Article

Bike Share Equity for Underrepresented Groups: Analyzing Barriers to System Usage in Baltimore, Maryland

Susan Hull Grasso 1,*, Philip Barnes 1 and Celeste Chavis 2

1 Institute for Public Administration, Biden School of Public Policy and Administration, University of Delaware, Newark, NJ 19716, USA; pbarnes@udel.edu
2 Department of Transportation & Urban Infrastructure Studies, School of Engineering, Morgan State University, Baltimore, MD 21251, USA; celeste.chavis@morgan.edu

* Correspondence: shgrasso@udel.edu

Received: 28 July 2020; Accepted: 10 September 2020; Published: 15 September 2020

Abstract: Bike share systems are a standard feature of the urban mobility ecosystem but they have received criticism for serving a narrow demographic band of residents and visitors while underrepresenting others. This analysis employed Chi-square and multivariate linear regression analyses to understand effect sizes associated with how various demographic groups in Baltimore, MD perceive barriers to utilizing the city’s new Baltimore Bike Share (BBS) system. The analysis revealed that people of color, Hispanics, the less-educated, females, low income earners, and the unemployed are underrepresented in system membership. Regression analysis of non-user survey data suggested that nonwhite individuals are associated with a moderate increase in perceiving BBS to be challenging when riding with children or cargo. Being female is associated with concerns about system use, the ability to ride comfortably, maintaining personal hygiene, being a victim of crime or harassment, and an overall lack of interest in biking in Baltimore. Identifying as having low income or less education was not observed to be associated with any of the barrier conditions examined in this study. These findings can be leveraged to develop programs and policies to improve participation rates within underrepresented groups and enhance system equity.

Keywords: transportation equity; bike share equity; bike share barriers; equity analysis; bike share systems; regression analysis; chi square analysis; survey research

1. Introduction

Cities across the United States, both large and small, are embracing bike sharing as an essential public service and quality-of-life enhancer. In addition to improved public health, advocates frequently cite decreased carbon emissions, reduced traffic congestion, and enhanced economic development as sustainable benefits of these systems [1].

Bike share systems, like other mobility modes, are not immune from criticism, however. A common critique is that the systems are inequitable because they serve a narrow segment of a city’s population while failing to reach other individuals [2]. Indeed, having ridership that reflects the demographics of a community is often a goal of efforts that promote bike share equity [3] (p. 17). Research has shown, however, that bike share users are predominately white, non-Hispanic, male, highly educated, employed, and high-income earners [4–9]. This lack of sociodemographic representativeness in bike share system usage has compelled system operators to understand the extent to which adequate access, or “equity of opportunity”, has been provided, even if less agreement on the need for “equity of outcome” exists [10] (p. 9).
There are multiple avenues available for investigating transportation equity depending on the type of equity, categories of people, units of measure, and impacts under consideration [10] (p. 2). Though nascent and not yet well-defined in the bike share literature, “bike share equity is generally conceptualized as addressing barriers to accessing bike share in order to create greater accessibility for targeted populations” [3] (p. 17). To be sure, demographic groups that are underrepresented in bike share usage may face unique challenges that factor into low participation rates. It is therefore important to research bike share equity by analyzing individual perceptions of barriers to usage. Understanding the factors that contribute to the unequal uptake of bike share is necessary so that vertical equity—that is the appropriate and fair distribution of costs and benefits among groups that differ by income or social class [10] (p. 4)—can be enhanced through programmatic and policy changes.

In this paper, we aimed to contribute to this knowledge gap by analyzing how different socioeconomic groups, traditionally underrepresented in bike share programs, perceive challenges to adopting bike share. This work was conducted as part of a larger effort to understand bike share usage and develop recommendations to advance equitable access to, and uptake of, the bike share system in Baltimore, Maryland [11]. Using statistical measures of association from a sample population in Baltimore, we explored the extent to which being a member of a traditionally underrepresented demographic group is likely to be associated with perceiving certain conditions as bike share barriers. Strong and statistically significant associations indicate opportunities for intervention to increase access for underrepresented communities.

The paper is organized as follows. Section 2 reviews past research on impediments to the uptake of bike share by underrepresented communities. Section 3 explains the research approach to understand barriers to entry. Analytical results are provided and interpreted in Sections 4 and 5. In Section 6, the paper concludes with final remarks concerning the broader implications of the study of bike share equity in Baltimore to inform the design and implementation of policies and programs to enhance system equity.

2. Barriers to Bike Share

Previous research has pointed to a wide range of conditions that may dissuade the use of bike share systems by members of the public, particularly underrepresented populations. Factors that effectively limit access to biking and bike sharing may be amenable to change through transportation practices and policies. The barriers raised below relate both to the physical nature of biking and those associated with accessing and using bike share systems.

2.1. Barriers Related to Biking

Several bike share studies have demonstrated that underrepresented communities, including low income groups, people of color, and women, are concerned about the safety of riding on the streets with traffic and a lack of quality cycling infrastructure [6,12–16].

Further, immigrants may be less likely to know how to ride bikes or understand rules of the road, bicyclist rights and responsibilities, and legal liability [17]. Barriers to bicycling for underrepresented groups also include concern over possible mechanical issues with a bicycle and the impact of weather or exertion on appearance [6,13,18].

Negative perceptions around bicycling in general is a significant barrier to bike share usage [19]. Biking can evoke mixed associations among traditionally underrepresented communities, from being a form of transportation used by professional business people to an indicator that one is not successful [6,15,16]. Bicycles have also been associated with drug dealers and perceived as symbols of gentrification [17,19,20].

Several studies revealed concerns among socioeconomically underrepresented groups about potential interactions with police—as either a victim of crime or target of police attention—while using bike share, even in cases of theft, accidents, or injuries related to biking [6,13,17,21]. In addition,
the presence of violent crimes along routes has been found to be a deterrent to choosing to bicycle, potentially exposing these vulnerable users to threats of personal injury [22].

2.2. Barriers Related to Bike Share

Accessing bike share systems poses a number of additional challenges. Several studies point to the need for convenient and useful docking station locations that provide connections to daily errand destinations like employment, grocery stores, social services, recreation opportunities, and dense residential populations [12,13,15,19,23,24]. These concerns extend to a need for stations near important destinations. A spatial mismatch may exist between low-income communities and access to jobs [6,23,25,26]. As a result of this mismatch, bicycle rental time limits may not be long enough [15,16,27] and bike share operators may be limited in their ability to serve underrepresented areas [19].

