Cycling by Choice or Necessity?

Exploring the Gender Gap in Bicycling in Oregon

Patrick A. Singleton and Tara Goddard

In Oregon, as in other areas of the United States, a greater percentage of men than women bicycle. This study illuminates the gender gap in bicycling by exploring differences in bicycling between women and men in Oregon. A one-day statewide travel survey of more than 30,000 adults was examined. Comparisons between individual, household, and trip and activity characteristics for people grouped by gender (women versus men) and bicycling (made a bicycle trip or normally commuted by bicycle versus did not bicycle) were assessed using chi-square tests of independence. Many significant differences were found. In particular, women who lived alone, were not working, had no high school degree or driver's license, and lived in low-income households or zero-vehicle households were less likely to bicycle than other women. Men with similar characteristics did not exhibit the same trends; sometimes they were even more likely to bicycle. These findings are consistent with a perspective that women who bicycle are more likely to bicycle by choice, whereas women of fewer means are less likely to turn to bicycling than are their male counterparts. In addition, there was partial support for the idea that women's roles and responsibilities may contribute to this deficit (that is, for household maintenance and escorting but not necessarily for the presence of children). The study's results begin to suggest a rethinking of bicycle-promoting policies and interventions to target certain women better, although further research is needed to understand bicycling's gender gap more fully.

As cities increasingly recognize the importance of bicycling to a multimodal transportation future that reduces congestion, improves health and well-being, and increases access to services and community, the low number of women bicycling relative to men is an area deserving of attention (*1*). In addition to increasing the mode share of bicycling, decreasing the disparity between men's and women's levels of bicycling (referred to as "the gender gap") is key to an equitable transportation system in which mobility and accessibility are available to all people. This gender gap in bicycling for transportation has been documented repeatedly, at least in countries and cities with low bicycling rates. Women are less likely than men to bicycle in most places in the United States, sometimes by a ratio of 3:1 (*1–8*). This finding has been confirmed in Australia (*9, 10*) and Canada (*11, 12*).

Conversely, women bicycle just as much as, if not more than, men in northern European countries such as Denmark, Germany, and the Netherlands across all ages and trip purposes (*6*). The overall bicycling mode share in countries and cities has been positively associated with the female proportion of people bicycling (*6, 13, 14*). This has led some to call women bicyclists an indicator of a good bicycling environment (*15*). It is clear that in areas where bicycling is low in practice (countries, states, and cities), there are opportunities to greatly increase the number of women bicycling. Closing the gender gap in bicycling is especially important for women's health because of the many physical activity benefits of regular bicycling (*13, 14*) and the potential for safety in numbers (*16*).

This study explores the gender gap in bicycling by using a very large existing household travel survey data set from Oregon to systematically examine differences in the individual, household, and trip and activity characteristics of bicycling and nonbicycling women and men. By identifying factors potentially associated with a larger or smaller gender gap in bicycling, this analysis can contribute to a stronger understanding of the gap and inform strategies to increase bicycling among women. The study is exploratory, allowing the use of a large data set to uncover potentially new explanations for the gender gap. The analysis examines some of the hypotheses for why the bicycling gender gap exists; namely, the constraints imposed by women's household responsibilities. Partial support for this conventional explanation is found, but the findings line up more strongly with a different explanation: that women who bicycle are more likely to do so by choice; whereas, women with fewer means are less likely to turn to bicycling than are their male counterparts.

BACKGROUND

Researchers have proposed many explanations for the gender gap in bicycling (*13*). These explanations include gender-based differences in attitudes and preferences (particularly surrounding bicycle facilities and safety), gender differences in time constraints and household responsibilities, and gendered social norms.

One potential reason for the gender gap is that existing bicycle facilities do not match women's preferences (*1*). Several studies have found that women are more concerned than men with safety while traveling (*11, 13, 17, 18*), despite no evidence that women are more likely to be involved in bicycling collisions (*11, 13*). A common explanation is that women tend to be more risk-averse (*19*). As a result, in automobile-dominant cultures, women are less likely to feel safe while bicycling, whether their concerns are about traffic safety or personal security (*4*). Similar safety concerns also deter walking for women (*20, 21*). Women more strongly prefer separated bicycle facilities, such as protected bicycle lanes, off-street paths, and traffic-calmed streets such as bicycle boulevards, over standard on-street bicycle lanes (*1, 4, 9, 10, 18, 22, 23*). Yet these preferred

P. A. Singleton, P.O. Box 751–CEE, Department of Civil and Environmental Engineering; and T. Goddard, Nohad A. Toulan School of Urban Studies and Planning, P.O. Box 751–USP, Portland State University, Portland, OR 97207-0751. Corresponding author: P. A. Singleton, patrick.singleton@pdx.edu.

