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# Correlates of active commuting, transport physical activity, and light rail use in a university setting

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ABSTRACT

*Introduction:* This study identified correlates of active commute mode, transport physical activity (TPA), and intention to use light rail transit (LRT) at a large university in advance of a new LRT connection to campus.
*Methods:* Staff, faculty and students completed a campus-wide travel survey in 2017. Multivariable logistic and linear regression models assessed associations between individual, organizational and environmental correlates with outcomes of interest in a sample of 6894 respondents to identify factors that may encourage a shift from vehicle to active commute modes and increase TPA.
*Results:* Those who biked or walked to campus exceeded weekly physical activity recommendations in TPA alone. Commuting by transit was associated with higher levels of TPA, compared to vehicle commuting. Greater commute mode enjoyment was associated with active modes. Staff were least likely to commute via active transport (AT) and had fewer minutes of TPA. Women and Asian racial groups were less likely to report TPA. Rideshare and discounted transit pass use were positively associated with all outcomes.
*Conclusions:* New LRT presents a critical opportunity to achieve gains in both campus health and environmental sustainability. The factors identified in this study should be further explored as potential intervention or programmatic targets to encourage mode shift.

## 1. Introduction

Physical inactivity is a leading cause of death from non-communicable diseases, responsible for more than 5 million deaths worldwide each year (Lee et al., 2012). Growing evidence indicates those who commute by active forms of transport (i.e., walking and biking) accumulate more minutes of physical activity (PA) and are more likely to meet PA guidelines (Audrey et al., 2014; Brown et al., 2017; Chaix et al., 2014a; Foley et al., 2015; Lachapelle et al., 2011; Rissel et al., 2012). Active transport (AT) is also associated with reduced risk for all-cause mortality and cardiovascular disease (Celis-Morales et al., 2017; Furie and Desai, 2012; Gordon-Larsen et al., 2009; Hamer and Chida, 2008; Maizlish et al., 2013). The new PA guidelines highlight that even short bouts of PA of less than 10 min,

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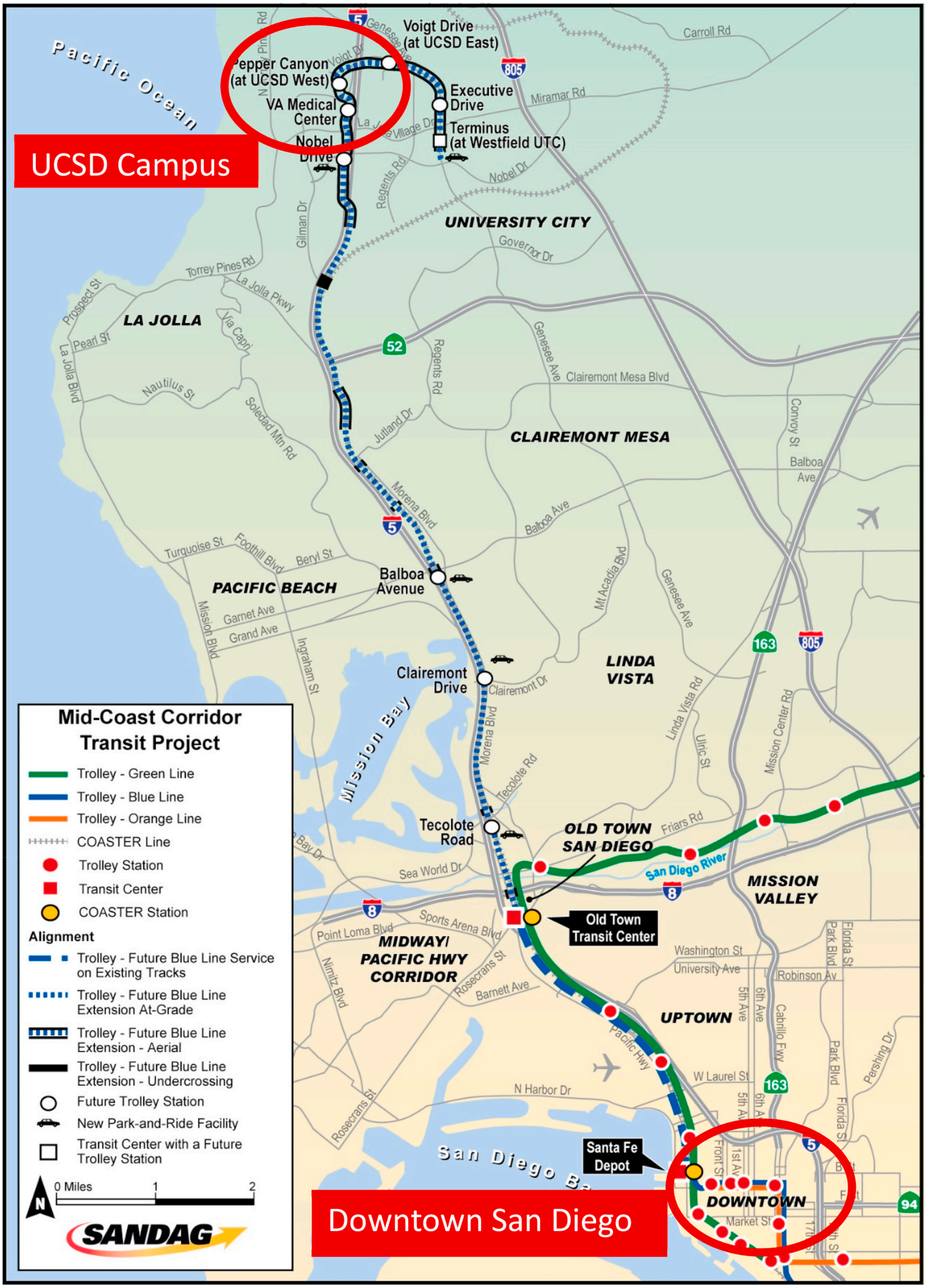


**Fig. 1.** Map of new LRT.

like walking to transit, are beneficial to health (Piercy et al., 2018). Replacing short vehicle trips with AT can also provide environmental co-benefits, like improved air quality, traffic congestion and reduced greenhouse gas emissions (GHG) ("AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability," 2014; Chastin et al., 2016; de Nazelle et al., 2011; Johansson et al., 2017; Maizlish et al., 2013; Quam et al., 2017; Rosenzweig et al., 2015; Stevenson et al., 2016), an achievable goal given that roughly 50% of car trips in the U.S. are less than two miles in length (Zegeer et al., 2010).

### 1.1. Setting

Transportation currently accounts for 55% of the City of San Diego's GHG emissions. Thus a recently adopted Climate Action Plan (CAP) called for significant increases in transit and AT mode share to meet emission reduction targets (City of San Diego, 2015). Currently, only 6% of city residents walk or bike to work, and roughly 5% take public transport ("United States Census Bureau's American Community Survey, 1 year estimates," n. d.). The adopted CAP calls for 25% transit, 18% cycling and 7% walking mode share in transit priority areas by 2035.

The University of California, San Diego (UCSD), located in the city of San Diego, is the region's second largest employer and has a population of approximately 36,000 students, 18,000 staff and 8000 faculty or academic personnel. It is a diverse campus; more than 50% of staff and nearly 80% of undergraduates are from racial and ethnic minority groups ("Staff Diversity Dashboard, 2003," n. d., "Undergraduate Student Profile," n. d.). As large employment and education centers, universities provide a feasible setting to intervene on commute behaviors. Single occupancy vehicle commutes are one of the top contributors to universities' negative environmental impact, in addition to limiting opportunities to achieve sufficient PA (Bonham and Koth, 2010). A new light rail transit (LRT) line is scheduled to open in 2021 that will connect downtown San Diego to UCSD, a distance of approximately 21 km, and presents a major opportunity to intervene on campus commuting behaviors (see Fig. 1). The LRT has potential to both reduce the number of vehicles on campus and increase transport physical activity (TPA) in users who walk or cycle to or from LRT stops near their home or campus location.