Previous research has also identified confusion and insufficient information about how to use and pay for bike share systems [6,12,16,19,23,28–30]. Misconceptions include believing helmets are required, thinking that the bike locks would automatically lock if time limits were exceeded, and having questions about the cost of the service. The act of biking is also often perceived as having recreational value rather than transportation utility [6,14]. Language barriers in particular pose a significant challenge for encouraging the use of bike share systems among non-English speakers [15,19,23].

Regarding registering and paying for bike share systems, a lack of internet and mobile wireless access is a potential barrier for low-income populations [6,16,19,23]. Yet, Freedman [27] reported that the majority of low-income residents in Boston do have access to registration and payment sites. Requiring a credit or debit card to sign up allows for efficient billing of users and equally serves as collateral [31], but poses problems for those who are unbanked, the majority of whom are low-income individuals [6,16,19,23]. Conversely, lack of access to credit or debit cards was not found to be a concern among some low-income communities [15,27]. Estimates for the entire unbanked population vary from 7.7% to 22%, but African-Americans and Hispanics are overrepresented in these statistics [31].

Concern about the inability to carry children or cargo while using bike share services was expressed in a number of studies [13,15–17]. Indeed, lower income people of color are more likely to have children at home, which indicates that child transport options are a barrier [6].

Finally, concerns about the cost of rentals and bike liability were raised in some studies [6,12,19]. Bike sharing base annual membership rates cost about the same as a monthly transit pass in most cities [15], which is an important threshold identified in equity studies [13,16].

3. Materials and Methods

This examination of the association of barriers to bike sharing with particular constituencies was conducted on the Baltimore Bike Share (BBS) system in Baltimore, Maryland. BBS was launched in 2016 to support the city’s “network of sustainable transportation options” [32], but was almost immediately accused of introducing an ill-conceived and inequitable public service program with racially charged claims that Baltimore’s “bike-share perpetuates [the city’s] transit apartheid” [33]. This debate about the equity impact of bike sharing presented an opportunity to contribute to research on this topic in a new urban setting and with a unique methodological approach.

3.1. Research Setting

After a history marked by consecutive periods of starts and stops, the BBS rolled out in two phases, with the first 20 docking stations opening in the downtown and Inner Harbor area in October 2016 [34]. The expansion of the system was delayed because of supply chain and maintenance backlog challenges, and a problematic theft issue that resulted from a design flaw in the bike docking mechanism. These issues eventually limited the ability of users to find bikes within the system and, despite the favorable reception of the initial release, the system was shut down in September 2017 to give the bike share operator time to design and install more secure locks on docking stations [35,36].
One month later in October 2017, the system reopened and docking station expansion resumed, with a total of 39 stations active by August 2018.

3.2. Data Collection and Analysis

To assess the presence of barriers to BBS usage, cross-sectional intercept survey data were collected from non-user Baltimore residents (see Section 3.2.1). To bolster findings from the barrier analysis, BBS membership data were also examined to understand whether inequities do exist in the BBS program (see Section 3.2.2), as it is the disparity between bike share membership and the population at large that call into question the presence of barriers to entry. In this study, the population at large, or target population, was the resident population who live within walking distance of BBS stations, referred to here as the BBS service area (see Section 3.2.3). Both BBS membership data and the intercept survey non-user data were compared against the demographics of the target population to establish the extent to which (1) inequities in BBS membership exist; and (2) surveyed non-users are representative of the target population.

3.2.1. BBS Non-User Data

The intercept survey instrument and protocol were adapted from the National Association of City Transportation Official’s Bike Share Intercept Survey Toolkit [37] based on research literature relating to bike share equity. Respondents were read seventeen statements, each representing a potential barrier condition, and were asked to indicate their level of agreement with each statement. Nine of the 17 conditions related to the act of riding a bicycle, while the remaining eight addressed access and use of the BBS system. A copy of the survey can be found in Appendix A.

The intercept surveys were conducted on six separate weekdays and five separate weekend days in April and May of 2018. To achieve a diverse sample, survey administrators spent three hours near eight docking stations characterized by a variety of land uses. Survey administrators were asked to solicit responses from individuals of diverse race, gender, and age characteristics. Participants were required to be Baltimore residents over 18 years of age, know how to ride a bike, and have heard of, though never used, the Baltimore Bike Share system. A total of 109 surveys were completed.

Chi-square tests of independence and a regression analysis were used to examine the presence of significant associations between barriers and being a member of a sociodemographic community of interest (SCOI). For ease of analysis, responses to the barrier statements were collapsed into dichotomous variables. Items in this set of dependent variables were each given a value of either “agree that the condition is true” or otherwise (as represented by any of “neither agree or disagree”, “disagree”, or N/A). Likewise, the non-user demographic data were collapsed into dichotomous variables that represent membership in a sociodemographic community of interest (SCOI), or not. The SCOIs considered in this study were female, low income, not white, less educated, unemployed, and Hispanic.

To confirm and assess the relative importance of statistically significant associations between SCOI and barrier conditions, multivariate regression was conducted using STATA statistical software. A linear probability model using ordinary least squares (OLS) with robust standard errors was selected for this analysis, instead of a logit model, for clarity of results and easier-to-interpret coefficients for a measure of effect size. Linear models with small sample sizes are unlikely to yield different answers than logit [38]. Substituting OLS for logit is appropriate when the split between the two levels of the dependent variable is close to being equal. Linear regression is a novel approach to understanding the magnitude of the relationship between SCOI membership and the perception of certain conditions as barriers to using bike share.

3.2.2. BBS Membership Data

BBS membership data were collected in partnership with the city of Baltimore to examine the distribution of underrepresented communities using the system. Data were collected via an emailed
survey distributed on 16 April 2018. Single-trip tourist users were excluded from the dataset, leaving a total of 245 usable survey responses (approximately 8% response rate). Demographic data collected included gender, age, educational attainment, employment status, household income, race/ethnicity, and Hispanic origin.

3.2.3. Bike Share Service Area

To assess demographic representativeness, both the BBS non-user and membership datasets were compared against American Community Survey (ACS) five-year estimates (2010–2015), averaged for the bike share service area. The bike share service area was defined as an area located within a one-quarter mile walk from each docking station in the Baltimore Bike Share system. Data from census block groups that intersect the service area were aggregated to represent the broader population of possible users for comparison against the study samples of non-users and BBS members.

4. Results

4.1. Representation and Demographics of Samples

Chi-square tests of independence indicated that Baltimore Bike Share members are statistically different from the BBS service area population (see Table 1). They are predominately male, white, highly educated, high-income earners, employed, and non-Hispanic. Thus, demographic communities underrepresented in BBS, referred to as SCOIs in this study, are female, nonwhite individuals, less educated, low income earners, unemployed, and Hispanic. This is consistent with previous research on bike share user demographics [4,5,7–9].