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facilities are still less common than bicycle lanes in American cities (*24*). Because safety perceptions play a significant role in bicycle mode choice (*3, 4*), the mismatch between existing bicycle facilities and the types of facilities that women view as safe and comfortable may be an important driver of the gender gap.

Another common explanation for bicycling's gender gap is that women in families may have different responsibilities and more time constraints that restrict their ability to bicycle than do their male counterparts. Despite generational changes in the gender makeup of the workforce, even employed women still often take on more responsibility for household maintenance and childcare than employed men (*25, 26*). Taking charge of household tasks such as grocery shopping, running errands, and escorting children means that women may have more demands on their time and need to use faster travel modes that are capable of carrying people and goods. Women often list having to transport goods and people as a barrier to bicycling (*4, 27*). In addition, employed women may have to coordinate with employed partners when choosing job and home locations, and women's lower wages, on average, may result in longer and less ideal commutes (*26, 28*). These responsibilities might explain gender differences in travel behavior: women tend to work closer to home, conduct more trip chaining, and make more but shorter trips than men (*25, 28*). Some of these gender differences in travel behavior extend to bicycling behavior (*5*).

A number of other gender-gap explanations have been proposed. There is little support for the presumption that women inherently dislike bicycling (*13, 29, 30*). Although some studies show a slightly less-positive attitude toward bicycling among women (*17*), others find that women are more motivated than men by the fun and enjoyment of bicycling (*10*). There is some evidence to suggest that helmets and bicycling gear deter women from bicycling because of an increased concern for hair and appearances (*11, 13*), which may relate, in particular, to gendered norms about workplace appearance. Many of these differences could be tied to social normative gender roles.

Several papers have investigated gender differences in the characteristics, preferences, and travel behavior of people who bicycle (*5, 10, 17, 31*). In one study, women were more likely than men to bicycle for purposes such as shopping, errands, and visiting friends (*5*). Another study showed that some attitudes toward bicycling had gender-specific effects on the odds of bicycling (*17*). A third study found that women were more likely to identify constraints to bicycling, including weather, safety, air quality, and terrain (*10*). Another study found that women had stronger preferences for protected bicycle facilities and for bicycle signals (*31*).

The authors' approach to this study was exploratory but also structured generally around some hypotheses that reflect the findings of the previously cited literature. Because of inherent data limitations in this study, neither differences in attitudes and preferences nor differences in perceptions of traffic safety and use of bicycle facilities could be directly examined. However, the hypothesis that a lower proportion of women bicycle because they are more constrained than men by household maintenance responsibilities was scrutinized. If women's childcare responsibilities are a barrier to bicycling, single women and women without children should have bicycled at similar rates to their male counterparts, or at least significantly more than women with children. Regardless of the presence of children in the household, women conducting more household maintenance activities such as shopping were expected to have been less likely to bicycle. Attenuated or no similar trends in bicycling for men were anticipated. It was also hypothesized that low-income women would bicycle more than higher-income women, similar to the trend seen among men. Examining bicycling by gender across demographic and household variables allowed the identification of possible characteristics of women who bicycle in numbers similar to their male counterparts, or at least with a reduced gap. Understanding areas with the largest gender gaps in bicycling may suggest possible interventions to close the gap or identify target populations for those interventions. This study examined these questions in the exploratory analysis of bicycling's gender gap.

DATA AND METHOD

To examine factors potentially associated with the gender gap in bicycling, travel survey data gathered as part of the statewide 2009–2011 Oregon Household Activity Survey (OHAS) was used (*32*). The sampling frame was the set of valid Oregon household addresses. Household members were recruited by phone or mail and used an activity diary to record their places, activities, and travel modes for a single weekday. Survey data were weighted by using person weights that attempted to adjust OHAS results due to the sampling strategy and sample non-response. The weights were developed to match regional census distributions of home ownership and age of head of household (*33*).

The analysis focused on a representative sample of all adults, aged 18 and older, living in Oregon. The weighted (unexpanded) data set reflected an estimated 30,090 adults. Subjects were grouped by self-reported gender—female or male—and by several different measures of bicycling. Using one measure, an estimated 453 women (2.8%) and 768 men (5.5%) made a bicycle trip on the survey weekday. Using a different measure, an estimated 356 women (2.2%) and 665 men (4.8%) normally used a bicycle to get to work or school. To identify people who regularly bicycle within the confines of a one-day travel diary survey, the two measures were combined for most of the analysis. Using this combination to define a "bicyclist," an estimated 590 women (3.6%) and 1,023 men (7.4%) either made a bicycle trip or normally commuted by bicycle. (When investigating measures of trips and activities specific to the day of the travel diary, the analysis was limited to adults who traveled on that day, and bicyclists were considered only to be those who made a bicycle trip on the survey day.) Although merging measures of bicycle trip-making and bicycle commuting has the potential to bias estimates of the gender gap in bicycling, in general, these data showed that the overall gender gap was similar for the two measures. The authors believe the larger size of their combined bicycling measure, although flawed by data limitations, comes closer to capturing who actually bicycles.