Behavior change is known to be influenced by factors across multiple levels of the ecological model, from the individual to built environments and policies; and likely requires a combination of approaches to achieve meaningful change (Bauman et al., 2012; Bird et al., 2018; Pucher et al., 2010; Sallis et al., 2006). In some cases, transit use has been associated with higher TPA and likelihood of meeting PA recommendations (Hirsch et al., 2018; Knell et al., 2018; Saelens et al., 2014). However, recent reviews have found PA increases were not achieved by all groups living in proximity to new transit or AT infrastructure, underscoring the necessity of targeted, context-specific programs, in addition to infrastructure, to encourage AT (Hirsch et al., 2018; Smith et al., 2017). Much of the prior research on university commuting has been from outside the U.S. (Chillón et al., 2016; Molina-García et al., 2014; Moniruzzaman and Farber, 2018; Rissel et al., 2013; Shannon et al., 2006; Wang and Liu, 2015; Whalen et al., 2013), limiting how generalizable it may be given cultural differences in AT attitudes and infrastructure. Among studies in the U.S. (Akar et al., 2008; Bopp et al., 2011; Delmelle and Delmelle, 2012; Jensen et al., 2013; Lundberg and Weber, 2014; Rybarczyk, 2018; Rybarczyk and Gallagher, 2014; Wang et al., 2012; Zhou, 2016), few have investigated the relationship between commute mode and PA (Morckel and Terzano, 2014; Terzano and Morckel, 2011).

The purpose of the present study was to identify potential correlates of commute behavior in order to inform strategies to increase TPA and shift commute mode in advance of a major LRT improvement project. The large and diverse sample can add to our understanding of differences in behaviors and preferences in population subgroups, which are not well understood (Aldred, 2019). The Ecological Model of Physical Activity provided a framework for assessing factors at multiple levels of influence on AT behaviors (Sallis et al., 2006). This study aimed to identify individual, organizational and environmental factors associated with 1) active commute mode, 2) intention to use LRT, and 3) TPA, in a sample of university staff, students and faculty.

## 2. Material and methods

### 2.1. Measures

The survey was developed in conjunction with UCSD's Resource, Management and Planning department and the Office of Strategic Initiatives. All UCSD affiliated faculty, staff and students (N = 60,593) were sent an email invitation to participate. The survey took approximately 15 min to complete and those who participated were entered into a $250 raffle in appreciation of their time. All data were collected in March of 2017. The survey asked about PA and commute behaviors and preferences. We selected variables for analysis based on previous research and relevance as a behavioral or programmatic target. We chose potential correlates at multiple levels of the ecological model, including individual characteristics, individual behaviors and preferences, as well as organizational and environmental factors. Appendix 1 contains the full list of variables.

#### 2.1.1. Dependent variables

The four outcomes of interest included the likelihood of: 1) active versus vehicle commute mode, 2) intention to use LRT versus not, 3) any amount of TPA versus none, and 4) minutes per week (min/wk) of TPA in the last 7 days, among those with any reported TPA. For outcome 1, respondents selected one mode from a list of options in response to the question "What is your primary mode of commuting to UCSD" and a binary variable of "Active" (which included walk, cycle, train, bus/shuttle, or LRT/trolley responses) or "Vehicle" (which included driving alone, carpool, dropped off/rideshare, or motorcycle responses) commute mode was derived. Telecommuters (n = 7) were excluded. For outcome 2, participants responded to the prompt "The UCSD Blue Line Trolley is expected to begin service in 2021. If this service was available now, how would it affect your commute?" Responses of "I would take the Trolley to UCSD often" or "I would take the Trolley to UCSD sometimes" were categorized as 'Intend to use' and "I wouldn't take the Trolley to UCSD" or "I don't know how it would affect my commute" as 'Don't intend to use'. "Not applicable" responses were coded as missing. TPA was assessed using the validated International Physical Activity Questionnaire (IPAQ) long form (Craig et al., 2003). We summed the duration and frequency of walking and cycling for transport in the last 7 days to calculate total minutes spent in TPA in the past week. Weekly sums were truncated at 1260 min (n = 144) per IPAQ scoring guidelines ("Guidelines for Data, 2003," n. d.). Data were used to create both a binary variable for outcome 3 of any minutes of TPA versus none and a continuous TPA variable (min/wk), among those who reported any TPA minutes for outcome 4.

#### *2.1.2. Individual characteristics*

Staff, faculty or student status was obtained from the travel survey. The survey did not collect demographic indicators, which have been associated with commute behavior. Age, gender and race/ethnicity data were obtained by linking the survey response ID to university registrar and payroll records (IRB #180662XL) to determine their relationship to the outcomes as well as the representativeness of the sample.

#### *2.1.3. Individual behavior and preference variables*

**Commute frequency:** Participants were asked "In a typical week, how many days do you commute to UCSD", with responses from 0 to 7 treated as a continuous variable. **Commute enjoyment** was determined in response to the question "How much enjoyment do you get from your primary commute mode", with responses of 'Small amount" and "Moderate amount' (combined into 1 category), 'Great deal' or 'None'. **Barriers:** Participants indicated whether listed barriers were a 'Major reason', 'Minor reason', or 'Not a reason' to not use alternative transportation, or 'Not applicable' (NA). Barriers included: 1) Reduced flexibility traveling between work or school, 2) Increased travel time, 3) Coordinating schedules with others, 4) Not having a vehicle on campus for trips during the workday. Responses of 'Major reason' or 'Minor reason' were categorized as 'Yes' and 'Not a reason' or 'Not applicable' as 'No'. 'Yes' responses were summed to create a continuous scale from 0 to 4. **Rideshare commuting:** Participants reported how many times in a typical week they took Uber or Lyft to get from where they live to UCSD. Responses were categorized as 'Ever use' (<1, 1,2,3,4,5, 5+ days per week) or 'Never use' (Never/NA). **Commute mode:** We were interested in the relationship of transit commute mode, distinct from walking or cycling, with TPA. Thus, for the TPA outcomes, commute mode was included as an independent variable, categorized as 'Active' (walk or cycle), 'Transit' (train, bus/shuttle, LRT/trolley), or 'Vehicle' (as previously described).

#### *2.1.4. Organizational variables*

**Transit pass:** Participants' indicated whether they used a university-discounted transit pass, which provided access to regional LRT and bus routes at a decreased rate or as part of student enrollment fees. Responses were 'Yes' or 'No'. **Parking permit:** Participants selected their primary parking permit from a list of options. Categories were created of 'Full access' for all passes with daily, 24-h access, 'Off-peak' for night, weekend or off-peak hour passes, 'Visitor' for hourly or full day visitor passes, and 'None', if no permit was selected.