In contrast, non-users surveyed in the intercept study proportionately reflect socioeconomic communities found in the bike share service area, lending support to findings that emerged from the study. In addition to the sample descriptive statistics reported in Table 1, intercept survey respondents were also asked to provide their age ($M = 36.4, SD = 12.8, range 19–73, n = 84$) and the last time they rode a bike (less than two years ago 73.8%, greater than two years ago 26.2%, $n = 107$).

Table 1. Non-user and member survey respondents—tests of independence and definitions of socioeconomic communities of interest (SCOI).

| Characteristic, n (%) | Bike Share Service Area (ACS 2010–2015) | Non-user Survey | Chi-Square | BBS Member Survey | Chi-Square |
|----------------------|------------------------------------------|-----------------|-------------|-------------------|------------|
| **Gender**           |                                          |                 |             |                   |            |
| Male                 | 49.9 (48.1)                              | 51 (48.9)       | $\chi^2 (1) = 0.14$ | 162 (68.6) | $\chi^2 (1) = 33.02$ |
| Female               | 50.1 (51.9)                              | 55 (51.9)       | $p = 0.707$  | 74 (31.4)         | $p < 0.001$ |
| **SCOI Female**      |                                          |                 |             |                   |            |
| Income               |                                          |                 |             |                   |            |
| Less than $50,000    | 43.6 (48.9)                              | 42 (48.9)       | $\chi^2 (1) = 0.97$ | 34 (14.7)  | $\chi^2 (1) = 78.96$ |
| Greater than or equal to $50,000 | 56.4 (51.2) | 44 (51.2) | $p = 0.326$  | 198 (85.3) | $p < 0.001$  |
| **SCOI Low income**  |                                          |                 |             |                   |            |
| (having a family income less than $50,000) | 48.9% | n = 222 |           |                  |            |
| **Race/Ethnicity**   |                                          |                 |             |                   |            |
| White                | 61.6 (63.8)                              | 67 (63.8)       | $\chi^2 (3) = 0.35$ | 213 (90.2) | $\chi^2 (3) = 83.54$ |
| Black or African American Asian | 27.4 (26.7) | 28 (26.7) | $p = 0.95$  | 11 (4.7) | $p < 0.001$  |
| Asian                | 5.9 (4.8)                                | 5 (4.8)         | n = 105     | 6 (2.5)           | n = 236 |
| Other                | 5.1 (4.8)                                | 5 (4.8)         |             | 6 (2.5)           |            |
Table 1. Cont.

| Characteristic, n (%) | Bike Share Service Area (ACS 2010–2105) | Non-user Survey Chi-Square | BBS Member Survey Chi-Square |
|-----------------------|-----------------------------------------|---------------------------|----------------------------|
| SCOI Not white ¹      | 36.3%                                   |                           |                            |
| Education attainment  |                                         |                           |                            |
| Master’s or higher    | 27.8 (29.4)                             | 30 (29.4)                 | 124 (51.2)                 |
| Bachelor’s            | 29.7 (36.3)                             | 37 (36.3)                 | 97 (40.6)                  |
| Associate’s, vocational, certificate | 3.4 (2.9)                      | 3 (2.9)                   | 3 (1.3)                    |
| Some college, no degree | 11.8 (14.7)                           | 15 (14.7)                 | 13 (5.4)                   |
| H.S. Diploma, GED, or less | 27.3 (16.7)                           | 17 (16.7)                 | 2 (0.8)                    |
| SCOI Less educated ²  | 34.3%                                   |                           |                            |
| Employment status ³   |                                         |                           |                            |
| Full or part-time employed | 92.8 (92.3)                           | 84 (92.3)                 | 229 (97.9)                 |
| Unemployed            | 7.2 (7.7)                               | 7 (7.7)                   | 5 (2.1)                    |
| SCOI Unemployed ⁴     | 7.7%                                    |                           |                            |
| Hispanic origin       |                                         |                           |                            |
| Non-Hispanic          | 92.6 (94.2)                             | 97 (94.2)                 | 226 (96.2)                 |
| Hispanic              | 7.4 (5.8)                               | 6 (5.8)                   | 9 (3.8)                    |
| SCOI Hispanic         | 5.8%                                    |                           |                            |

Note: ¹ all categories except white; ² having less than a bachelor’s degree; ³ excludes retirees.

4.2. BBS Non-User Barrier Analysis—Survey Results

Respondents agreed with only one barrier in the majority—feeling unsafe riding on Baltimore’s streets and sidewalks (Table 2). All other barrier conditions were agreed to at a rate of 50% or less.

Table 2. Perceptions of bike share barriers by non-users.

| Potential Barrier Condition (VARIABLE NAME) | All Respondents ¹ (n = 109) | Underrepresented Socioeconomic Community in BBS (SCOI) ² |
|--------------------------------------------|-----------------------------|--------------------------------------------------------|
|                                            |                             | Underrepresented Socioeconomic Community in BBS (SCOI) ² |
|                                            |                             | Female (n = 55) | Low Income (n = 42) | Not White (n = 37) | Less Education (n = 35) |
| Barrier conditions primarily associated with biking |                             |                           |                           |                           |                           |
| Baltimore’s streets and sidewalks feel unsafe to ride on (traffic, safe routes). (UNSAFE) | 52 ± 9% | 60 | 57 | 43 | 43 |
| I would not ride a Baltimore Bike Share bike without a helmet. (HELMET) | 50 ± 9% | 56 | 60 | 59 | 60 |
| I prefer to use my own bike instead of a Baltimore Bike Share bike. (OWNBIKE) | 40 ± 9% | 38 | 36 | 24* | 43 |
### Table 2. Cont.