Bivariate analyses were conducted of bicycling and nonbicycling women and men across levels of different variables of interest, where the percentages of women and men bicycling across the variable levels were observed. These factors of interest included individual, household, and trip and activity characteristics; the socioeconomic characteristics of travelers are considered critical determinants of mode choice (*34*). The statistical analysis used Pearson's chi-square tests of independence on two-way contingency tables (*35*). Four tests were conducted for each variable of interest and compared

1. Men and women defined by the authors as bicyclists,
2. Women and men who did not bicycle,

3. Women bicyclists and nonbicyclists, and
4. Men bicyclists and nonbicyclists.

These four tests were designed to identify potential gender differences among bicyclists and potential gender-specific associations of explanatory factors with bicycling. Data analysis was performed in *R* statistical computing (*36*) using the "survey" and "weights" packages (*37, 38*). To control for the possible inflation of Type 1 errors due to the large number of hypotheses tests (116), the Dunn-Bonferroni method (*39*) was used, with a desired familywise error rate of 0.10.

Some combinations of findings were of particular interest for understanding the gender gap in bicycling. A significant difference in Test 3 and no significant difference in Test 4 indicated that this variable had a women-specific association with bicycling because there was no significant association with bicycling for men. However, significant differences in both Tests 3 and 4 suggested an association with bicycling overall, with potentially less to say about the gender gap. The authors were slightly less interested in results of the first two tests. While a significant difference in Test 1 indicated differences between women and men who bicycle, this could be explained (if Test 2 is also significant) by societal and non-bicycle-specific differences between women and men. In reporting the results, these variations were investigated in more depth. The key findings of the four tests are presented in the results section. A more nuanced interpretation of the results appears in the discussion section.

RESULTS

Table 1 displays the results of the chi-square tests of independence. Tables showing the weighted cross-tabulations of bicycling and nonbicycling women and men and the percentages of women and men bicycling across variable levels are not presented because of space limitations but are available from the authors upon request. Figures 1 through 4 present the percentages of women and men who bicycled for different levels of selected variables: demographics and household composition, socioeconomics, mobility characteristics, and trips and activities.

Gender Gap in Bicycling

The analysis confirmed past U.S.-centered research about a gender gap in bicycling. In Oregon around 2010, the gap was roughly 2 to 1, with the percentage of men who bicycled (7.4%) roughly twice the percentage of women who bicycled (3.6%). This gap remained relatively consistent across different areas of the state, including the Portland, Oregon, region (9.6% of men vs. 4.7% of women).

Demographics and Household Composition

Significant differences between bicyclists and nonbicyclists in only one gender or the other suggested that a variable may be a factor in the bicycling gender gap (see Figure 1). Women living alone (i.e., in a single-person household) were significantly less likely to bicycle than women in households with more than one person. In a related but distinct measure, a significantly greater proportion of women living with another adult bicycled than did women living in single-adult households. There was no similar trend for men on either measure of household size. Women with two or more children bicycled in greater proportions than did other women; the number of children did not significantly affect the proportions of men who bicycled. In fact, the gender gap in bicycling was narrowest among adults with two children; although, women with two children still cycled at a lower rate than men with any number of children. However, the trends were different when examining children by age. Men in households with children aged 0 to 5 were more likely to bicycle than men in households without very young children, as were women (although the difference was not significant). A greater proportion of men with children aged 6 to 11 bicycled than did men without children of those ages, yet women exhibited an opposite (but not significant) trend. Proportionately fewer women bicyclists had adolescent children than did men bicyclists (78% vs. 85%).

However, significant differences in proportions of bicyclists for both genders suggested that a characteristic affects bicycling but does not necessarily contribute to a gender gap in bicycling. Bicycling rates decreased with age for both women and men, suggesting that age is a limiting but not gender-specific factor. Similarly, disability status predicted a much lower rate of bicycling for both men and women. Student status increased the likelihood of bicycling for both men and women. There were several demographic and household composition variables that did not have a significant relationship with either gender or bicycling, including the presence of older children (ages 12 to 17) and the race or ethnicity of the household respondent.