#### *2.1.5. Physical environment variables*

Participants provided their zip code and selected their neighborhood from a prepopulated list. GIS data were used to calculate environmental variables using ESRI ArcGIS version 10.5 software (ESRI, Redlands, CA, USA). Neighborhood shape files were joined to corresponding land use layers, downloaded from the San Diego Geographic Information Source (SanGIS) warehouse ("SanGIS, 2018," n. d.). **Distance to UCSD:** Respondents' addresses were not collected so we computed the Euclidean distance, in kilometers (km), from participants' neighborhood centroid to the center of UCSD campus, using the ArcGIS Network Analyst. The **distance to the nearest LRT station** was calculated similarly ("ArcGIS - SD, 2014" n. d.). To calculate overall **transit access,** a count of all bus, commuter and LRT stops by neighborhood was calculated using public transit stops and station files covering the County of San Diego ("City of San Diego Open Data Portal," n. d.) and categorized as ≤ 100 stops, or > 100 stops.

### *2.2. Statistical analysis*

From the full sample of survey respondents (N = 10,943), those with no missing data (n = 6894) were included in the analyses. The "intention to use LRT" analysis was conducted in a subsample (n = 979) with data for that outcome. Statistical significance was set at $p < .05$ and all analyses were conducted using SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY:IBM Corp.) and Stata 15.1 (StataCorp LP, College Station, TX, USA).

Multiple logistic regression was used to assess the association between potential correlates and the three following binary outcomes: 1) active versus vehicle commute mode, 2) intention to use LRT versus not, 3) any amount of TPA versus none. The Hosmer - Lemeshow test assessed model fit (Hosmer et al., 2013). Preliminary analyses revealed that minutes of TPA followed a mixed discrete-continuous distribution that was positively skewed (since negative PA minutes are not possible) and had a large number of respondents who reported zero minutes of TPA (n = 858, 12.5%). The distribution of minutes of TPA is generated by two distinct behaviors; the first is whether someone engages in any TPA versus not, and then, among those who have some TPA, the second behavior relates to the duration of TPA minutes. Thus, a two-part model (Duan et al., 1983) was used to identify correlates associated with 1) the odds of any TPA versus none, and 2) duration (min/wk) of TPA, among those who reported any walking or biking for transport in the previous week, similar to other studies (Lee et al., 2010; Sugiyama et al., 2014). The positive minutes of TPA were log transformed to satisfy the normality assumption and modeled using linear regression. Part one identified the relationship between the independent variables and the probability of any TPA, whereas the second model provided information about the relationship between the independent variables and quantity of TPA. For interpretation, odds ratios (ORs) were used for the logistic regression and average marginal effects (AME) for the log-linear regression. AME averages over the marginal effect of each independent variable on the predicted minutes of TPA, for all observations, taking into account all other independent variables. For continuous variables, the AME represents the change in minutes of TPA for a one-unit change in the independent variable. For categorical variables, it represents the change in TPA minutes for each group, compared to the reference category. Results indicated that AT commute mode, odds of any TPA and duration of TPA outcomes differed significantly across student, staff or faculty groups. Thus, we conducted stratified analyses to better understand potential differences in factors related to transport behaviors in each subgroup.

## 3. Results

There was an 18% response rate to the survey, with a final analytic sample of n = 6894, comprised of 43% staff, 45% students, and 12% faculty. As shown in Table 1, the analytic sample matched the full respondent sample closely based on demographic characteristics. Compared to the overall university population, there were more staff, whites and women in the analytic sample.

Both faculty and staff had a greater proportion of vehicle commuters than students. The percentage of women using active modes was lower than men. AT was higher in non-white racial groups compared to whites. Those using active modes were, on average, younger and lived closer to campus (See Table 2).

### 3.1. Associations with commute mode and intention to use LRT

Table 3 shows that staff were least likely to actively commute, compared to faculty or students. Older age was associated with decreased odds of active commuting. No significant associations were identified with gender or race. Results revealed a dose response relationship between degree of enjoyment from commute mode and active commuting. Those who reported a great deal of enjoyment had greater odds of commuting via AT (OR = 2.04), compared to those who reported no enjoyment. Respondents who utilized rideshare for commuting were also more likely to report active commute mode. Every additional reported barrier to AT commute mode was associated with 43% lower odds of active commuting. Organizational correlates were significantly related to commute mode. Users of the university-discounted transit pass were more than five times as likely to commute via AT, compared to non-users. Not having a full parking permit was strongly associated with active commute mode. Those without any type of permit were ten times more likely to commute via AT, compared to those with full permits. Among environmental variables, the relationships with transit were unexpected. Increased distance to LRT was associated with slightly increased odds of commuting by bike, walking or transit, whereas a greater number of transit stops in respondents' neighborhood decreased the odds of active commute mode. We did not have access to home address, thus utilizing neighborhood centroid for these variables may explain this contradictory relationship. Living further from campus was associated with decreased odds of active commuting.

Stratified analyses of students, staff and faculty largely agreed with the overall results; however, a few contrasting relationships by respondent type were identified (Appendix 2). Female students were more likely to report AT commuting while female staff and faculty had roughly 50–60% lower odds, compared to males. Overall, the likelihood of AT commuting decreased slightly with age, but stratified analyses show this was true only for faculty, while for students, increased age was associated with slightly increased odds of AT. A greater commute frequency was associated with roughly a 9% reduction in the odds of AT commuting among students. Relationships for commute enjoyment and discounted transit pass use with commute mode appeared to be driven by faculty and staff.

Few variables were related to the intention to use LRT outcome. Both rideshare and discounted transit pass use greatly increased the odds of intended LRT use, while increased distance to campus had a slight positive association. Greater distance to LRT stops decreased the odds of LRT intention, as expected.

### 3.2. Associations with TPA

Table 4 presents associations with both the odds of any TPA (Model 1) and minutes of TPA per week (Model 2), among those who reported any TPA. Staff, women and Asian racial groups had significantly lower odds of getting any TPA, compared to their reference groups. Among those who reported some amount of TPA, both staff and faculty had roughly 100 fewer minutes of TPA per week,

**Table 1**
Demographic characteristics of respondents.

| | n | Analytic sample (%) | All survey respondents[a] (%) | University population (%) |
|---|---|---|---|---|
| Staff | 2993 | 43 | 44 | 27 |
| Faculty | 810 | 12 | 11 | 13 |
| Student | 3091 | 45 | 45 | 60 |
| Men | 2719 | 39 | 39 | 50 |
| Women | 4175 | 61 | 61 | 50 |
| Non-white/unknown | 3734 | 54 | 58 | 67 |
| White/Caucasian | 3160 | 46 | 42 | 33 |

[a] The full survey sample was 10,943, however, we had matched demographic data for n = 10,105.