| Potential Barrier Condition (VARIABLE NAME) | Percent Agreeing with Barrier Condition | Underrepresented Socioeconomic Community in BBS (SOCI) 2 |
|--------------------------------------------|----------------------------------------|------------------------------------------------------|
|                                            | All Respondents 1                      | Underrepresented Socioeconomic Community in BBS (SOCI) 2 |
|                                            | (n = 109)                              | Female (n = 55) Low Income (n = 42) Not White (n = 37) Less Education (n = 35) |
| I am concerned that I cannot ride a Baltimore Bike Share bike with my child(ren) or easily carry things I need. (CARGO) | 28 ± 8% | 25 | 21 | 41* | 29 |
| I would be too concerned about the potential to be a victim of crime or harassment while riding a bike. (VICTIM) | 21 ± 7% | 35 ** | 26 | 19 | 14 |
| I would be concerned about getting sweaty or getting my clothes or hair messed up while riding. (HYGIENE) | 19 ± 7% | 29 ** | 17 | 24 | 9 |
| I am not interested in riding a bike in Baltimore. (NOTINTERESTED) | 18 ± 7% | 29 ** | 12 | 16 | 9 |
| I’m not comfortable enough riding a bike to use a Baltimore Bike Share bike. (COMFORT) | 17 ± 7% | 25 ** | 10 | 22 | 17 |
| I am embarrassed to be seen riding a Baltimore Bike Share bike. (EMBARRASS) | 7 ± 5% | 15 ** 3 | 10 | 11 | 11 |
| Barrier conditions primarily associated with BBS |                                       |                                                      |
| I’m worried about being held responsible financially if anything happens to the bike. (RESPONSIBLE) | 44± 9% | 44 | 55 | 51 | 54 |
| I am concerned that station locations are not near where I would want to go. (LOCATIONS) | 34 ± 9% | 35 | 40 | 43 | 43 |
| I am worried that it will be difficult to check out or return Baltimore Bike Share bikes. (BIKESECURE) | 25 ± 8% | 25 | 21 | 24 | 23 |
Table 2. Cont.

| Potential Barrier Condition (VARIABLE NAME) | All Respondents $^1$ (n = 109) | Underrepresented Socioeconomic Community in BBS (SCOI) $^2$ |
|-------------------------------------------|---------------------------------|----------------------------------------------------------|
|                                           | Percent Agreeing with Barrier Condition | Female (n = 55) | Low Income (n = 42) | Not White (n = 37) | Less Education (n = 35) |
| I don’t want to enter my credit or debit card information on the internet in order to register. (NOREGISTER) | 25 ± 8% | 31 | 21 | 32 | 26 |
| I have concerns about knowing how to use the Baltimore Bike Share system. (USE) | 24 ± 8% | 33 * | 19 | 24 | 26 |
| I’m worried about the cost of joining or using the Baltimore Bike Share. (COST) | 17 ± 7% | 24 | 17 | 19 | 14 |
| I don’t have a credit card or debit card to use for registration. (NOCARDREGISTER) | 7 ± 5% | 9 | 7 | 14 * $^3$ | 11 |
| I don’t have access to the internet to register. (NOACCESS) | 6 ± 4% | 7 | 7 | 11 | 6 |

Note: * $p < 0.05$, ** $p < 0.01$; $^1$ margin of error at 95% confidence interval; $^2$ SCOI groups unemployed and Hispanic not included due to low data variability; $^3$ statistical significance not valid due to small predicted frequencies.

Statistically significant differences were found between the study sample and being female (Table 2). Females were more likely to be concerned about the potential to be a victim of crime or harassment [VICTIM, $\chi^2 (1, n = 106) = 11.11, p < 0.001$]; getting sweaty or having their clothes or hair messed up [HYGIENE, $\chi^2 (1, n = 106) = 7.80, p = 0.005$]; being comfortable [COMFORT, $\chi^2 (1, n = 106) = 9.57, p = 0.002$], and knowing how to use the BBS system [USE, $\chi^2 (1, n = 106) = 6.64, p = 0.010$]. In addition, being female was associated with being uninterested in riding [NOTINTERESTED, $\chi^2 (1, n = 106) = 9.69, p = 0.002$].

Statistically significant relationships were also found between the variable ‘notwhite’ and two barriers, OWNBIKE and CARGO. Individuals identifying as white were more likely to prefer riding their own bike over a BBS bike, $\chi^2 (1, n = 104) = 5.48, p = 0.019$, while identifying as not white was associated with concern about the ability to carry a child or cargo when using a bike share bike, $\chi^2 (1, n = 104) = 5.41, p = 0.020$.

Other significant relationships were deemed invalid based on Chi-square test limitations related to small expected frequencies and are noted as such in Table 2.

4.3. BBS Non-User Barrier Analysis—Regression Results

Multivariate regressions were run for each of the barriers against SCOI (variable names ‘female’, ‘notwhite’, ‘lowincome’ and ‘loweducation’), age of respondent (continuous variable ‘age’), and last time respondent rode a bike (dichotomous variable ‘recent’) to add credence to the Chi-square findings.
of significant difference, and to estimate the marginal effect of SCOI explanatory variables on the outcome probability of perceiving a condition as a barrier. The regression equation is thus:

$$\text{Barrier}_i = \beta_0 + \beta_1 \times \text{female} + \beta_2 \times \text{notwhite} + \beta_3 \times \text{lowincome} + \beta_4 \times \text{loweducation} + \beta_5 \times \text{age} + \beta_6 \times \text{recent}$$

The regression analysis was limited to only six of the 17 barrier dependent variables: UNSAFE, HELMET, RESPONSIBLE, OWNBIKE, LOCATIONS, and CARGO after dropping dependent variables that do not vary. Significant findings stable in magnitude and direction over a range of specifications were found for two of these six dependent variables: CARGO and OWNBIKE, consistent with Chi-square findings. Table 3 presents fully controlled models of the regression analyses for these two outcome variables.

Collinearity between predictor variables was assessed using standard measures for dichotomous and continuous variables (Chi-square and ANOVA, respectively) and found to be within acceptable limits with two exceptions. A degree of collinearity was found between two pairs of independent variables: ‘notwhite’ and ‘recent’ $[\chi^2 (1, n = 102) = 8.07, p = 0.005]$, and ‘loweducation’ and ‘lowincome’ $[\chi^2 (1, n = 85) = 15.01, p < 0.001]$. In both cases, however, regression results remained stable for the variable of interest (‘notwhite’) independent of the presence of these variables. Thus, they were retained in the final models.

### Table 3. Significant results of regression analysis.

| Barrier Condition Dependent Variable (Goodness of Fit $^1$) | Fully Specified Model (n = 63) |
|------------------------------------------------------------|---------------------------------|
|                                                            | Independent Variable(s) | Coefficient (standard error) | t statistic |
| CARGO (0.71)                                               | female                  | 0.064 (0.112)                | 0.57       |
|                                                            | lowincome               | −0.113 (0.110)               | −1.03      |
|                                                            | notwhite                | 0.360 (0.128)                | 2.80 **    |
|                                                            | loweducation            | 0.052 (0.131)                | 0.39       |
|                                                            | age                     | 0.002 (0.005)                | 0.35       |
|                                                            | recent                  | 0.203 (0.137)                | 1.48       |
| OWNBIKE (0.68)                                             | female                  | −0.002 (0.115)               | −0.02      |
|                                                            | lowincome               | −0.015 (0.128)               | −0.11      |
|                                                            | notwhite                | −0.226 (0.109)               | −2.07 *    |
|                                                            | loweducation            | 0.059 (0.155)                | 0.38       |
|                                                            | age                     | −0.007 (0.004)               | −1.39      |
|                                                            | recent                  | −0.187 (0.137)               | −1.36      |