Socioeconomics

Several individual and household characteristics related to socioeconomic status seemed to relate to bicycling differently for women than for men (Figure 2). Overall, employed people were more likely to bicycle, an association that was stronger for women than for men. Relatedly, a greater proportion of both women and men with undergraduate or graduate degrees bicycled, but very few women without a high-school degree bicycled, a deficit not observed among men. And, while low-income men were more likely to bicycle than were middle- and high-income men, low-income women were less likely to bicycle than were other women. With respect to housing type, a greater proportion of men in multifamily housing bicycled than did men in single-family housing, yet there was no significant difference for women.

Other housing characteristics did not appear to have gender-specific associations with bicycling. For both women and men, renters were more likely to bicycle than were homeowners. And for both women and men, bicycling was negatively associated with the length of time living in the current home.

Mobility Characteristics

Characteristics related to mobility options also appeared to have different associations with bicycling for women and men (Figure 3). While men without a driver's license were slightly (but not significantly) more likely to bicycle, women without a driver's license were much less likely to bicycle than women with a driver's license. As a result, a significantly greater proportion of women bicyclists had driver's licenses than did bicycling men. In general, the percent-

TABLE 1 Pearson's Chi-Square Tests of Independence on Counts of Bicycling and Nonbicycling Women and Men Across Variable Levels Using Weighted OHAS Data

Variable	Degrees of Freedom	1 Bicyclists: Women vs. Men		2 Nonbicyclists: Women vs. Men		3 Women Bicyclists vs. Nonbicyclists		4 Men Bicyclists vs. Nonbicyclists	
		χ^2	p	χ^2	p	χ^2	p	χ^2	p
Demographics and Household Composition									
Age	3	1.10	.7772	8.124	.0435	**153.36**	**.0000**	**242.76**	**.0000**
Disability status	1	2.16	.1416	6.342	.0118	**47.73**	**.0000**	**54.53**	**.0000**
Student status	1	1.18	.2781	3.126	.0771	**76.30**	**.0000**	**93.93**	**.0000**
Race–ethnicity	2	5.47	.0650	2.276	.3204	4.570	.1018	2.37	.3051
Household size	3	15.62	.0014	**158.80**	**.0000**	**47.89**	**.0000**	2.51	.4730
Number of adults in household	3	16.37	.0010	**386.11**	**.0000**	**73.07**	**.0000**	8.51	.0366
Number of children in household	3	**45.62**	**.0000**	9.78	.0205	**66.07**	**.0000**	14.78	.0020
Children ages 0–5 in household	1	0.05	.8213	4.89	.0271	5.67	.0173	**19.96**	**.0000**
Children ages 6–11 in household	1	**13.14**	**.0003**	1.12	.2905	4.23	.0397	**13.59**	**.0002**
Children ages 12–17 in household	1	0.95	.3308	2.90	.0887	8.80	.0030	7.61	.0058
Socioeconomics									
Education level	5	**24.18**	**.0002**	**55.43**	**.0000**	**171.59**	**.0000**	**219.11**	**.0000**
Worker status	1	**43.61**	**.0000**	**85.79**	**.0000**	**181.78**	**.0000**	**35.48**	**.0000**
Household income	3	10.15	.0174	**109.95**	**.0000**	**26.16**	**.0000**	**16.63**	**.0008**
Housing type	1	**20.07**	**.0000**	**36.64**	**.0000**	1.59	.2069	**143.62**	**.0000**
Homeownership status	1	0.96	.3264	**37.43**	**.0000**	**44.78**	**.0000**	**87.09**	**.0000**
Length of time in current home	4	11.73	.0195	15.11	.0045	**92.16**	**.0000**	**158.64**	**.0000**
Mobility Characteristics									
Driver's license	1	**21.83**	**.0000**	10.30	.0013	**23.71**	**.0000**	3.21	.0733
Number of vehicles per licensed driver	3	**44.70**	**.0000**	**107.96**	**.0000**	**516.82**	**.0000**	**391.36**	**.0000**
Number of bicycles in household	3	**68.13**	**.0000**	**28.56**	**.0000**	**770.34**	**.0000**	**827.36**	**.0000**
Number of bicycles per person in household	3	3.13	.3722	**32.42**	**.0000**	**868.14**	**.0000**	**1051.68**	**.0000**
Transit pass	1	1.76	.1847	0.71	.4009	**84.13**	**.0000**	**202.72**	**.0000**
Trip and Activities									
Survey day of week (Monday–Friday)	4	**60.57**	**.0000**	16.38	.0026	**51.88**	**.0000**	**24.77**	**.0001**
Number of trips, work- or school-related	2	**38.01**	**.0000**	**331.38**	**.0000**	**172.87**	**.0000**	13.42	.0012
Number of trips, household-serving	2	4.20	.1225	**532.64**	**.0000**	**35.86**	**.0000**	12.09	.0024
Number of trips, discretionary or recreation	2	2.19	.3344	**80.08**	**.0000**	**51.99**	**.0000**	**150.28**	**.0000**
Number of trips, escorting household member	2	**31.77**	**.0000**	**352.47**	**.0000**	**23.37**	**.0000**	**22.14**	**.0000**
Time, at work or school	3	**47.94**	**.0000**	**495.17**	**.0000**	**211.88**	**.0000**	13.81	.0032
Time, household-serving activities	3	**32.73**	**.0000**	**442.12**	**.0000**	**44.38**	**.0000**	**42.49**	**.0000**
Time, discretionary–recreation activities	3	13.27	.0041	**92.04**	**.0000**	**129.25**	**.0000**	**189.66**	**.0000**

