Commute Well-Being among Bicycle, Transit, and Car Users in Portland, Oregon

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ABSTRACT

To understand the impact of daily travel on personal and societal well-being, measurement techniques that go beyond satisfaction-based measures of travel are used. Such metrics are increasingly important for evaluating transportation and land-use policies. This study examines commute well-being, a multi-item measure of how one feels about the commute to work, and its influences using data from a web-based survey that was distributed to Portland, Oregon, U.S.A. workers. Valid surveys (n=828) were compiled from three roughly equally sized groups based on mode: bike, transit and car users. Average distances between work and home varied significantly among the three groups. Descriptive results show that commute well-being varies widely across the sample. Those who bike to work have significantly higher commute well-being than transit and car commuters. A multiple linear regression model shows that along with travel mode, traffic congestion, travel time, income, health, job satisfaction and residential satisfaction also play important individual roles in shaping commute well-being. While more analysis is needed, these results support findings in previous research that commuting by bike enhances well-being while congestion detracts from well-being. Implications for future research and sustainable transportation policy efforts are discussed.

INTRODUCTION

The term "subjective well-being" (SWB) is rooted in psychology and is defined as an evaluation of one's happiness or life satisfaction. Researchers are applying measurements of SWB in studies of how different circumstances, policies, and choices affect quality of life, happiness, and life satisfaction. A growing body of research extends the study of SWB from overall life satisfaction to specific life domains, such as relationships and work. Travel behavior researchers have begun collaborative research to apply SWB metrics to travel (*1-6*). At this point, however, there is only a scattering of empirical evidence of how travel affects SWB and most of it is was researched outside the U.S.

Well-being studies complement a growing chorus that argues that policies should focus on well-being, rather than on economic indicators. Nobel-prize winning psychologist Danial Kahneman and others maintain that SWB measurements could complement conventional tools for measuring benefits and losses in policy analysis (*7*). Current transportation-related goals such as increasing accessibility and reducing vehicle miles traveled, single occupancy vehicle trips, and greenhouse gases do not account for well-being explicitly. They also may have limited appeal to the public (*8*). Demonstrating increased SWB from modes of transportation consistent with transportation related goals could help policy makers to better market transportation policies.

Transportation research and planning has focused heavily on individuals' decisions about travel and less on the experiences resulting from their decisions. Travel mode choice models often fail to capture key factors, for example - feelings of freedom or personal safety, associated with travel experiences (*9-10*). Accounting for SWB in travel experiences will improve predictions of future mode choices and how well-being is affected by these choices (*1*).

This paper presents a model of "commute well-being" (CWB), a multi-item measure of the experience of commuting to work. This model builds on work by other researchers and represents one of the first applications of this metric in the U.S. It uses data gathered in winter 2012 from commuters who travel to work in central Portland, Oregon via car, public transit, and bicycle. U.S. Census ACS 2009 data show that commute mode shares for bike and transit (6 and 12 percent of commute trips, respectively) are relatively high in Portland, making it a good testing ground for evaluating the impact of modes on CWB.

REVIEW OF EXISTING LITERATURE

Measuring travel well-being

There have been several recent efforts to include measures of affect (how one feels or experiences travel) so as to more holistically measure satisfaction with travel. Such studies have paid particular attention to how mode, commute length, sociodemographics, and comparisons with others' commutes affect travel well-being.

Anable and Gatersleben looked at affective and instrumental factors and found that for commuting, instrumental factors such as convenience were more important to commuters but that affective factors such as "no stress", control, and freedom were still important (*9*). A second study by Gatersleben and Uzzell examined primary sources of pleasure and displeasure for commuters by mode (*11*). These included delays and traffic (for drivers); delays (for public transport); other road users (for cyclists); poor infrastructure and "noise, pollution, and danger" from vehicle traffic (for pedestrians). Both studies find that bicyclists are most satisfied with their mode, but the researchers do not take land use factors (e.g. accessibility) or trip distance/time into account.

Based on findings about enjoyment of commutes, Páez and Whalen used survey data from 1,251 university students in Hamilton, Ontario, Canada and analyzed commute satisfaction by obtaining the ratio of ideal commute time to actual commute time (*12*). They regressed this value on mode, socio-demographic attributes, and attitudes and found that bike/walk commuters are least dissatisfied with their commute, while car, and to a greater extent, transit commuters are more dissatisfied. Those who walk/bike and strongly agree that "getting there is half the fun" would like to commute longer distances.