Note: * $p < 0.05$, ** $p < 0.01$; $^1$ goodness of fit was calculated using a pseudo coefficient of determination recommended by Studenmund [39] for binary choice models, as the average of the percent of 1s explained correctly and percent of 0s explained correctly.
5. Discussion

Significant interest in bicycle transportation exists across all demographic groups in the non-user survey sample, with only 18% of respondents reporting a lack of interest in riding a bike in Baltimore, with SCOI values ranging between 9% and 29% (Table 2). These results are consistent with research in low income, majority minority communities, which has reported similar levels of interest in using bike share [6]. The potential for greater bike share uptake rates is also suggested by the relatively low rates of respondents (less than 20% overall) who are (1) embarrassed to ride a bike (10%–15% per SCOI), (2) not comfortable knowing how to ride a bike share bike (10%–25% per SCOI), or (3) concerned with personal hygiene/appearance (9%–29% per SCOI).

Along with this interest in bicycling, however, respondents voiced strong concern for riding on Baltimore streets, independent of socioeconomic condition. Half of all respondents reported not feeling safe using Baltimore’s bicycling infrastructure (43%–60% per SCOI) and preference for wearing a helmet (56%–60% per SCOI). Together, these results are consistent with studies that have indicated a majority of people fall into an “interested but concerned” category about bicycling [40,41].

Of the eight barriers related to the Baltimore Bike Share system specifically, most respondents (66% or more) did not report concerns about the seven conditions that addressed accessing and participating in the program, including registration, cost, physically handling the bikes, and convenience of station locations. Fewer than 10% of respondents agreed that they do not have access to the internet to register (6%–11% per SCOI) or do not have a credit or debit card to use for registration (7%–14% per SCOI). These findings suggest substantial opportunity to increase bike share participation rates. The primary concern that non-users had about the Baltimore Bike Share program is being held financially responsible if anything happens to the bike (44%–55% per SCOI). This finding is somewhat higher than previously measured [6], possibly a consequence of the widely reported challenges the program faced during the summer of 2017, including stories of stolen and damaged bikes.

5.1. SCOI: Not White

‘Not white’ is a classification that captured intercept survey respondents who selected any race category except ‘white’. Of this group, 74% identified as black and 13% as Asian, with 13% accounting for all other response categories. Contrary to findings previously reported in the bike share equity literature, this study did not find significant associations between being not white and perceiving certain conditions as barriers for the majority of barrier statements considered here.

Only two conditions, represented by the variable statements CARGO and OWNBIKE, were predicted by classification in this group. Being ‘notwhite’ was positively associated with an effect size of an approximate 36-point increase in the probability of being concerned about the ability to carry items or ride with children, ceteris paribus. This finding is generally consistent with previous research [13,15–17]. While a recent large-scale study suggested there is no difference between lower income people of color and the general population regarding challenges to using bike share with children, wealthier white respondents were found to be statistically significantly less likely to perceive this condition as an important barrier [6] (p. 146). This same study also concluded that lower income people of color were statistically significantly more likely to be concerned about carrying items on a bike, while higher income white people were not (p. 100). The rate at which CARGO was found to be a concern for all respondents in our survey sample (28%) is consistent with previously reported findings (carrying items: 29%; riding with children: 22%) (ibid).

The regression analysis also indicated that being ‘notwhite’ is negatively associated with a preference to ride one’s own bike (OWNBIKE). White non-users are associated with an estimated 23-point increase in the probability of preferring to use their own bikes over a BBS bike, ceteris paribus. Similar overall levels of agreement with a preference for riding one’s own bike (40% in this study) have been reported elsewhere, with statistically significant higher levels for higher income white individuals and statistically significant lower levels for low income people of color [6] (p. 146). These consistent findings may relate to bike ownership, as research has suggested that lower income people of color are
statistically significantly more likely to be concerned about not having a bike or related gear than the general population (p. 100).

5.2. SCOI: Female

While relative size effects could not be established for the female SCOI using regression analysis due to limitations in data variability, the Chi-square statistically significant associations found for women in relation to several barrier conditions (USE, COMFORT, VICTIM, HYGIENE, and NOTINTERESTED) are generally supported in the research literature. For example, understanding how to access and use bike share programs was found to be broadly challenging, particularly for women [6,12,15,16,19,23,28–30]. Evidence has also suggested that women are more likely to agree with the statement that they are out of shape or not physically able to ride, which is a dimension of being comfortable riding a bike [6,18]. Likewise, the association between being female and concern about being a target of crime or harassment has also been previously reported [6].

While some qualitative studies suggest gender effects for the impact of biking on personal appearance (becoming sweaty or disheveled), recent surveys of riders and nonriders found no gender differences [6,18]. Instead, frequency and purpose of riding may be explanatory factors [18]. Lastly, not being interested in riding a bike in Baltimore is not surprising given that 60% of women expressed concern about feeling safe using Baltimore’s bicycling infrastructure.

5.3. SCOs: Low Income and Less Education

Compared to the overall sample population, respondents who self-identified as low income or less educated were not found to be more or less likely to perceive the barrier conditions as impediments to bike share. While no studies have previously examined the impact of being less educated on the perception of bike share barriers, these results are counter to what has been suggested in the bike share equity literature for low income individuals. Interaction effects between independent variables, which were not examined as part of this study, may explain the absence of positive findings. In addition, these results need to be considered in light of data collection methods, as intercept surveys are prone to interviewer bias that may result from respondent social desirability concerns, observable traits of the interviewer, and interviewer experience [42] (p. 292).

5.4. Strengths and Limitations

This study contributes to biking and bike share equity scholarship through a quantitative analysis of data collected from cross-sectional intercept surveys designed to evaluate the barriers to bike share by traditionally underrepresented populations. In addition to interviewer bias described earlier, sampling bias is also an inherent limitation of intercept surveys. Despite the demonstrated representativeness of the non-user survey sample population to the population of interest (residents living within the bike share service area), the small sample size limited the ability to achieve demographic variability for some SCOs, and thus the opportunity to observe and measure significant relationships and their effect sizes. Nonresponse bias against individuals who lack regular email access and those who are non-native English speakers can also be a source of error in the member survey [43,44].

6. Conclusions and Policy Implications

Bike share systems have become a common feature of the modern urban landscape and provide residents and visitors with a transportation mode that promotes multiple social, environmental, and health benefits. Yet these systems have endured equity-focused criticism for serving a narrow demographic band of residents and visitors, underrepresenting populations for whom physical activity and health differentials exist, including people of color, women, low-income communities, and the less educated. This research sought to understand factors associated with these populations that are conducive to policy responses that can reduce disparities and enhance equity. For Baltimore residents
who were not members of the Baltimore Bike Share, racial and female identity emerged as being associated with particular barriers to accessing and using the system.