NOTE: Bold text indicates a significant difference: $p < .000862 = 0.10 \div 116$ tests (Dunn-Bonferroni method).

ages of both women and men bicycling decreased with increasing automobile ownership, yet some interesting trends were apparent. Auto-owning men and women with less than one vehicle per licensed driver bicycled in greater proportions than people with more than one vehicle per licensed driver. However, women in zero-vehicle households were the least likely to bicycle, while men in zero-vehicle households were the most likely to bicycle. Regarding bicycle ownership, a greater number of bicycles per person was associated with an increased likelihood of bicycling for both women and men. However, the gender gap in bicycling was narrowest among adults in households with more than three bicycles and with more than one bicycle per person. The positive association of transit pass holding with bicycling was similar for both women and men.

Trips and Activities

Finally, a number of characteristics related to trip-making and activity participation of adult travelers appeared to have gender-specific associations with bicycling (Figure 4). A greater proportion of women surveyed on Fridays bicycled than did women surveyed on other weekdays (5.3% vs. 2.7%); Tuesdays and Thursdays were high-bicycling days for men (7.6% vs. 5.5%). Mirroring the trend in worker status, women who made any trips for work or school were more likely to bicycle than were women who made no work or school trips. Similarly, a greater proportion of women spending more than 4 h working or in school during the day bicycled than did women working fewer hours. There were no similar trends with

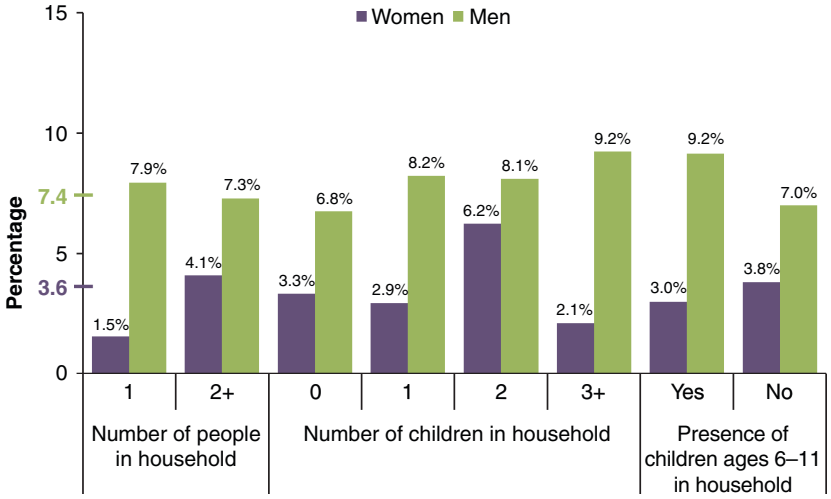

FIGURE 1 Percentage of bicyclists by gender for demographics.