Jakobsson Bergstad et al. developed a Satisfaction with Daily Travel (STS) scale (*6*). It is quite similar to the Satisfaction with Life Scale and includes statements such as “I am completely satisfied with my daily travel” and “When I think of my daily travel the positive aspects outweigh the negative” and asked respondents to use Likert scale rankings. The scale is reliable, with a Chronbach’s alpha of .77. Ettema et al. help enhance the STS scale by adding specific measures of affective responses to travel, including scales of affect (i.e. relaxed versus time-pressed, calm versus stressed, alert versus tired, enthusiastic versus bored, and engaged versus unengaged) (*4*). The multi-item scale showed high statistical reliability, as Chronbach’s alpha was .91. Even with the latter refinenments, the STS scale still does not include any specific measures of enjoyment in its affective response questions. Feelings of pleasure, escape, thrill, and other feelings would not fall clearly into this scale.

Abou-Zeid and Ben-Akiva focus on how social comparisons affect commute satisfaction. Survey questions of commuters asked about the mode, stress level, and commute time of another person whose commute is familiar to them (*2*). Using structural equation models, the authors find that favorable comparisons with others’ commutes and with previous personal commutes are significantly associated with higher commute satisfaction. Having a shorter commute significantly increases favorable comparisons with other commutes. Non-motorized mode-using commuters have favorable comparisons to others that commute by car, while car commuters have favorable comparisons when others also commute by car and negative comparisons when others commute by non-motorized modes. The authors also find that commute satisfaction is significantly increased by commute enjoyment and decreased by commute stress. Commute stress is found to be increased by longer travel times, higher travel time variability, frequent congestion (for car and bus users), and traveling alongside car traffic (for walk and bike commuters).

Sociodemographic variables such as age, income, household structure, vehicle availability, and gender are commonly associated with commute mode choice decisions (that likely impact commute well-being), but direct impacts on commute well-being (if any) are unclear. Jakobsson Bergstad et al. found that satisfaction with travel is higher in households without children and in households with older adults than in households with children and younger adults (*6*). This finding was in line with other studies showing that driving stress decreases with age and driving experience (*13*). Ettema et al. found that CWB was lower among men than women (*5*). However, earlier research by Novaco and others that found that females, in particular, show higher stress impacts from commuting (*13*).

DATA

Data was collected via web-based surveys that were completed between January 16 and March 7, 2012. Participating organizations were recruited via phone calls and emails to personal contacts and employers (often HR managers) in central Portland. In this study, central Portland includes downtown Portland and a roughly one-mile perimeter that includes the adjacent Lloyd District, Pearl District, Old Town Chinatown, and Central Eastside. Respondents were recruited via forwarded emails containing information on the

study from contacts within their organizations. Over 20 organizations, mostly private companies, distributed survey information. In addition, bike commuters were recruited by handing out cards during peak morning commute hours on three separate bridges leading to central Portland. Eligible participants must have commuted outside of the home to central Portland at least two days per week. 828 valid responses were collected. The overall response rate was 30%, although only 75% of surveys received were from respondents at a workplace or intercept site in which a known number of surveys were distributed.

The sample is not random and therefore is not generalizable to the Portland regions' population of commuters. The sample was convenience-based, largely based on organizations and individuals that were willing to participate in the study. Because the sample of commute trip destinations is drawn from "Central Portland," it neglects the large percentage of commute trips to other destinations within the region.

The data was analyzed primarily with SPSS and Microsoft Excel. Respondents' residential location was geocoded using ArcGIS software. Street network data was drawn from Metro's RLIS database, which contains detailed layers of information on the Portland region's (including Vancouver, Washington's) transportation and land-use network. Figure 1 shows a map of the shortest-path routes between home and work locations all valid survey respondents. Locations of homes are well-distributed throughout the Portland metro region.