In order to ensure that bike share welcomes populations traditionally underrepresented in system usage, this study suggests that the adoption of strategies that address specific concerns related to female residents and nonwhite individuals may be appropriate. Strategies could include a robust community outreach effort that targets these populations, including initiatives such as a grassroots bike share ambassador program, organized community rides, opportunities to test bike share bikes at community events, and targeted marketing materials [11,12,23,45–49]. Importantly, bicycle designs should incorporate gear to make it easier for residents to transport items and to ride with children.

Significantly, one of the biggest barriers to biking, across all demographic categories, is concern about personal safety. The results of this study support the need for infrastructure upgrade policies (separated bike lanes, road diets, traffic calming measure, surface enhancements, etc.) in bike share service areas to make progress toward a more equitable bike share system.

Author Contributions: Conceptualization, P.B., C.C., and S.H.G.; methodology, P.B. and S.H.G.; formal analysis, S.H.G.; investigation, S.H.G.; data curation, S.H.G.; writing—original draft preparation, S.H.G.; writing—review and editing, P.B.; visualization, S.H.G.; supervision, P.B.; project administration, P.B.; funding acquisition, P.B. and C.C. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the US Department of Transportation Office of the Secretary-Research UTC Program, RDT-30 (grant number DTRT13-G-UTC33).

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A

Baltimore Bike Share Non-member Intercept Survey

1. How did you first learn about the Baltimore Bike Share program?

- Employer/information at work or school
- Community center/faith-based organization/local nonprofit
- Friend/family/coworker
- Social media (Facebook, Twitter, Instagram, etc.)
- Television/radio
- Ad on a bus/bus shelter/train/water taxi
- Newspaper, magazine, or radio/TV news
- Seeing the stations/kiosks or bike on the street
- Community event
- Internet search
- Other: ____________________________

2. When was the last time you rode a bike?

- Less than one month ago
- 1–6 months ago
- 1–2 years ago
- 2–5 years ago
- 6–12 months ago
- Greater than 10 years ago

3. I have concerns about knowing how to use the Baltimore Bike Share system.

4. I am concerned that station locations are not near where I would want to go.

5. I don’t want to enter my credit or debit card information on the internet in order to register.

6. I don’t have a credit card or debit card to use for registration.

7. I don’t have access to the internet to register.
|   | Statement                                                                                           | Agree | Disagree | Neither Agree nor Disagree | Not Applicable |
|---|----------------------------------------------------------------------------------------------------|------|----------|-----------------------------|----------------|
| 8 | I’m worried about the cost of joining or using the Baltimore Bike Share.                           |      |          |                             |                |
| 9 | I am worried that it will be difficult to check out or return BBS bikes.                          |      |          |                             |                |
| 10| I would not ride a Baltimore Bike Share bike without a helmet.                                     |      |          |                             |                |
| 11| I’m worried about being held responsible financially if anything happens to the bike.             |      |          |                             |                |
| 12| I am concerned that I cannot easily carry things I need or ride with my child(ren) when using the Baltimore Bike Share. |      |          |                             |                |
| 13| I’m not comfortable enough riding a bike to use a Baltimore Bike Share bike.                       |      |          |                             |                |
| 14| I am embarrassed to be seen riding a Baltimore Bike Share bike.                                    |      |          |                             |                |
| 15| I would be too concerned about the potential to be a victim of crime or harassment while riding a bike. |      |          |                             |                |
| 16| Baltimore’s streets and sidewalks feel unsafe to ride on (traffic, safe routes).                   |      |          |                             |                |
| 17| I would be concerned about getting sweaty or getting my clothes or hair messed up while riding.     |      |          |                             |                |
| 18| I prefer to use my own bike instead of a Baltimore Bike Share bike.                                |      |          |                             |                |
| 19| I am not interested in riding a bike in Baltimore.                                                 |      |          |                             |                |

Read: “When considering whether you might try the Baltimore Bike Share, for each of the following statements, please indicate whether you Agree, Disagree, or Neither Agree nor Disagree. You may also choose Not Applicable.”

20: What is the primary reason why you have not tried the Baltimore Bike Share? (Surveyor: Circle respondent’s answer on the previous question. If the response is not listed, please write on line below.)

21: Do you have any other comments about the Baltimore Bike Share?

22: With which gender identity do you most identify?<br>☐ Female ☐ Male ☐ Other (please specify) ☐ Refusal

23: What is your age in years? (Surveyor: Enter REFUSAL, if Respondent chooses not to answer.)

24: What is the current status of your employment situation?<br>☐ Employed full-time ☐ Employed part-time ☐ Retired ☐ Not currently employed ☐ Refusal
25: What is the highest level of education you’ve received?
□ No H.S. diploma □ Master’s degree
□ H.S. diploma/equivalent (GED) □ Professional/Doctoral degree (MD, JD, PhD, etc.)
□ Some college, but no degree □ Refusal
□ Associate degree, vocational school, or certificate program □ Bachelor’s degree

26: Approximately what was your total household income last year? (If you live with roommates or other persons who are unrelated to you, please report your individual income).
□ less than $10,000 □ $35,000–$49,999 □ $125,000–$149,999
□ $10,000–$14,999 □ $50,000–$74,999 □ $150,000–$199,999
□ $15,000–$24,999 □ $75,000–$99,999 □ more than $200,000
□ $25,000–$34,999 □ $100,000–$124,999 □ Refusal

27: Which category best describes your race/ethnicity? (You may select multiple options)
□ Caucasian or White □ Black or African American
□ Asian □ American Indian or Alaska Native
□ Middle Eastern or North African □ Native Hawaiian or other Pacific Islander
□ Other (please specify) ______________________
□ Refusal