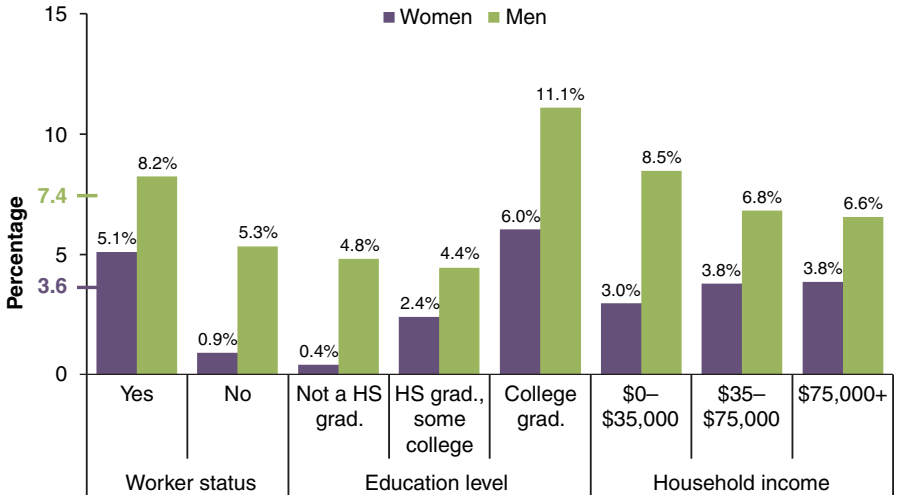

FIGURE 2 Percentage of bicyclists by gender for socioeconomics (HS = high school; grad. = graduate).

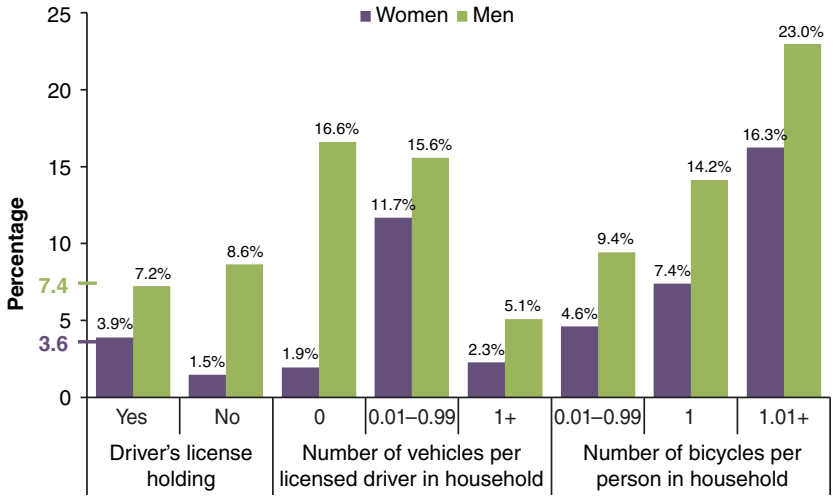

FIGURE 3 Percentage of bicyclists by gender for mobility characteristics.

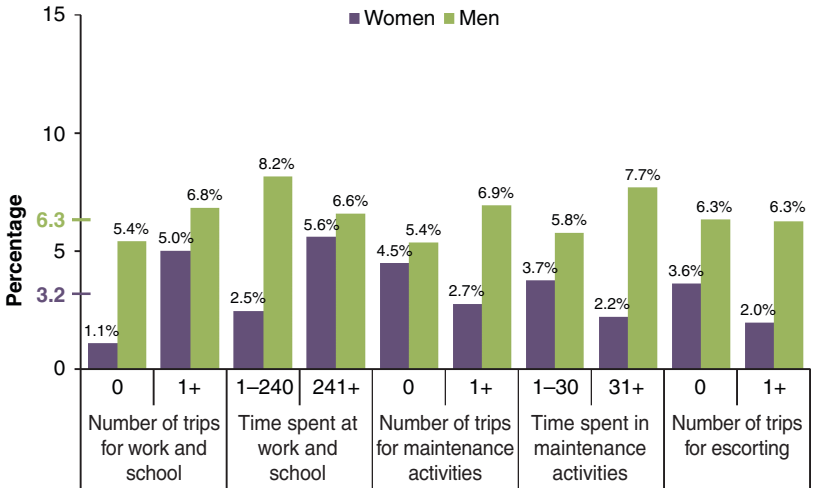

FIGURE 4 Percentage of bicyclists by gender for trips and activities.

work or school and bicycling among men. Opposite trends appeared with trips for household maintenance activities. While women traveling for maintenance activities were slightly less likely to bicycle than women making no household-serving trips, men were slightly more likely to bicycle. A smaller proportion of women spending more than 31 min on maintenance activities bicycled than did women spending less time on maintenance activities; the opposite was true for men. When examining only trips escorting other household members (a subset of household maintenance trips), women making any escort trips were less likely to bicycle than were women making no escort trips; there was no such association with bicycling for men. While the number of discretionary trips and the duration of time spent in discretionary activities was positively associated with bicycling for both women and men, there appeared to be no significant gender differences.