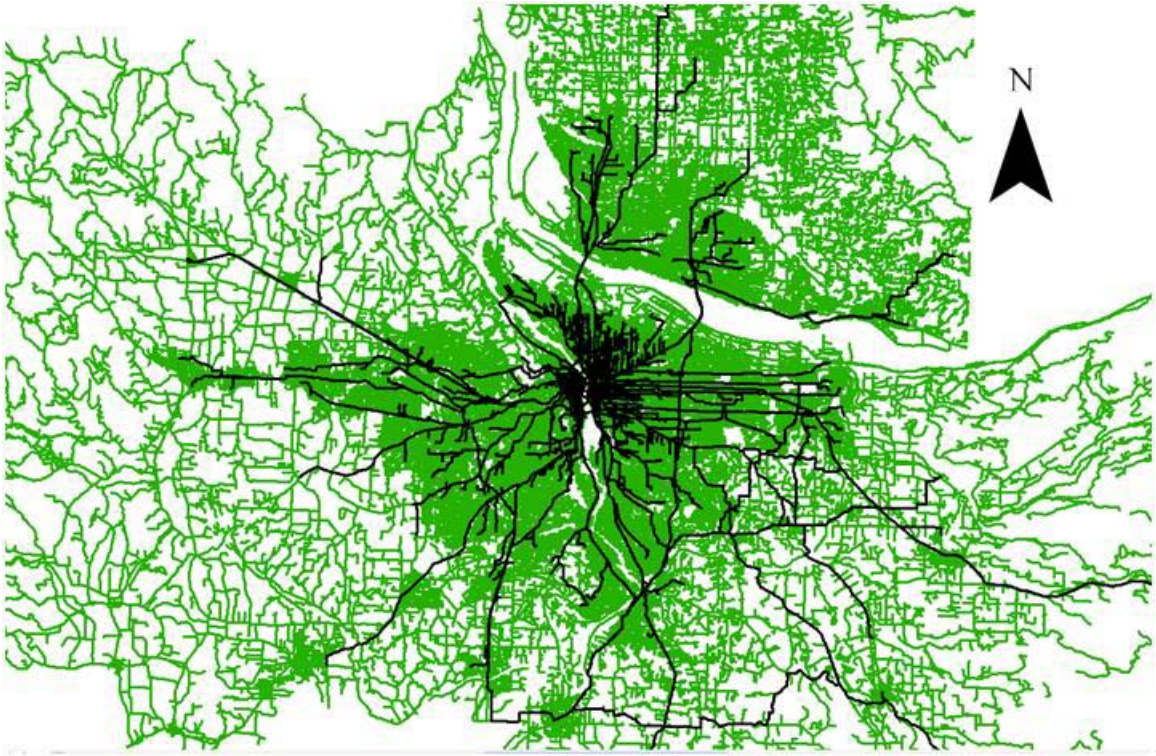


FIGURE 1 Map of shortest paths between respondents' home and work locations.

The demographic profile of respondents is somewhat different than of commuters to work in the Portland region based on Census CTTP 2006-2008 data for people working in (i.e. commuting to) Portland. As shown in Table 1, the majority of respondents fall into the 25 to 44 year age group, while the age distribution is more spread out for commuters to Portland. Bike commuters in this age group are

particularly overrepresented. Incomes of survey participants are somewhat higher than incomes of commuters to Portland overall. This is expected since jobs in central Portland provide higher wages than in other parts of the city. The percentages of female and white respondents in this study are slightly higher than for commuters to Portland overall. However, the percentage of female respondents that bike to work is low compared to the percentage of female respondents using car or transit. Although education and household structure data cannot be obtained from the CTTP, it is likely that respondents in the sample have higher education levels, particularly among bike commuters, compared to the commuters to Portland overall, but may be in line with workers in central Portland.

TABLE 1 Sociodemographic Description of Respondents

	Study Respondents				Commuters to Portland (CTTP)			
	Car	Bike	Transit	Total	Car	Bike	Transit	Total
Age 25 to 44	60.7%	82.4%	58.8%	67.0%	45.4%	47.3%	48.8%	48.0%
Income (% 75K or more)	55.3%	46.6%	47.0%	49.2%	51.9%	37.4%	37.9%	48.9%
Vehicle Availability (1 or more)	99.2%	87.7%	94.1%	93.2%	98.7%	77.2%	79.4%	94.6%
Gender (% Female)	60.5%	37.1%	59.8%	52.3%	NA	NA	NA	44.9%
Race/ethnicity (% white)	87.0%	90.9%	81.9%	86.8%	NA	NA	NA	76.4%
Education (% 4-yr college)	73.3%	90.8%	80.1%	81.2%	NA	NA	NA	NA
Children (% with children in hh)	34.4%	40.8%	41.1%	37.8%	NA	NA	NA	NA
Zipcar member	19.8%	31.0%	17.0%	22.3%	NA	NA	NA	NA
n	257	261	241	828	314,060	12,720	48,410	409,330

Survey questions were developed independently and borrowed from other researchers. Questions asked both about commuting in general and the most recent normal commute.