28: Are you of Hispanic origin?
□ Yes □ No □ Refusal

References
1. Shaheen, S.; Cohen, A.; Martin, E. Public Bikesharing in North America: Early Operator Understanding and Emerging Trends. Transp. Res. Rec. 2013, 2387, 83–92. [CrossRef]
2. Braun, L.; Rodriguez, D.; Gordon-Larsen, P. 2397—Social (in)Equity in Access to Cycling Infrastructure: Examining the Distribution of Bike Lanes with Respect to Area-Level Sociodemographic Characteristics in 23 Large U.S. Cities. J. Transp. Health 2018, 9, S28. [CrossRef]
3. MacArthur, J.; McNeil, N.; Broach, J.; Cumings, A.; Stark, R.; Sanders, R.; Witte, A. National Scan of Bike Share Equity Programs: Approaches and Best Practices for Promoting Equity in Bike Share; Transportation Research and Education Center (TREC): Portland, OR, USA, 2019. [CrossRef]
4. Buck, D.; Buehler, R.; Happ, P.; Rawls, B.; Chung, P.; Borecki, N. Are Bikeshare Users Different from Regular Cyclists? A First Look at Short-Term Users, Annual Members, and Area Cyclists in the Washington, D.C., Region. Transp. Res. Rec. 2013, 2387, 112–119. [CrossRef]
5. Goodman, A.; Cheshire, J. Inequalities in the London bicycle sharing system revisited: Impacts of extending the scheme to poorer areas but then doubling prices. J. Transp. Geogr. 2014, 41 (Suppl. C), 272–279. [CrossRef]
6. McNeil, N.; Dill, J.; MacArthur, J.; Broach, J.; Howland, S. Breaking Barriers to Bike Share: Insights from Residents of Traditionally Underserved Neighborhoods; NITC-RR-884b; Transportation Research and Education Center (TREC): Portland, OR, USA, 2017. [CrossRef]
7. Shaheen, S.; Elliot, M.; Chan, N.; Cohen, A.; Pogodzinski, M. Public Bikesharing in North America During a Period of Rapid Expansion: Understanding Business Models, Industry Trends & User Impacts; MTI Report 12-29; Mineta Transportation Institute Publications: San Jose, CA, USA, 2014.
8. Smith, C.S.; Oh, J.-S.; Lei, C. Exploring Equity Dimensions of US Bicycle Sharing Systems; TRCLC 14-01; Transportation Research Center for Livable Communities at Western Michigan University: Kalamazoo, MI, USA, 2015.
9. Ursaki, J.; Aultman-Hall, L. Quantifying the equity of bikeshare access in US cities. In Proceedings of the 95th Annual Meeting of the Transportation Research Board, Washington, DC, USA, 10–14 January 2016.
10. Litman, T. Evaluating Transportation Equity Guidance for Incorporating Distributional Impacts in Transportation Planning; Victoria Transport Policy Institute (VTPI): Victoria, BC, Canada, 2020; Available online: https://www.vtpi.org/equity.pdf (accessed on 10 August 2020).

11. Chavis, C.; Barnes, P.; Grasso, S.; Bhuyan, I.; Nickkar, A. Bicycle Justice or Just Bicycles? Analyzing Equity in Baltimore’s Bike Share Program; MATS-UTC, DTRT13-G-UTC3; National Transportation Center (NTC), Department of Transportation and Urban Infrastructure Studies, Morgan State University: Baltimore, MD, USA, 2018.

12. Filling-Yeh, K.; Chaney, B. Bringing Equitable Bike Share to Bed-Stuy: Progress Report from Bedford Stuyvesant Restoration Corporation in Partnership with NACTO. 2017. Available online: http://restorationplaza.org/wp-content/uploads/Restoration-NACTO_BikeShareEquity_Report_WEB_FINAL.pdf (accessed on 11 September 2020).

13. Hoe, N.; Kaloustian, T. Bike Sharing in Low-Income Communities: An Analysis of Focus Group Findings, Fall 2014; Report for the Bicycle Coalition of Greater Philadelphia and the Philadelphia Mayor’s Office of Transportation and Utilities; Institute for Survey Research, Temple University: Philadelphia, PA, USA, 2014.

14. Kansas City B-Cycle. Bike Share Access for the Underserved in Kansas City. 2014. Available online: http://ridkcbike.com/files/2020/06/KC-B-cycle-Equity-Report-1.pdf (accessed on 11 September 2020).

15. Ketchman, N. Bublr Bikes: A Bike Share System for All Milwaukeeans. Report for Midwest Bike Share, Inc. 2015. Available online: http://mobility-workspace.eu/wp-content/uploads/BublrBikesForAll-Report-FINAL-07.08.15.pdf (accessed on 11 September 2020).

16. Kretman Stewart, S.; Johnson, D.C.; Smith, W.P. Bringing Bike Share to a Low-Income Community: Lessons Learned Through Community Engagement, Minneapolis, Minnesota, 2011. Prev. Chronic Dis. 2013, 10, 120274. [CrossRef] [PubMed]

17. Community Cycling Center. Understanding Barriers to Bicycling Project. 2012. Available online: http://www.communitycyclingcenter.org/wp-content/uploads/Understanding-Barriers-Final-Report.pdf (accessed on 11 September 2020).

18. Fowler, S.; Berigan, D.; Pollack, K. Perceived Barriers to Bicycling in an Urban U.S. Environment. J. Transp. Health 2017, 6, 474–480. [CrossRef]

19. Howland, S.; McNeil, N.; Broach, J.; Rankins, K.; MacArthur, J. Breaking Barriers to Bike Share: Insights on Equity from a Survey of Bike Share System Owners and Operators; NITC-RR-884a; Transportation Research and Education Center (TREC): Portland, OR, USA, 2017. [CrossRef]

20. Hoffmann, M.L. Bike Lanes are White Lanes: Bicycle Advocacy and Urban Planning; University of Nebraska Press: Lincoln, NE, USA, 2016; ISBN 978-0803276789.

21. Brown, C. Fear: A Silent Barrier to Bicycling in Black and Hispanic Communities. ITE J. 2016, 86, 22–24.

22. Appleyard, B.S.; Ferrell, C.E. The Influence of Crime on Active & Sustainable Travel: New Geo-Statistical Methods and Theories for Understanding Crime and Mode Choice. J. Transp. Health 2017, 6, 516–529. [CrossRef]

23. Kodransky, M.; Lewenstein, G. Connecting Low-Income People to Opportunity with Shared Mobility. Institute for Transportation and Development Policy. 2014. Available online: https://www.itdp.org/wp-content/uploads/2014/10/Shared-Mobility_Full-Report.pdf (accessed on 11 September 2020).

24. Serna, A.; Ruiz, T.; Kepa Gerrikagoitia, J.; Arroyo, R. Identification of Enablers and Barriers for Public Bike Share System Adoption Using Social Media and Statistical Models. Sustainability 2019, 11, 6259. [CrossRef]

25. Tomer, A.; Kneebone, E.; Puentes, R.; Berube, A. Missed Opportunity: Transit and Jobs in Metropolitan America. Brookings Institution. 12 May 2016. Available online: https://www.brookings.edu/research/missed-opportunity-transit-and-jobs-in-metropolitan-america/ (accessed on 14 September 2017).