**Table 2**
Descriptive characteristics of the analytic sample by primary commute mode.

| | | Primary Commute Mode | |
|---|---|---|---|
| | Total n = 6894 | Vehicle n = 4658 | Active or Transit n = 2236 |
| Respondent Type, n (%) | | | |
| Staff | 2993 (43) | 2631 (88) | 362 (12) |
| Faculty | 810 (12) | 609 (75) | 201 (25) |
| Student | 3091 (45) | 1418 (46) | 1673 (54) |
| Gender, n (%) | | | |
| Female | 4175 (61) | 2946 (71) | 1229 (29) |
| Male | 2719 (39) | 1712 (63) | 1007 (37) |
| Age in years, mean (SD) | 35 (14) | 38 (14) | 28 (11) |
| Race/Ethnicity, n (%) | | | |
| African American/Black | 185 (3) | 140 (76) | 45 (24) |
| Asian | 2135 (31) | 1212 (57) | 923 (43) |
| Chicano/Latino | 908 (13) | 633 (70) | 275 (30) |
| White or Caucasian | 3160 (46) | 2382 (75) | 778 (25) |
| Other/Unknown | 501 (7) | 289 (58) | 212 (42) |
| Distance to campus in km, mean (SD) | 13 (10) | 15 (10) | 7 (8) |

**Table 3**
Odds ratios for correlates of AT commute mode and intention to use LRT.

| | AT Commute Mode | | | Intention to use LRT | | |
|---|---|---|---|---|---|---|
| | n = 6894 | | | n = 979 | | |
| | OR | (p-value) | 95% CI | OR | (p-value) | 95% CI |
| Individual characteristics | | | | | | |
| Respondent type Staff | 0.76* | (0.045) | 0.58, 0.99 | 0.99 | (0.965) | 0.62, 1.59 |
| Faculty | 1.62** | (0.004) | 1.17, 2.23 | 1.20 | (0.509) | 070, 2.07 |
| Student | ref | | | ref | | |
| Age per year | 0.99* | (0.017) | 0.98, 1.00[a] | 1.00 | (0.635) | 0.98, 1.01 |
| Gender Female | 0.86 | (0.056) | 0.74, 1.00[a] | 1.17 | (0.288) | 0.88, 1.55 |
| Male | ref | | | ref | | |
| Race/ethnicity African American/Black | 0.98 | (0.941) | 0.61, 1.57 | 1.35 | (0.472) | 0.60, 3.03 |
| Asian/Asian American | 0.92 | (0.365) | 0.77, 1.10 | 0.82 | (0.253) | 0.58, 1.15 |
| Chicano/Latino | 0.98 | (0.875) | 0.77, 1.25 | 1.03 | (0.897) | 0.66, 1.61 |
| Other/Unknown | 1.01 | (0.959) | 0.76, 1.34 | 1.16 | (0.600) | 0.67, 1.98 |
| White/Caucasian | ref | | | ref | | |
| Individual behavior and preference variables | | | | | | |
| Commute frequency per week | | | | | | |
| Each additional day | 0.96* | (0.047) | 0.92, 1.00[a] | 0.97 | (0.467) | 0.89, 1.06 |
| Commute enjoyment | | | | | | |
| Small or moderate amount | 1.67** | (0.000) | 1.40, 1.99 | 1.46* | (0.036) | 1.03, 2.07 |
| Great deal | 2.04** | (0.000) | 1.57, 2.64 | 1.37 | (0.207) | 0.84, 2.25 |
| None | ref | | | ref | | |
| Barriers to non-vehicle modes | | | | | | |
| Each additional barrier | 0.57** | (0.000) | 0.53, 0.61 | 1.11 | (0.056) | 1.00[a], 1.24 |
| Rideshare commuting | | | | | | |
| Ever use | 1.35** | (0.001) | 1.14, 1.60 | 1.75** | (0.001) | 1.25, 2.46 |
| Never use | ref | | | ref | | |
| Organizational Variables | | | | | | |
| Discounted transit pass user Yes | 5.53** | (0.000) | 4.50, 6.78 | 2.04** | (0.000) | 1.41, 2.95 |
| No | ref | | | ref | | |
| Parking permit | | | | | | |
| Visitor | 3.21** | (0.000) | 2.50, 4.12 | 0.87 | (0.719) | 0.42, 1.82 |
| Off-Peak | 5.75** | (0.000) | 4.43, 7.46 | 0.78 | (0.487) | 0.39, 1.56 |
| None | 10.17** | (0.000) | 8.57, 12.07 | 0.95 | (0.743) | 0.68, 1.31 |
| Full access | ref | | | ref | | |
| Physical environment variables | | | | | | |
| Distance to campus Per 1 km | 0.93** | (0.000) | 0.92, 0.94 | 1.03** | (0.000) | 1.02, 1.05 |
| Distance to nearest LRT Per 1 km | 1.02** | (0.000) | 1.01, 1.03 | 0.93** | (0.000) | 0.91, 0.95 |
| Transit access by neighborhood >100 stops | 0.86* | (0.047) | 0.74, 1.00[a] | 0.87 | (0.316) | 0.66, 1.15 |
| ≤100 stops | ref | | | ref | | |

ref = reference category, * for $p < .05$, ** for $p < .01$, [a] rounded value.

**Table 4**
Odds ratios and duration of TPA.

| | | Model 1: Odds of any TPA | | | | Model 2: Duration (min/wk) of TPA | | |
|---|---|---|---|---|---|---|---|---|
| | | OR | (p-value) | 95% CI | exp(b) | Average marginal effect (AME) | (p-value) | 95% CI |
| Individual characteristics | | | | | | | | |
| Respondent type Staff | 0.55** | (0.000) | 0.42, 0.72 | −0.47** | −96.26** | (0.000) | −115.26, −77.27 | |
| Faculty | | 0.70* | (0.040) | 0.50, 0.98 | −0.51** | −101.73** | (0.000) | −123.38, −80.08 |
| Student | | ref | | | ref | | | |
| Age per year | 1.00 | (0.355) | 0.99, 1.00 | −0.01** | −1.27** | (0.000) | −1.87, −0.67 | |
| Gender Female | 0.83* | (0.023) | 0.71, 0.97 | −0.15** | −32.19** | (0.000) | −43.80, −20.57 | |
| Male | | ref | | | ref | | | |
| Race/ethnicity African American/Black | 0.73 | (0.126) | 0.49, 1.09 | −0.03 | −7.62 | (0.677) | −43.42, 28.19 | |
| Asian/Asian American | | 0.82* | (0.037) | 0.69, 0.99 | −0.10** | −21.24** | (0.002) | −34.64, −7.84 |
| Chicano/Latino | | 0.98 | (0.880) | 0.78, 1.24 | 0.02 | 4.50 | (0.636) | −14.12, 23.12 |
| Other/Unknown | | 0.63** | (0.002) | 0.47, 0.85 | −0.23** | −45.25** | (0.000) | −64.90, −25.60 |
| White/Caucasian | | ref | | | ref | | | |
| Individual behavior and preference variables | | | | | | | | |
| Commute frequency per week | | | | | | | | |
| Each additional day | | 1.08** | (0.003) | 1.03, 1.13 | 0.02* | 4.28* | (0.013) | 0.92, 7.64 |
| Commute enjoyment | | | | | | | | |
| Small or moderate amount | | 1.28** | (0.003) | 1.08, 1.50 | −0.04 | −7.52 | (0.246) | −20.22, 5.18 |
| Great deal | | 1.11 | (0.421) | 0.86, 1.42 | 0.07 | 14.87 | (0.160) | −5.89, 35.62 |
| None | | ref | | | ref | | | |
| Barriers to non-vehicle modes | | | | | | | | |
| Each additional barrier | | 1.05 | (0.110) | 0.99, 1.12 | 0.02 | 3.60 | (0.124) | −0.99, 8.19 |
| Rideshare commuting | | | | | | | | |
| Ever use | | 1.14 | (0.223) | 0.92, 1.41 | 0.18** | 40.49** | (0.000) | 25.46, 55.52 |
| Never use | | ref | | | ref | | | |
| Primary commute mode Transit | 1.55** | (0.001) | 1.19, 2.02 | 0.13** | 25.93** | (0.002) | 9.26, 42.60 | |
| AT | | 3.26** | (0.000) | 2.17, 1.58 | 0.62** | 158.62** | (0.000) | 127.68, 189.55 |
| Vehicle | | ref | | | ref | | | |
| Organizational Variables | | | | | | | | |
| Discounted transit pass user Yes | 1.20 | (0.188) | 0.91, 1.58 | 0.11** | 23.02** | (0.010) | 5.55, 40.49 | |
| No | | ref | | | ref | | | |
| Parking permit | | | | | | | | |
| Visitor | | 0.84 | (0.222) | 0.63, 1.11 | 0.05 | 11.46 | (0.326) | −11.41, 34.34 |
| Off-Peak | | 0.63** | (0.004) | 0.46, 0.86 | −0.11 | −21.83 | (0.053) | −43.91, 0.24 |
| None | | 0.94 | (0.546) | 0.75, 1.16 | 0.01 | 1.49 | (0.851) | −14.07, 17.05 |
| Full access | | ref | | | ref | | | |
| Physical environment variables | | | | | | | | |
| Distance to campus Per 1 km | 1.00 | (0.777) | 0.99, 1.01 | 0.00 | 0.40 | (0.219) | −0.24, 1.03 | |
| Distance to nearest LRT Per 1 km | 1.00 | (0.603) | 0.99, 1.01 | 0.00 | −0.35 | (0.251) | −0.93, 0.24 | |
| Transit access by neighborhood >100 stops | 1.08 | (0.304) | 0.93, 1.26 | −0.01 | −1.54 | (0.786) | −12.68, 9.59 | |
| ≤100 stops | | ref | | | ref | | | |