METHODS

Commute well-being is a composite measure adapted from Ettema, D., et al. (*4*). It uses an average of responses to the following seven questions following the statement “Please select the box that best corresponds to your experience during the [most recent commute] trip. For example, if you were very tense, select the box for -3. If you were neither tense nor relaxed, select the box for 0.”:

- Tense (-3) to Relaxed (3)
- Worried that you would arrive on time (-3) to Confident that you would arrive on time (3)
- Bored (-3) to Enthusiastic (3)
- Tired (-3) to Excited (3)
- Not enjoyable (-3) to Enjoyable (3)
- My trip went poorly (-3) to My trip went smoothly (3)
- My trip was the worst I can imagine (-3) to My trip was the best I can imagine (3)

The first five questions measure affective responses to the commute (i.e. how they felt during the commute) while the latter two questions measure cognitive responses (i.e. evaluations of the commute). A Cronbach’s alpha test measures the reliability (i.e. internal consistency) of the measure using the number of test items and the average inter-correlation among the items. Values range between 0 and 1, with values closer to 1 indicting greater internal consistency. The Commute Well-Being scale shows good internal consistency based on a Cronbach's alpha of 0.87.

In the next section, differences in CWB between modal, sociodemographic, trip-specific, and satisfaction-related variables are described and tested using t-tests and F-tests. Following that, CWB is regressed on these same variables, such that:

$$N = \beta + \beta'M + \beta'T + \beta'J + \beta'S + u \quad (1)$$

where
N = CWB;
M = mode variables;
T = travel time and traffic congestion variables;
J = job and residential satisfaction variables;
S = sociodemographic variables (i.e. education, race, income, gender, age, household structure); and
u = regression error term.

All of the independent variables are categorical except Commute Time and Age, which are continuous.

RESULTS OF ANALYSES

Descriptive Results

Average CWB scores range from -2.6 (indicating low CWB) to 3.0 (indicating high CWB). Mean CWB is 1.01 (S.D. = .995, n = 828) and the distribution of CWB is somewhat skewed to the right, as shown in Figure 2, meaning that the sample expresses positive commute experiences overall.