DISCUSSION OF FINDINGS

The results of the analysis appear to run partially counter to what previous research has found, and contrary to the authors' general hypotheses that women without children, women living alone, and lower-income women would be more likely to bicycle. When the data were more deeply examined, what appeared to be a different story was found: women who bicycle are more likely to be bicyclists by choice, while women with fewer economic and mobility means are less likely to turn to bicycling. More broadly, the data suggested that women and men are not homogeneously affected by sociodemographic and mobility characteristics. The differences between women bicyclists and nonbicyclists, and between bicycling women and men, painted a picture that revolves around issues of class and resources, with specific traits that did not seem to affect men in the same way.

Bicycling as a Choice

Women with greater economic means and more mobility options may view bicycling as a "choice" activity in which they can participate if and when they want. For example, women bicyclists were more likely to have a higher income, be employed, have a driver's license, and have access to a motor vehicle. These characteristics all suggest that for many women who bicycle, bicycling is not a necessity, but a choice. Interestingly, women surveyed on Friday were more likely to bicycle. A possible explanation is that Fridays are a more flexible day in some (particularly white-collar) workplaces with respect to both hours and dress, which may free women to choose the bicycle as their mode of transportation.

Another finding to support the choice gap is that women with three or more bicycles in the household, and more than one bicycle per person, were more likely to bicycle. This might be explained by households that can afford, and choose to own, multiple types of bicycles on the basis of desired use (e.g., a road bike and a mountain bike). In addition, owning multiple, potentially specialized, bicycles may reflect a probicycling attitude, which strongly predicts both bicycle ownership and regular use (*40*). Data limitations (no information on bicycle types) prevent explaining these findings fully, but they are suggestive of these resource gap or attitudinal factors.

Bicycling, or Not, by Necessity

Women at the other end of the resource spectrum, however, are not bicycling in similar numbers. Women who did not have a high-school degree, were not workers, lived in low-income households, and made no trips for work or school on the day of the survey were much less likely to bicycle. Conversely, men with less resources (e.g., low-income) were actually more likely to use a bicycle. This finding suggests that, for women with constrained means, the bicycle may not be perceived to be a viable transportation mode.

Women with limited automobile-centric mobility options were less likely to bicycle, which was not true of men. Women without a driver's license were much less likely to bicycle, as were women in zero-vehicle households. While men without automobile-related options were more likely to use a bicycle, women were less likely. This finding again suggests that, for women facing constraints, bicycle transportation is not a viable choice.

Bicycling as a Social Activity

The finding that single women bicycled less than women in households with more than one adult was surprising at first. There is evidence, however, that women are more likely to bicycle with others; that is, women view bicycling as a social activity (*1, 3, 4, 10, 12, 13*). The importance of collective household decision making on bicycling behavior is an area worthy of future study. Numerous programs exist that seek to increase women's bicycling via the social aspect of group rides (*13, 18*), but research on the effect of intrahousehold social support on women's bicycling in particular is more limited.

Women and Household Roles

The authors' hypotheses about women's greater household responsibilities contributing to the bicycling gender gap were partially supported, including that in the area of household-serving (maintenance) trips. Maintenance trips cover a wide range of activities, including grocery shopping, personal business (e.g., visiting the post office), eating outside the home, taking a passenger by car, and going to a healthcare appointment. Women who made any trips for maintenance activities were slightly less likely to bicycle than women who made no trips for maintenance activities. However, men making more trips for maintenance activities were slightly more likely to bicycle. This may contribute to the bicycling gender gap, because a greater portion of women made some trips for maintenance activities than did men (72% vs. 61%). This difference may reflect, in part, that men and women may not be making the same types of maintenance trips, because some activities lend themselves to bicycle use more easily than others (e.g., eating out vs. making a large grocery run). Further analyses could disaggregate maintenance trips to explore this hypothesis.

As expected, time spent on household maintenance activities was also significantly related to bicycling for women, but not for men. Women participating in household-serving trips were less likely to bicycle, and a greater proportion of women spent more than 30 min on maintenance activities than did men (47% versus 38%), which may further widen the bicycling gender gap. This may be compounded for women who are solely responsible for household maintenance. Women living in one-person households were much less likely (rather than more likely) to bicycle, as were women who were the sole adult in their household. This trend may contribute to the gender gap, because a greater proportion of women lived in one-person households than did men (17% versus 13%), and even more women lived in single-adult households than men (22% versus 13%).

The presence of children in a household had mixed results. While women with two children were more likely to bicycle, women with children aged 6 to 11, specifically, were slightly less likely to bicycle. Previous research has demonstrated a reluctance among U.S. parents to allow children aged 11 and younger to independently travel to school (*41*), and escorting by bicycle may be less feasible than escorting by car; women making escort trips were significantly less likely to bicycle. Also, children at this age may be engaged in other activities more easily served by the automobile, statistics that may be captured in the greater number of women making maintenance trips.