ref = reference category, * for $p < .05$, ** for $p < .01$, [a] rounded value.

compared to students. Though age was not associated with the odds of any TPA, a one-year increase in age had a small negative association with weekly TPA duration. Women had 32 fewer minutes of TPA, compared to men, and minority racial/ethnic groups had fewer minutes compared to whites, with the exception of Latinos. Among the behavior and preference variables, greater commute frequency and enjoyment were both positively associated with odds of any TPA; however only commute frequency was positively correlated with minutes of TPA. The barriers addressed in the survey, which were specific to commuting, were not related to overall TPA outcomes. Interestingly, rideshare use was associated with 40 additional minutes of TPA per week, compared to those who never used it for commuting. As expected, those who commuted via biking and walking had greater odds of TPA. However, transit commuters were also more likely to get any TPA than non-users (OR = 1.6). Among those reporting any TPA, walking or biking commute mode was associated with 159 more TPA minutes per week, compared to vehicle commuting. Transit commuters also accumulated nearly 30 more weekly minutes than drivers. The use of subsidized transit passes was positively associated with TPA duration only, with users achieving 23 additional minutes per week, compared to non-users. Environmental variables were not significantly associated with TPA duration.

Analyses stratified by respondent type indicated the lower odds of TPA in women was observed among faculty only, and differences by race/ethnicity were only significant in students (Appendix 3). Greater transit access was associated with increased likelihood of TPA in students, whereas no relationship was observed in the overall results. Appendix 4 presents relationships with minutes of TPA, stratified by respondent type. Interestingly, among students, every 1-year increase in age was associated with a small decrease in weekly minutes of TPA. Though women had fewer TPA minutes than men overall, this negative association was strongly significant for faculty and staff, not students. All non-white staff had fewer TPA minutes compared to whites, though differences were not statistically significant, while a large negative association was observed for Asian students. Though transit as a primary commute mode was associated with greater TPA minutes in all groups, stratified results did not achieve statistical significance. This could be due to small sample sizes within groups.

## 4. Discussion

Results from the present study confirmed transit use should be considered an active form of travel, as transit commuters accumulated significantly more PA, compared to vehicle modes (Audrey et al., 2014; Batista Ferrer et al., 2018; Brown et al., 2017; Chaix et al., 2014b; Foley et al., 2015; Morckel and Terzano, 2014; Rissel et al, 2012, 2013; Terzano and Morckel, 2011). The potential health benefits of AT modes were substantial. Those who walked or cycled as their primary commute mode exceeded the recommended PA guidelines of 150 min/wk in just TPA alone. Staff were identified as an important group for a mode shift intervention as they were significantly less likely to commute via active modes and had 96 fewer minutes of TPA per week, compared to students. Women and Asian respondents were less likely to get any TPA and had fewer minutes than their reference groups, suggesting AT interventions could benefit these groups. Unexpectedly, rideshare use for commuting was correlated with increased odds of active commute mode, intention to use LRT and weekly TPA. This could be because rideshare commuters were less likely to have their own vehicles. Discounted transit passes and limited parking permits were positively associated with outcomes and might present opportunities to influence commute mode at the organizational level. Several individual, organizational and environmental factors were significantly associated with the study outcomes and should be further explored as potential intervention targets to induce mode shift.

### *4.1. Individual characteristics*

Our findings related to staff align with most previous research (Lundberg and Weber, 2014; Rissel et al., 2013; Rybarczyk and Gallagher, 2014; Shannon et al., 2006; Wang and Liu, 2015; Zhou, 2016). Roughly 54% and 34% of students and faculty, respectively, lived in two neighborhoods adjacent to campus, versus 11% of staff, which may explain the difference in active commuting. Staff lived furthest from campus and had a greater proportion living in areas south of campus that will be accessed by the new LRT line, though no difference across groups in intention to use LRT was found. These findings support targeting staff with promotional interventions to use LRT as they live in accessible areas and are currently least likely to use non-vehicle commute modes.

Unlike most prior studies showing a higher likelihood of AT among men (Lundberg and Weber, 2014; Rissel et al., 2013; Rybarczyk, 2018; Sims et al., 2018; Zhou, 2016), we did not find a significant difference in the likelihood of active commute mode by gender overall. However, stratified analyses revealed female students were more likely to actively commute, whereas female staff and faculty were far less likely, compared to their male counterparts. Many studies have reported greater safety concerns and preferences for separated cycling facilities among women (Aldred et al., 2017; Broach and Dill, 2016; Delmelle and Delmelle, 2012; Garrard et al., 2008; Heesch et al., 2012; Piatkowski and Marshall, 2015; Pucher and Buehler, 2008; Raser et al., 2018). We did not explore whether results were specific to cycling as all active modes were combined in the present analyses. However, since students generally lived closer to campus, they may be more likely to walk and therefore less sensitive to cycling conditions. In line with previous studies, we observed lower odds and duration of overall TPA among women compared to men. These results indicate the provision of safe and comfortable cycling infrastructure in and around campus, in conjunction with gender – specific education and encouragement programs, may be necessary to promote AT among female staff and faculty. (Braun et al., 2016; Piatkowski and Marshall, 2015; Shannon et al., 2006; Wilson et al., 2018; Winters et al., 2017).

Few studies have assessed the relationship between active commuting or TPA and race/ethnicity, especially in the university setting. Overall, race was not related to odds of active commuting or intended LRT use. However, Asian/Asian American students and those of unknown ethnicity had lower odds of TPA and fewer TPA minutes, compared to whites. These results support findings from studies of Asian subgroups in California (Li and Wen, 2013; Yi et al., 2015). Results from previous non-university studies differ, finding higher (Knell et al., 2018) and lower (Sims and Bopp, 2018) AT levels in blacks, while race/ethnicity was not a significant predictor of walking time or AT in a cross-sectional, multi-city study (Frank et al., 2006; Saelens et al., 2014).