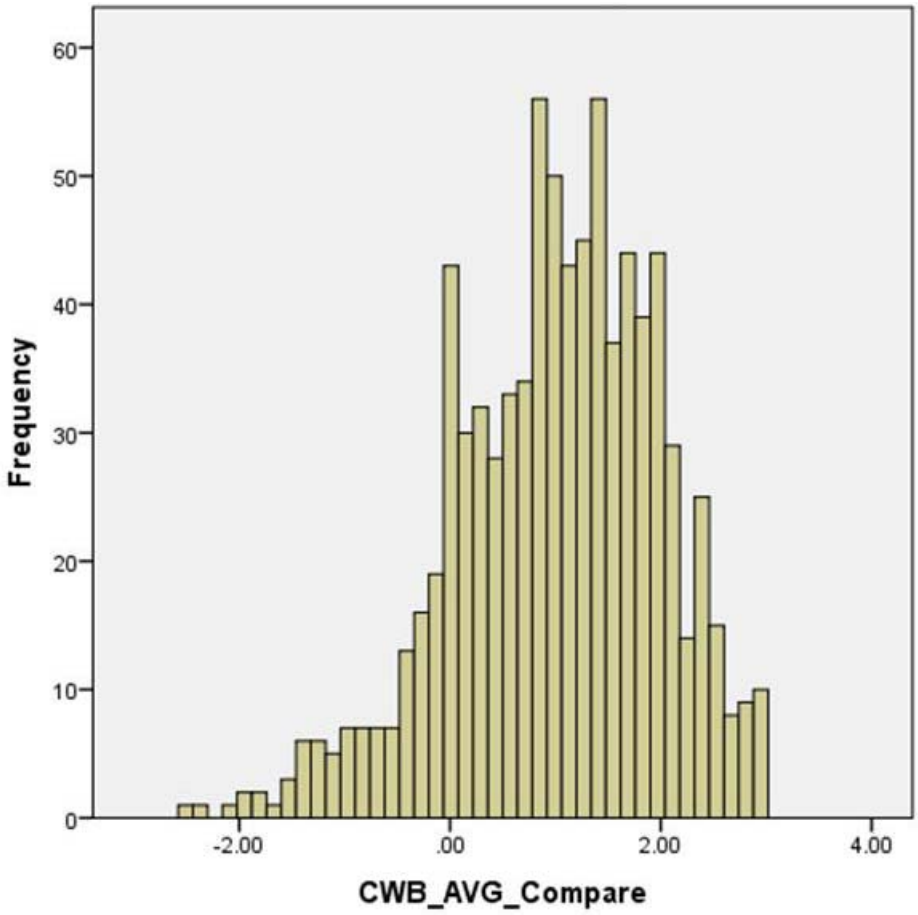


FIGURE 2 Distribution of commute well-being among respondents (n = 828).

Mode

Mean CWB among modes used by sample respondents are shown in Figure 3. Commuters that bicycle to work have the highest CWB (mean = 1.59; S.D. = 0.70, n = 261), while those who drive alone have the lowest CWB (mean = 0.59; S.D. = 1.01; n = 176), as. These results are in line with findings from similar research showing high commute satisfaction among non-motorized modes (*2, 9, 11-12*). Among car commuters, those who carpool to work have higher CWB (mean = 0.77; S.D. = 1.01, n = 79) than those who drive alone, however the difference is not statistically significant. Among transit users, CTRAN bus users (mean = 1.14; S.D. = 1.05, n = 19) had higher CWB than light rail (mean = 0.84; S.D. = 0.88, n = 100) and Trimet bus users (mean = 0.65; S.D. = 0.98, n = 100) and the differences were significant using t-tests ($p<.05$). CTRAN bus users likely use the express service from Vancouver, Washington to downtown Portland and Lloyd Center, both within central Portland. Along with having very few stops, CTRAN buses are equipped with more comfortable seating than Trimet buses. Trimet is the transit service for the Portland metro area in Oregon only. Trimet MAX (light rail) users have significantly higher CWB than Trimet bus users. This may reflect that light rail has greater comfort than trimet buses in terms of space, noise and ride smoothness. MAX also uses dedicated right of way that is not impacted by congestion.

