complexity of factors influencing bike share program usage, further research is imperative to unravel the underlying mechanisms driving these patterns. A deeper understanding of these dynamics can aid in the creation of more targeted and effective strategies to promote cycling as a viable and attractive mode of transportation for diverse urban populations. Such studies are essential for refining policy interventions and fostering a more inclusive and sustainable urban mobility landscape.

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