### 4.2. Individual behavior and preference variables

In contrast to Moniruzzaman and Farber, we found lower odds of active commuting with greater commute frequency, especially among students (Moniruzzaman and Farber, 2018). Universities may consider consolidating course schedules or increasing tele-commuting to limit commute days as a strategy to encourage AT. This study confirmed a potential psychological motivator for active commuting among staff and faculty. Our results aligned with studies that found cyclists and pedestrians reported significantly higher levels of enjoyment, compared to driving or transit (Rissel et al., 2016) as well as greater commute satisfaction (Morris and Guerra, 2015; Páez and Whalen, 2010; St-Louis et al., 2014; Titze et al., 2007). Enjoyment has been identified as a motivator for mode shift among university staff and students (Shannon et al., 2006), indicating that helping commuters attain increased commute enjoyment may provide a useful intervention strategy. In our study, a small or moderate amount of commute enjoyment, compared to none, was also associated with intention to use LRT. For longer commutes, train travel may have positive utility as it provides the ability to do other tasks or activities that may be enjoyable, like listening to music or reading (Páez and Whalen, 2010; St-Louis et al., 2014). Systems to improve the transit experience, such as improved safety and wifi-enabled busses and trains, could encourage use.

As expected, more reported barriers to non-vehicle commuting was associated with lower odds of AT commute mode across all respondent groups. Similar constructs, like increased travel time, combining commuting with other responsibilities, efficiency, and general convenience have been found to negatively impact non-vehicle commute mode (Batista Ferrer et al., 2018; Braun et al., 2016; Lundberg and Weber, 2014; Piatkowski and Marshall, 2015; Shannon et al., 2006; Wang and Liu, 2015). The barriers studied were not significantly related to TPA in general, which is logical given that they were specific to commute challenges. Rideshare incentives or the provision of campus vehicles for workday trips could address the need for a vehicle during the workday. A phone app or travel planning service for commuters could compare travel time across modes to inform potential active commuters of actual, versus perceived, differences. On-campus childcare could reduce the need for a vehicle between home and work.

Our findings on those who use rideshare for commuting were informative and timely given the surge in usage, especially in urban, transit-oriented locations. Some recent reports have highlighted negative consequences of these services indicating that roughly 50%–60% of rideshare users would have used active modes, transit, or not completed the trip if rideshare was not available, thus likely adding to vehicle trips (Clewlow and Mishra, 2017; Schaller, 2018). In contrast to a recent study among university students, we found that rideshare commuters were not only more likely to commute via active modes and intend to use the new LRT, but also accumulated 40 more minutes of TPA per week, compared to non-users (Moniruzzaman and Farber, 2018). Campuses could explore incentives for rideshare use to lessen the need for private vehicle commuting, especially among staff and students.

### 4.3. Organizational variables

Our results supported the subsidization of transit passes as an effective strategy to encourage non-vehicle commuting and TPA (Moniruzzaman and Farber, 2018; Shannon et al., 2006; Zhou, 2016). Shannon et al. (2006) found the introduction of a transit pass was the most significant motivator to switch commute mode at an Australian university. Present results highlight the significant positive relationship between parking access and vehicle commuting for all campus groups (Batista Ferrer et al., 2018; Buehler, 2012; Delmelle and Delmelle, 2012; Whalen et al., 2013). We expect active commuters would not purchase full-access parking permits; however, it is possible the reverse is true and the cost or difficulty of parking on campus incentivized commuters to choose alternative modes. We cannot determine the causal direction of the relationship in this analysis; however, research has shown policies to discourage parking are essential in reducing single occupancy vehicle (SOV) commuting. Programs including both disincentives, like restricted parking access and increased parking prices, in addition to incentives for alternate modes were more effective in reducing SOV commuting among hospital staff (Petrunoff et al., 2015). Further, university staff living within cycling distance to campus have been shown to be especially sensitive to increased parking prices (Petrunoff et al., 2015; Rybarczyk and Gallagher, 2014). Stanford University successfully induced active commuting by paying employees not to drive, in addition to raising parking prices (Streetsblog USA, n.d.). Changes were only sustained while economic incentives or disincentives were in place, indicating the need for long term policies as opposed to short-term promotions (Graham-Rowe et al., 2011). The implementation of park and ride facilities or parking access based on need, rather than seniority, have been viewed favorably by staff (Cairns et al., 2010; Petrunoff et al., 2015) and could both limit congestion and provide opportunities for short AT trips from off campus lot locations.

### 4.4. Physical environmental variables

Consistent with prior studies, lower odds of AT commuting with greater distance to campus were observed in our study among students, staff and faculty (Batista Ferrer et al., 2018; Chillón et al., 2016; Delmelle and Delmelle, 2012; Lundberg and Weber, 2014; Moniruzzaman and Farber, 2018; Rybarczyk, 2018; Rybarczyk and Gallagher, 2014; Shannon et al., 2006; Zhou, 2016). Chillón et al. found distances of 2.6 km for walking and 5.1 km for cycling distinguished active versus passive commuters in university students (Chillón et al., 2016), though other studies indicated Americans were unwilling to walk one mile (Watson et al., 2015). The average commute distance to UCSD campus (13 km) was large; thus, biking or walking to LRT stops may be a more feasible strategy for those living in transit accessible areas. We found slightly higher intention to use LRT with greater commute distance, though prior studies have mixed results (Wang and Liu, 2015; Zhou, 2016). Bus and LRT can offer value over personal vehicles for longer commute distances by allowing commuters to do other tasks, which could provide motivation for some commuters. In our study, students with greater transit access were more likely to get some TPA per week, and greater distance to LRT was associated with fewer minutes of TPA. Others found contrasting associations between increased distance to transit and levels of PA, which could be due to differences between choice and dependent transit riders (Knell et al., 2018; Lachapelle and Frank, 2009). Those dependent on transit may have to travel further by active modes to stations, and thus have higher TPA, as opposed to choice riders who have the option of traveling to transit by vehicle (Lachapelle et al., 2016).

### *4.5. Strengths and limitations*

The large and diverse sample was a significant strength and allowed us to assess correlates of transport behaviors and TPA among multiple subgroups. The over-representation of staff was advantageous given they are the population group most in need of an intervention to increase TPA. The stratified analyses allowed us to explore whether the observed relationships differed across respondent types; however, given the small cell sizes, results should be interpreted with caution. The inclusion of PA survey questions allowed us to investigate how active commuting relates to health, in addition to the assumed environmental benefits. A limitation was that we only assessed transport related PA, which does not provide insight on other PA domains or total PA. The use of the IPAQ may have introduced recall bias and inflated PA levels, as average weekly minutes of TPA alone were high compared to national PA data (Troiano et al., 2008). The commute mode outcome did not allow for multiple modes and thus may have led to misclassification. The LRT outcome was based on respondents' stated intention to utilize the new LRT line which, while not robust for use in transport models, is suitable to assess demand for a new transport alternative as was our goal ("Stated-preference surveys, 2003," n. d.) and is commonly used in transport research (Aldred et al., 2017; Hensher, 1994; Winters and Teschke, 2010). The question assessing LRT intention did not include detailed information on schedules or transit stop locations which may explain the lower response rate compared to the other outcomes. This lack of specificity may explain the nonsignificant findings. In trying to limit the number of survey questions, there were many unmeasured variables that affect commute behavior, like vehicle ownership/access or childcare responsibilities. More specific barriers and motivators should be explored as potential determinants of behavior change. Finally, this cross-sectional study identified significant associations between the factors assessed and the outcomes, but does not provide evidence of causality. A longitudinal intervention study could provide insight on causal relationships.