26. Cohen, A. Equity in Motion: Bikeshare in Low-Income Communities. Report for the District Department of Transportation; UCLA Institute of Transportation Studies. May 2016. Available online: https://www.lewis.ucla.edu/wp-content/uploads/sites/2/2016/09/2015-2016_Cohen_Equity-in-Motion_Edit_August2016.pdf (accessed on 11 September 2020).

27. Freedman, N. Boston Bikes Bike Share Equity. Slideshow published 14 October 2014. Available online: nacto.org/wp-content/uploads/2014/10/Freedman_Bike-Share-Equity.pdf (accessed on 11 September 2020).

28. Hoe, N. Bike Sharing in Low-Income Communities: Results from a Spring 2015 Baseline Survey; Report for the Bicycle Coalition of Greater Philadelphia and the Philadelphia Mayor’s Office of Transportation and Utilities; Institute for Survey Research, Temple University: Philadelphia, PA, USA, 2015.
29. Murphy, B. Council Order #10 Dated October 20, 2014 Regarding Hubway Membership; Community Development Department: Cambridge, MA, USA, 2014.

30. National Association of City Transportation Officials. Can Monthly Passes Improve Bike Share Equity? NACTO Bike Share Equity Practitioner’s Paper #2: New York, NY, USA, 2015.

31. Carney, M. Bike-Sharing and the Unbanked: A Study of the Unbanked Population in Chicago and Best Practices for their Inclusion in Bike-Sharing; College of Urban Planning and Public Affairs, University of Illinois: Chicago, IL, USA, 2012; Available online: http://chi.streetsblog.org/wp-content/uploads/sites/4/2013/09/Bikeshare_Untanked_Carney_Final.pdf (accessed on 11 September 2020).

32. Campbell, C. Baltimore Approves Bike Rental Program to Launch in Fall with 500 Bicycles. Baltimore Sun. 16 March 2016. Available online: http://www.baltimoresun.com/news/maryland/baltimore-city/ba-md-ci-bike-share-approved-20160316-story.html (accessed on 20 July 2018).

33. Kinney, J. Baltimore Launches Bike-Share. Next City. 27 October 2016. Available online: https://nextcity.org/daily/entry/baltimore-launches-bike-share-equity (accessed on 20 July 2018).

34. Campbell, C. Baltimore to Launch Bike-Share Program Friday. Baltimore Sun. 27 October 2016. Available online: http://www.baltimoresun.com/news/maryland/baltimore-city/bs-md-ci-bikeshare-launch-20161027-story.html (accessed on 13 June 2018).

35. Campbell, C. Bike Share Manufacturer Designing “Baltimore Lock” to Prevent Theft. Baltimore Sun. 28 September 2017. Available online: http://www.baltimoresun.com/news/maryland/baltimore-city/bs-md-bike-share-baltimore-lock-20170928-story.html (accessed on 13 June 2018).

36. Munshaw, J. Baltimore’s Bike Share Program Expansion Delayed until September. Baltimore Business Journal. 14 July 2017. Available online: https://www.bizjournals.com/baltimore/news/2017/07/14/expansion-of-baltimore-bike-share-program-pushed.html (accessed on 13 June 2018).

37. National Association of City Transportation Officials. A How-to Guide for Learning More About Bike Share in your Community. 2016. Available online: https://nacto.org/interceptsurveytoolkit/ (accessed on 11 September 2020).

38. Beck, N. Estimating Grouped Data Models with a Binary Dependent Variable and Fixed Effects: What are the Issues? In Proceedings of the Annual Meeting of the Society for Political Methodology, Rochester, NY, USA, 17 July 2015.

39. Studenmund, A.H. Using Econometrics: A Practical Guide, 7th ed.; Pearson: Boston, MA, USA, 2016; ISBN 978-0134182742.

40. Dill, J.; McNeil, N. Revisiting the Four Types of Cyclists. Transp. Res. Rec. 2016, 2587, 90–99. [CrossRef]

41. Geller, R. Four Types of Cyclists; Portland Office of Transportation: Portland, OR, USA, 2009. Available online: https://www.portlandoregon.gov/transportation/article/264746 (accessed on 11 September 2020).

42. Groves, R.M.; Fowler, F.J., Jr.; Couper, M.P.; Lepkowski, J.M.; Singer, E.; Tourangeau, R. Survey Methodology, 2nd ed.; John Wiley & Sons: Hoboken, NJ, USA, 2009; ISBN 978-0-470-46546-2.

43. Anderson, M.; Kumar, M. Digital Divide Persists Even as Lower-Income Americans Make Gains in Tech Adoption. Pew Research Center. 22 March 2017. Available online: http://www.pewresearch.org/fact-tank/2017/03/22/digital-divide-persists-even-as-lower-income-americans-make-gains-in-tech-adoption/ (accessed on 19 June 2018).

44. Perrin, A.; Turner, E. Smartphones Help Blacks, Hispanics Bridge Some but Not All Digital Gaps with Whites. Pew Research Center. 31 August 2017. Available online: http://www.pewresearch.org/fact-tank/2017/08/31/smartphones-help-blacks-hispanics-bridge-some-but-not-all-digital-gaps-with-whites/ (accessed on 19 June 2018).

45. Better Bike Share Partnership. Engaging Youth in Urban Biking and Bikeshare. June 2016. Available online: http://betterbikeshare.org/wp-content/uploads/2016/06/youth-bike-toolkit-2016.pdf (accessed on 11 September 2020).

46. City of Philadelphia. Indego 2nd Birthday Snapshot. 2017. Available online: https://u626n26h74f16ig1p3pt0f2g-wpengine.netdna-ssl.com/wp-content/uploads/2017/05/INDEGO_SNAPSHOT.pdf (accessed on 10 October 2017).

47. Greenfield, J. “Divvy for Everyone” Aims to Boost Ridership in Low-Income Areas. Streetsblog Chicago. 10 June 2015. Available online: http://chi.streetsblog.org/2015/06/10/divvy-for-everyone-program-will-expand-access-to-low-income-people/ (accessed on 3 July 2017).
48. Greenfield, J. Divvy Will Be a Subject of a Bike-Share Equity Study; CDOT Announces Free Cycling Classes. Streetsblog Chicago. 2 June 2017. Available online: http://chi.streetsblog.org/2017/06/01/divvy-will-be-a-subject-of-a-bike-share-equity-study-cdot-announces-free-cycling-classes/ (accessed on 3 July 2017).

49. Musser, M. Portland’s BIKETOWN Receives Equity Boost from the Community Cycling Center. Community Cycling Center. 11 May 2016. Available online: http://www.communitycyclingcenter.org/news-release-portlands-biketown-receives-equity-boost-from-the-community-cycling-center/ (accessed on 7 August 2017).

© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).