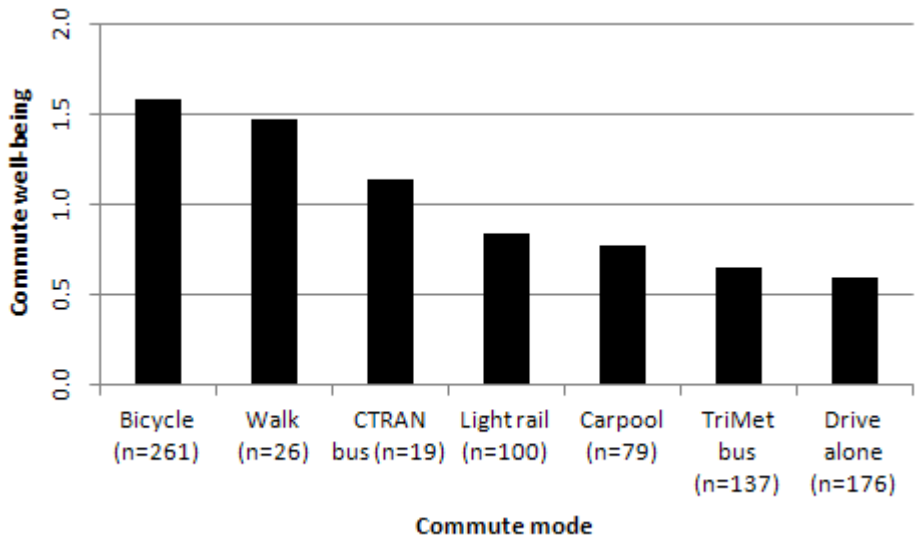


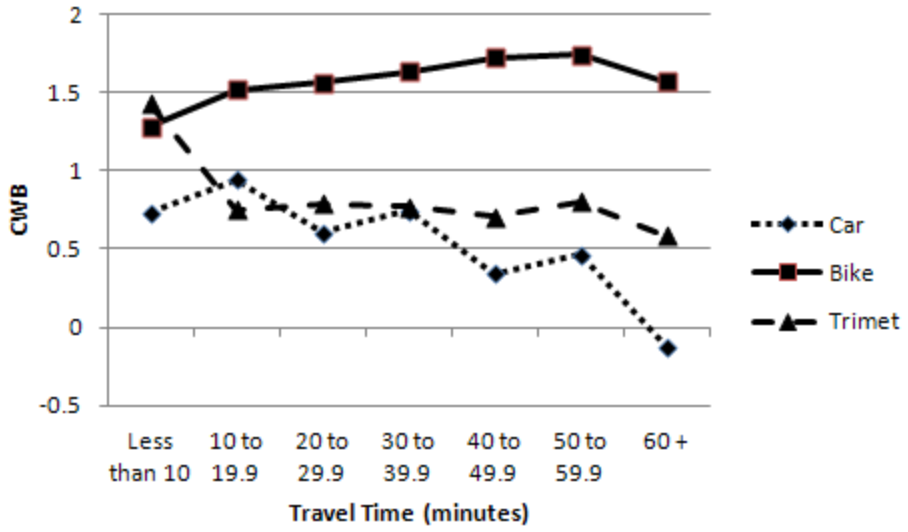
FIGURE 3 Commute well-being by mode (n = 828).

Travel Time and Congestion

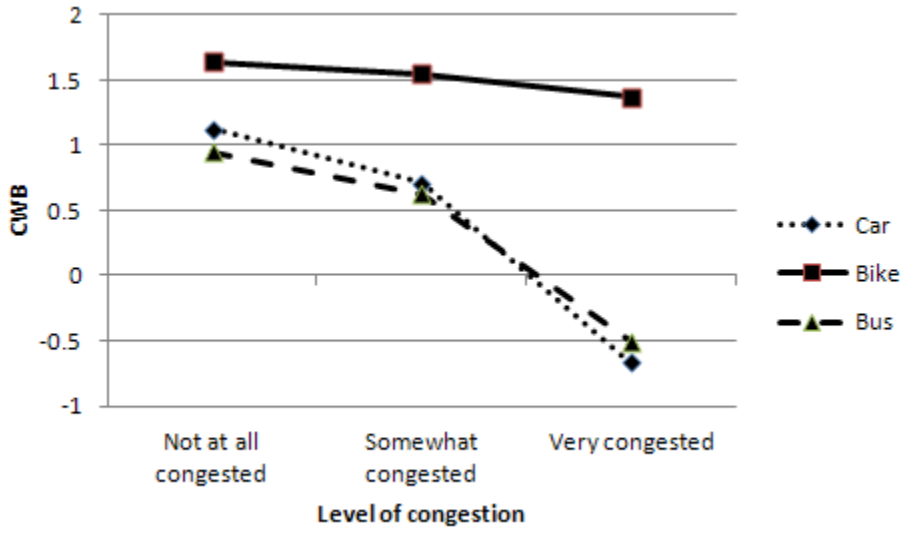
Travel time is weakly negatively correlated with CWB, with a Pearson Correlation coefficient of -0.17 ($p < .001$). Its association differs by mode, however. As shown in Figure 4, car commuters' CWB declines as travel time increases, although not in a linear way. Car commuters with (one-way) commutes in excess of one hour have the lowest CWB of all mode and travel time categories. For Trimet commuters, CWB stays relatively flat as travel time increases. For those who bike to work, CWB increases as travel time increases, but drops off after one hour. Bike and car commuters with short commutes (less than 10 minutes) have lower CWB than those with commutes of 10 to 20 and 30 to 40 minutes. These results are consistent with findings in other literature that note the importance of having some transition time between home and work.

Respondents were asked about the level of traffic congestion encountered during the commute (i.e. not at all, somewhat or very congested). For both car and bus commuters CWB decreases substantially as the level of traffic congestion increases, as expected. However, this is not the case for bike commuters. ANOVA tests confirmed significant differences in means for different congestion levels among car and bus commuters (both $p < .01$), but no significant differences among bike commuters. These findings are consistant with some other research but are not necessarily consistent with other research that finds that cyclists are sensitive to moderate and heavy traffic volumes (*2*, *11*, *14*).

Several possible reasons could explain the lack of significant change in CWB among bicyclists facing increasing traffic congestion. First, bicycle commuters may be able to navigate congested streets, often through using bike lanes or separated paths, while avoiding much delay. Second, it could be that cyclists in this study are more experienced than in the Sener et al. study. Third, there could be some measurement error. Respondents may have reported that their commute was heavily congested but only experienced traffic congestion at the very end of the ride (entering downtown, for example). Respondents that used MAX were not asked questions about congestion as light rail uses dedicated rights-of-way that are not subject to traffic congestion.