## 5. Conclusions and recommendations

A planned new transit connection to campus presents a timely opportunity to intervene on commute behaviors, and results reported here provide insight into intervention strategies and campus programs that could be implemented to encourage a shift from vehicle commuting to active modes. Nearly 70% of the study sample were vehicle commuters, underscoring the need for effective programs to achieve both health and sustainability goals. Importantly, a clear relationship between active commuting, including transit, and increased TPA was found. Given the markedly reduced odds of active commuting and lower accumulation of TPA in staff and women, interventions and programs should focus on these groups. Given that Asian students reported much less TPA and comprise 52% of UCSD undergraduate students, further research should be conducted to understand what may be driving these differences. Organizational factors like transit passes, rideshare incentives, and consolidated class schedules should be explored as ways to encourage active commuting to campus.

Access to LRT and AT infrastructure alone is unlikely to induce substantial mode shift without programs and policies to change these habitual behaviors. Campus programs could be expanded to include offerings like safe cycling courses, route planning, and walking or cycling buddies to address barriers. Promoting transit and rideshare use could both increase PA and decrease vehicle travel. Potential health consequences of campus programs designed to reduce GHGs should be carefully considered as some, like carpool incentives, may decrease SOV commutes but also limit opportunities for TPA. The transit pass program was positively associated with all outcomes and should be expanded, as only one third of the population reported use. In conjunction with AT incentive programs, restrictions on parking should be considered, as those without regular parking permits had up to 10 times greater odds of active commuting. Restricting parking on campus would likely be controversial; however, other campuses have successfully implemented policies to decrease parking demand. Research on effective strategies to change travel mode is still evolving and recent reviews highlight the need for stronger evidence (Petrunoff et al., 2016; Scheepers et al., 2014; Winters et al., 2017). Well-designed longitudinal interventions in conjunction with transit infrastructure could provide much needed insight into the most successful policies and behavior change strategies to incur mode shift at a scale that is meaningful for the health of individuals and the environment.

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## CRediT authorship contribution statement

**Katie Crist:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Visualization, Project administration. **Ruben Brondeel:** Methodology, Formal analysis, Writing - review & editing. **Fatima Tuz-Zahra:** Methodology, Formal analysis, Writing - review & editing. **Chase Reuter:** Methodology, Formal analysis, Writing - review & editing. **James F. Sallis:** Writing - review & editing. **Michael Pratt:** Writing - review & editing. **Jasper Schipperijn:** Conceptualization, Methodology, Formal analysis, Writing - review & editing.

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## Appendix 1. List of variables included in each analysis

| | n (%) or mean (SD) | Commute mode | Intention to use LRT | Odds of any TPA | Non-zero TPA (min/wk) |
|---|---|---|---|---|---|
| Dependent variables | | | | | |
| Commute mode AT | 2236 (32) | Outcome | N | Y | Y |
| Vehicle | 4658 (68) | | | | |
| Intention to use LRT Often/sometimes | 442 (6) | N | Outcome | N | N |
| Never/NA | 537 (8) | | | | |
| Any TPA Some amount | 6036 (88) | N | N | Outcome | N |
| None | 858 (12) | | | | |
| Duration of TPA (min/wk) | 307 (284) | N | N | N | Outcome |
| Individual characteristics | | | | | |
| Respondent type Staff | 2993 (43) | Y | Y | Y | Y |
| Faculty | 810 (12) | | | | |
| Student | 3091 (45) | | | | |
| Age (years) | 35 (14) | Y | Y | Y | Y |
| Gender Women | 4175 (61) | Y | Y | Y | Y |
| Men | 2719 (39) | | | | |
| Race/ethnicity Non-white/unknown | 3733 (54) | Y | Y | Y | Y |
| White/Caucasian | 3161 (46) | | | | |
| Individual behavior and preference variables | | | | | |
| Commute frequency (days/wk) | 4 (2) | Y | Y | Y | Y |
| Commute enjoyment Small/moderate | 4182 (61) | Y | Y | Y | Y |
| Great deal | 815 (12) | | | | |
| None | 1897 (28) | | | | |
| Barriers to AT modes | 3 (1) | Y | Y | Y | Y |
| Rideshare use Yes | 1496 (22) | Y | Y | Y | Y |
| No | 5398 (78) | | | | |
| Primary commute mode Transit | 1523 (22) | N | N | Y | Y |
| AT | 713 (10) | | | | |
| Vehicle | 4659 (68) | | | | |
| Organizational variables | | | | | |
| Discounted transit pass user Yes | 2284 (33) | Y | Y | Y | Y |
| No | 4610 (67) | | | | |
| Parking permit Visitor | 504 (7) | Y | Y | Y | Y |
| Off-peak | 450 (7) | | | | |
| None | 1740 (25) | | | | |
| Full access | 4200 (61) | | | | |
| Physical environment variables | | | | | |
| Distance to campus (km) | 13 (10) | Y | Y | Y | Y |
| Distance to nearest LRT (km) | 11 (10) | Y | Y | Y | Y |
| Transit access >100 transit stops | 3240 (47) | Y | Y | Y | Y |
| ≤100 transit stops | 3654 (53) | | | | |

Variables included in each analysis indicated by Y(yes) or N (no).

## Appendix 2. Odds of AT commute mode, by respondent type

| | Student | | Staff | | Faculty | |
|---|---|---|---|---|---|---|
| | OR | (p-value) | OR | (p-value) | OR | (p-value) |
| Individual characteristics | | | | | | |
| Age per year | 1.03* | (0.026) | 1.00 | (0.566) | 0.95*** | (0.000) |
| Gender Female | 1.25* | (0.031) | 0.54*** | (0.000) | 0.41*** | (0.000) |
| Male | ref | | | | | |
| Race/ethnicity African American/Black | 0.82 | (0.599) | 1.175 | (0.640) | 0.24 | (0.181) |
| Asian/Asian American | 1.03 | (0.789) | 0.743 | (0.111) | 0.81 | (0.440) |
| Chicano/Latino | 1.20 | (0.293) | 0.786 | (0.254) | 1.13 | (0.806) |

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(*continued*)

| | Student | | Staff | | Faculty | |
|---|---|---|---|---|---|---|
| | OR | (p-value) | OR | (p-value) | OR | (p-value) |
| Other/Unknown | 1.07 | (0.699) | 0.542 | (0.193) | 0.83 | (0.731) |
| White/Caucasian | ref | | | | | |
| Individual behavior and preference variables | | | | | | |
| Commute frequency per week | | | | | | |
| Each additional day | 0.912*** | (0.001) | 1.07 | (0.323) | 0.96 | (0.573) |
| Commute enjoyment | | | | | | |
| Small or moderate amount | 1.21 | (0.105) | 3.28*** | (0.000) | 4.14*** | (0.000) |
| Great deal | 1.05 | (0.791) | 4.15*** | (0.000) | 9.78*** | (0.000) |
| None | ref | | | | | |
| Barriers to non-vehicle modes | | | | | | |
| Each additional barrier | 0.62*** | (0.000) | 0.52*** | (0.000) | 0.51*** | (0.000) |
| Ride share commute | | | | | | |
| Ever use | 1.15 | (0.203) | 2.21*** | (0.000) | 1.11 | (0.718) |
| Never use | ref | | | | | |
| Organizational Variables | | | | | | |
| Discounted transit pass user | | | | | | |
| Yes | 3.99*** | (0.000) | 44.80*** | (0.000) | 43.83*** | (0.000) |
| No | ref | | | | | |
| Parking permit | | | | | | |
| Visitor | 3.76*** | (0.000) | 2.40*** | (0.001) | 2.89* | (0.013) |
| Off-Peak | 8.67*** | (0.000) | 1.18 | (0.696) | 10.07*** | (0.000) |
| None | 15.80*** | (0.000) | 5.22*** | (0.000) | 7.75*** | (0.000) |
| Full access | ref | | | | | |
| Physical environment variables | | | | | | |
| Distance to campus | | | | | | |
| Per 1 km increase | 0.92*** | (0.000) | 0.94*** | (0.000) | 0.95** | (0.003) |
| Distance to nearest LRT | | | | | | |
| Per 1 km increase | 1.00 | (0.863) | 1.03*** | (0.000) | 1.00 | (0.768) |
| Transit access by neighborhood | | | | | | |
| >100 transit stops | 0.61*** | (0.000) | 1.21 | (0.195) | 1.91** | (0.006) |
| ≤100 transit stops | ref | | | | | |

ref = reference category.
* for $p < .05$, ** for $p < .01$, and *** for $p < .001$.