Overall, the results confirmed previous research and the hypotheses in some areas (e.g., household maintenance) but suggested an unanticipated split along class lines that affect women differently than men. This may suggest a need to re-think programs or interventions aimed at reducing the bicycling gender gap, especially any one-size-fits-all solutions that may be unhelpful, or even alienating, to women for whom the bicycle does not currently serve as a viable transportation mode. That the bicycle provides transportation options to men of lower resources but is not used by women in similar situations has important policy implications.

Potential Policy Implications

Because the analysis focused mostly on individual and household characteristics and did not consider bicycle facilities or the built environment, the policy implications for land use and transportation planning and engineering are limited. However, levels of personal characteristics where the gender gap in bicycling is accentuated highlight potential demographic groups of women to target with interventions. Specifically, women who tend to bicycle proportionately less than other women are living alone, have less than a high-school education, are not working, do not have a driver's license, and are living in a low-income and zero-vehicle household. Men with similar characteristics do not bicycle proportionately less than other men and may even bicycle more.

This demographic of women may be harder to reach by traditional targeted marketing and may not benefit as much from bicycle facilities designed and installed in locations to support bicycle commuting to the central city or bicycling amenities in the workplace. The authors are unable to recommend specific interventions, which might include infrastructure installations (e.g., protected bike lanes in low-income areas), awareness raising (e.g., maps of low-stress bicycle routes to nearby destinations), training and skills-building (e.g., bicycle maintenance, riding a bicycle in traffic, all-weather bicycling), and social events (e.g., bicycling group rides, open streets events). Across the country, there are many programs aimed at decreasing barriers to bicycling among women, including low-income and immigrant women (*42*). One example is WE Bike NYC, whose tagline is "Women's Empowerment through Bicycles." In addition to general group rides, workshops, and field trips for all women, WE Bike NYC has programs aimed at mothers and children as well as low-income, Spanish-speaking mothers (*43*).

Limitations and Future Work

This study had several limitations that could be addressed in future work. Methodologically, many differences in individual, household, and trip characteristics were likely correlated to varying degrees. While the tests of independence revealed important differences among bicycling and nonbicycling women and men, a full multivariate gender-interacted model of bicycling could illuminate primary differences in each factor by parsing out the effects of other variables. The authors plan to conduct a multivariate analysis as a follow-up to this study. Despite best attempts at mitigation, the bicycling measure used was from a one-day travel survey, possibly obscuring more systematic differences between women and men who bicycle, in general, less frequently or seasonally. A measure that assesses the frequency of bicycling for different purposes (e.g., transportation or recreation) could be more effective at finding potential explanations for the gender gap in bicycling.

Because of data limitations, the authors were unable to investigate several hypothesized explanations for the gender gap in bicycling. Although an examination of the neighborhood-scale built environment (e.g., density, diversity, design) was considered, the authors

noted that these types of factors may have less to do with the gender gap in bicycling than do more microscale environmental measures. However, bicycling studies have rarely examined gender interactions with the built environment, so this may be an interesting area for future research. However, because there was no access to statewide information on the proximity, type, and quality of bicycle facilities, the authors were unable to examine the gender-specific impact of street-level urban design on bicycling. Furthermore, the OHAS study included no questions about bicycling attitudes, norms, and preferences, especially with respect to bicycling comfort or safety. Such attitudes and social norms may help to explain why certain women were less likely to bicycle.

It would be valuable to further examine the findings in more detail: for instance, a closer look into the trip-making, activity participation and household role assignment of women who bicycled and those who did not bicycle. Examining the propensity of women to bicycle with respect to participation in different types of maintenance activities (e.g., grocery shopping, shopping for major purchases, visiting the bank) could help to illuminate these issues. It may also be useful to understand how women with limited mobility options who do not bicycle get around: Do they walk or use transit more? Finally, it would be valuable to see whether the findings could be replicated outside of Oregon by using different data sets.

Future work should consider qualitative interviews and case studies (*18, 27*) to supplement travel diaries and questionnaires. Such mixed-method studies might be better able to answer why more women—especially women living alone and those with limited economic means and fewer mobility options—do not turn to the bicycle to the same extent as do men under similar conditions. Do they not have the time to learn how to adapt bicycling into their routines or to figure out how to navigate the city by bicycle? Do they not have the financial means to acquire a bicycle and bicycling accessories and to maintain them in good working order? Is a lack of bicycle parking and storage a deterrent? Are there other social and cultural barriers or influences that lead some women to not even consider bicycling as an option? These important questions are left to future research.

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