(a)



(b)

FIGURE 4 Mean CWB by commute travel time by mode (a) and level of congestion (b).

Job satisfaction, home satisfaction and health

Bivariate correlations show weak to moderate positive associations between CWB and job satisfaction (Pearson Correlation coefficient = 0.154, $p < .001$), home satisfaction (Pearson Correlation coefficient = 0.220, $p < .001$), and health (Pearson Correlation coefficient = 0.259, $p < .001$). These results are intuitive. Research shows that health and job satisfaction are common correlates of happiness or overall well-being, which may carry over to commute experiences (*7*).

Sociodemographic variables

Differences in mean CWB among different sociodemographic groups were calculated and T-tests (for two groups) and ANOVA tests (for more than two groups) were performed to examine whether the differences in means are statistically significant. Results are summarized in Table 2.

Significantly higher levels of CWB were found among commuters:

- Living in Portland city limits compared to those living outside Portland city limits;

- With four year college degrees compared to those without four year college degrees; and
- Identifying as white compared to those identifying with non-white race/ethnicity categories.

In addition, a bivariate correlation shows that CWB increases as household income category increases (Pearson Correlation coefficient =0.089, $p < .05$). However, the differences in mean CWB between income categories were not significantly different based on an ANOVA test.

Those living in Portland likely have higher CWB than those living outside of Portland because average distances and travel times are substantially higher for those living outside Portland. In addition, there are fewer mode options for those living outside Portland besides the car. Those with four year college degrees may have higher CWB than those without four year college degrees because higher education levels are associated with higher income jobs and higher incomes may allow commuters to locate closer to work. Similarly, white workers generally have higher incomes and may be able to optimize their home location.

No significant differences in CWB were found among groups organized by gender, age, or household structure categories. The results are somewhat surprising given the associations found in previous studies. Despite the lack of statistical significance, females in the sample have slightly lower CWB than males, as expected. Regarding age categories, 30 to 39 year olds, which have the highest CWB, are also the group that biked to work more than any other age group which may explain their higher CWB. 40.1 percent of respondents aged 30 to 39 biked to work, while only 10.4% of 50 to 59 year olds, the group with the lowest CWB, biked to work. The lack of significant differences in CWB among household structure categories was not unexpected and could be due to many factors. For example, while those with children were expected to be more time pressed in their commutes, roughly the same percentage of respondents with children expressed that saving time was important when choosing a travel mode as those without children (87.2% versus 86.4%, respectively). In addition, the commute experience may be an experience that largely unaffected by household members.

TABLE 2 Variation in CWB by Demographic Group

Variable	Category	Mean CWB	N	Std. Dev.	Sig.
Home in Portland	No	0.72	214	1.02	
	Yes	1.12	614	0.97	<.001
Four year college	No	0.82	155	1.05	
	Yes	1.06	669	0.98	<.01
Race	White	1.04	684	0.99	
	Non-white	0.81	104	1.06	<.05
Income	Less than $15,000	0.73	7	0.85	
	$15,000-$24,999	0.89	24	0.91	
	$25,000-$34,999	0.79	68	1.22	
	$35,000-$49,999	1.11	102	1.00	
	$50,000-$74,999	0.91	195	1.00	
	$75,000-$99,999	1.08	156	0.93	
	$100,000-$149,999	1.09	168	0.93	
	$150,000 and over	1.21	58	1.05	NS
Gender	Male	1.08	383	0.94	
	Female	0.96	426	1.03	
	Other	0.54	5	1.46	NS
Age	20 to 29	0.93	158	0.99	
	30 to 39	1.09	307	1.00	
	40 to 49	1.05	183	0.93	
	50 to 59	0.87	125	1.05	
	60 +	1.08	51	1.06	NS
Children	No children	1.02	437	1.03	
	Children present	1.02	266	0.98	NS
Household size	One person	1.01	125	0.91	
	Two + persons	1.02	703	1.01	NS

Multiple Linear Regression Results

Results of the multiple linear regression analysis are provided in Table 3. Both significant and non-significant variables are included in the estimation to provide a fuller explanation of the relative influence of the variables examined.

First, the regression shows that even when trip attributes, job and home satisfaction, and sociodemographic variables are taken into account, both biking and walking to work have positive and significant effects on CWB. Motorized modes have no significant effect on CWB in this model, possibly because other factors such as traffic congestion, health and job satisfaction influence CWB more than the mode itself.