## Appendix 3. Odds of any TPA versus none, by respondent type

| | Student | | Staff | | Faculty | |
|---|---|---|---|---|---|---|
| | OR | (p-value) | OR | (p-value) | OR | (p-value) |
| Individual characteristics | | | | | | |
| Age per year | .98 | (0.104) | 1.00 | (0.536) | 1.01 | (0.617) |
| Gender Female | 0.98 | (0.895) | 0.81 | (0.068) | 0.62* | (0.033) |
| Male | ref | | | | | |
| Race/ethnicity African American/Black | 0.93 | (0.876) | 0.78 | (0.325) | 0.54 | (0.367) |
| Asian/Asian American | 0.69* | (0.032) | 0.92 | (0.494) | 1.06 | (0.843) |
| Chicano/Latino | 1.19 | (0.526) | 0.96 | (0.763) | 0.75 | (0.545) |
| Other/Unknown | 0.64* | (0.044) | 0.76 | (0.294) | 0.54 | (0.214) |
| White/Caucasian | ref | | | | | |
| Individual behavior and preference variables | | | | | | |
| Commute frequency day/wk | 1.06 | (0.087) | 1.10* | (0.027) | 1.04 | (0.639) |
| Commute enjoyment Small/moderate amount | 1.68*** | (0.000) | 1.08 | (0.515) | 1.20 | (0.454) |
| Great deal | 1.73 | (0.054) | 0.88 | (0.429) | 1.16 | (0.693) |
| None | ref | | | | | |
| Barriers to AT modes per barrier | 1.06 | (0.313) | 1.08 | (0.078) | 0.91 | (0.400) |
| Rideshare for commuting Yes | 1.00 | (0.995) | 1.35 | (0.120) | 1.26 | (0.468) |
| No | ref | | | | | |
| Primary commute mode Transit | 1.21 | (0.335) | 1.79* | (0.019) | 2.19 | (0.117) |
| AT | 2.15** | (0.005) | 12.19*** | (0.001) | 3.37* | (0.037) |
| Vehicle | ref | | | | | |
| Organizational Variables | | | | | | |
| Discounted transit pass user Yes | 1.19 | (0.275) | 1.48 | (0.341) | 0.76 | (0.712) |
| No | ref | | | | | |
| Parking permit Visitor | 0.99 | (0.960) | 0.77 | (0.186) | 0.90 | (0.827) |
| Off-Peak | 1.17 | (0.542) | 0.39*** | (0.000) | 1.52 | (0.699) |
| None | 1.12 | (0.550) | 0.97 | (0.826) | 0.77 | (0.475) |

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(*continued*)

| | Student | | Staff | | Faculty | |
|---|---|---|---|---|---|---|
| | OR | (p-value) | OR | (p-value) | OR | (p-value) |
| Full access | ref | | | | | |
| Physical environment variables | | | | | | |
| Distance to campus per 1 km | 1.01 | (0.151) | 0.99 | (0.151) | 1.02 | (0.327) |
| Distance to nearest LRT per 1 km | 0.98 | (0.067) | 1.00 | (0.393) | 0.98 | (0.103) |
| Transit access by neighborhood >100 transit stops | 1.35* | (0.039) | 0.96 | (0.678) | 1.07 | (0.781) |
| ≤100 transit stops | ref | | | | | |
| ref = reference category | | | | | | |

* for p < .05, ** for p < .01, and *** for p < .001.

## Appendix 4. Duration (min/wk) of TPA, by respondent type

| | Student | | Staff | | Faculty | |
|---|---|---|---|---|---|---|
| | Average marginal effect (AME) | (p-value) | Average marginal effect (AME) | (p-value) | Average marginal effect (AME) | (p-value) |
| Individual characteristics | | | | | | |
| Age per year | −7.88*** | (0.000) | −0.049 | (0.858) | −1.38** | (0.008) |
| Gender Female | −9.60 | (0.342) | −40.12*** | (0.000) | −32.51** | (0.005) |
| Male | ref | | | | | |
| Race/ethnicity African American/ Black | 10.96 | (0.791) | −18.51 | (0.237) | 15.11 | (0.765) |
| Asian/Asian American | −48.83*** | (0.000) | −13.92 | (0.072) | 10.17 | (0.499) |
| Chicano/Latino | 10.78 | (0.564) | −4.10 | (0.653) | 16.39 | (0.565) |
| Other/Unknown | - 68.23*** | (0.000) | −10.68 | (0.538) | 33.84 | (0.364) |
| White/Caucasian | ref | | | | | |
| Individual behavior and preference variables | | | | | | |
| Commute frequency day/wk | −0.35 | (0.893) | 11.10*** | (0.000) | 5.352 | (0.195) |
| Commute enjoyment Small/ moderate amount | −23.47* | (0.045) | −11.11 | (0.145) | 25.75* | (0.034) |
| Great deal | −15.70 | (0.428) | 2.82 | (0.803) | 56.48** | (0.008) |
| None | ref | | | | | |
| Barriers to AT modes per barrier | 11.77** | (0.003) | −0.05 | (0.984) | −1.91 | (0.724) |
| Rideshare for commuting Yes | 43.05*** | (0.000) | 43.09*** | (0.001) | 17.22 | (0.301) |
| No | ref | | | | | |
| Primary commute mode Transit | 9.42 | (0.482) | 24.20 | (0.087) | 37.99 | (0.092) |
| AT | 134.9*** | (0.000) | 202.7*** | (0.000) | 116.5*** | (0.000) |
| Vehicle | ref | | | | | |
| Organizational Variables | | | | | | |
| Discounted transit pass user Yes | 38.97*** | (0.001) | 14.87 | (0.470) | −3.64 | (0.908) |
| No | ref | | | | | |
| Parking permit Visitor | 4.20 | (0.826) | 12.18 | (0.396) | 24.00 | (0.422) |
| Off-Peak | −16.54 | (0.345) | −24.33 | (0.145) | −38.54 | (0.225) |
| None | 3.55 | (0.799) | 8.045 | (0.400) | −27.14 | (0.095) |
| Full access | ref | | | | | |
| Physical environment variables | | | | | | |
| Distance to campus per 1 km | 0.81 | (0.171) | −0.06 | (0.861) | 0.740 | (0.372) |
| Distance to nearest LRT per 1 km | −1.28* | (0.046) | −0.10 | (0.725) | −0.37 | (0.588) |
| Transit access by neighborhood >100 stops | −12.21 | (0.234) | −0.35 | (0.956) | −1.86 | (0.877) |
| ≤100 stops | ref | | | | | |

ref = reference category.
* for p < .05, ** for p < .01, and *** for p < .001.

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