Second, both commute time and congestion have a significant negative effect on CWB. The magnitude and significance of commute time is low, but the magnitude of the effect of traveling to work on highly congested streets on CWB is particularly large and highly significant. For all modes, encountering heavy traffic on the way to work substantially diminishes CWB.

Third, CWB increases significantly with both job and residential satisfaction, although the effect is larger and more significant for residential satisfaction. It is likely that people who can optimize their home location choice with respect to their work location express both high home and commute satisfaction. The job satisfaction result is in line with previous research (*2*).

Fourth, income and health have significant effects on CWB, holding other variables in the model constant and their signs are positive, as expected. All other sociodemographic variables included are not significant. Higher incomes tend to reflect greater flexibility to optimize other areas of one's life, which may result in better commute experiences. Like having higher income, better health is known to significantly increase overall life satisfaction, and the effects on CWB may be similar. For people that bike to work, better health may allow them to enjoy the bike ride or move quickly. For people that take a car to work, better health may increase CWB because the time savings and sedentary nature of the car allows them be physically active during non-commute activities, such as running during lunchtime or after work.

TABLE 3 Estimation Results of Multiple Linear Regression Model

	Coeff.	Sig.
(Constant)	-.820	.016
Mode		
DriveAlone	-.139	.448
Carpool	-.004	.984
Bike	.669	.000
Walk	.516	.027
MAX	.053	.779
BusTrimet	-.137	.455
CTRAN	.423	.103
Other Trip Attributes		
Commute Time (minutes)	-.004	.044
Very congested streets	-1.218	.000
Satisfaction with Job and Home		
Job satisfaction	.075	.015
Residential satisfaction	.126	.002
Demographics		
Household Income	.066	.005
General Health	.116	.004
Age	.002	.541
Female	.030	.636
White	.065	.479
Children present	-.068	.327
TwoPlusPersons	.014	.883
Four year college degree	-.007	.935
Number of observations	828	
R Square	.347	

CONCLUSIONS

A multi-item measure of commute well-being was adapted from previous research and used in a survey of workers commuting to central Portland, Oregon. The CWB measure showed good statistical reliability and a fairly normal distribution.

Descriptive analysis shows that those who bike and walk to work are happiest with their commutes. Those who drive alone to work are least happy with their commutes. CWB decreases significantly with travel time and increases significantly with income, job satisfaction, home satisfaction, and general health, based on Pearson Correlations. CWB is significantly higher among groups living inside versus outside Portland, having college degrees versus not having college degrees, and identifying as white versus non-white. Descriptive analysis suggests that bike commuters avoid negative impacts from traffic congestion on CWB and, along with transit commuters, may be less sensitive to travel time.

Multiple regression analysis shows that biking and walking to work, commute time, congestion, job and home satisfaction, income and health have significant effects (all $< .05$) on commute well-being. To improve the model, interactions should be tested between mode and travel time and mode and congestion. Availability of commute mode options, stops made along the commute, and attitudes about travel should also be examined. Having more mode options available may increase CWB by allowing one to select a preferred mode based on the day's activities or weather. Land use variables approximating the accessibility of home locations to the transportation network, such as distances to transit stops and bike routes, should be tested. Due to the complexity of influences among modes how these variables influence each other, future research should test structural equations model that would better illuminate the complex relationships among these variables.

More than any other individual factor in this study, traffic congestion affects commute well-being. This result confirms previous research on psychological costs of congestion. Combating congestion in cities, however, is difficult to accomplish, costly, and often conflicts with sustainable transportation goals. There may be options for reducing congestion for buses, such as dedicated rights of way, that could increase the commute well-being of bus users. Reducing congestion for the population of car commuters is unlikely. It should be noted that car users that endure very congested streets may gain something through that increases their well-being (e.g. feelings of security or control) that they may not obtain by using another mode.

The results of this study emphasize the positive commute experiences had by people that bike and walk to work, which is consistent with previous findings on the enjoyment of commuting by non-motorized modes. Bicycling to work appears to benefit mental as well as physical health. Since commuting is a routine activity, these positive benefits could regularly carry over into the workplace and the home, similar to how commute stress carry over into other life domains (*13*). Results suggest that strategies to increase biking and walking should, if additional research supports it, be framed as ways to improve happiness. This will complement other transportation-related goals of reducing air pollution, congestion, oil consumption, and greenhouse gases.

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