Affordable Housing for Climate Change: A Study of the Relationship Between Housing Cost and Transportation Footprint of UC Berkeley Undergraduates

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ABSTRACT

The transportation sector in the USA is the biggest emitter of climate change-inducing greenhouse gases (GHG), especially from passenger vehicles as people commute to work or schools far from their residence. Studentification increases housing costs near universities, discouraging students from living close to campus and indirectly incentivizing the use of carbon-emitting transport modes to complete commutes that may cause bigger transportation footprints. To address the knowledge gap in research regarding the relationship between housing cost and transportation footprint, I distributed an online survey and collected data on UC Berkeley undergraduate students' housing and transport mode choices, costs, and behaviors. I conducted correlation tests to examine the association between these variables of interest, comparing values between respondents identified as commuters and non-commuters. I found a statistically significant negative correlation between housing cost and distance from campus. When choosing their housing accommodations, non-commuters most highly valued living close to campus while commuters valued housing cost. Transport mode choice was most influenced by distance between students' residence and campus. Commuters used GHG-emitting transport modes more frequently and, consequently, had greater transportation costs and footprints. There was no association between annual household income and housing cost or living situation, suggesting that factors other than financial status influence students' housing decisions. I found a negative correlation between housing cost and transportation footprint, although it was not statistically significant. These results indicate that more research is needed to understand the relationship between individuals' housing and transport mode choices, both of which appear to influence transportation footprint.

KEYWORDS

transport mode choice, housing preferences, Likert scale, carbon emissions, studentification

INTRODUCTION

Climate change has become the most pressing issue of the 21st century, yet countries worldwide are slow to curb greenhouse gas (GHG) emissions, the main driver of this problem. Human activity generates excessive GHG emissions, and one of the greatest offenders is transportation (Sims et al. 2014, US EPA 2015). Over the decades, the transportation sector at every government level has consistently contributed among the most to GHG emissions worldwide, with carbon dioxide (CO_2) being the primary GHG produced through travel (Sims et al. 2014, US EPA 2015, California Air Resources Board 2019, Claire et al. 2015, City of Berkeley 2019), and transportation by road, be it passenger vehicles or light-duty trucks, are consistently the biggest contributors to GHG emissions in the transportation sector (Sims et al. 2014, California Air Resources Board 2019). This emissions trend shows little sign of slowing as the world population continues to grow and globalize, leading to increased travel demand of both goods and people across national and international borders.

GHG emissions across all countries, however, are not equal. Most people in developing countries live near where they work, removing the need for long-distance travel reliant on GHG-emitting vehicles. However, as the economies of these countries grow, increase the availability of specialized jobs, and achieve a more gender-diversified workforce, there may be an increase in the number and length of commutes among those populations leading to an increase in GHG emissions (Li et al. 2012). In comparison, developed countries—particularly those belonging to the Organization for Economic Cooperation and Development (OECD)—have the highest GHG emissions for transport relative to GDP per capita because the social and economic infrastructure in these countries necessitate travel for work (Sims et al. 2014). As such, people have little choice but to undertake long commutes through various modes of transport.

A person's choice of travel mode depends heavily on factors like proximity to intended destination, lifestyle habits, and socioeconomic status (SES). These factors have varying effects on the availability and convenience of transport options for each person. Furthermore, each transport option has varying levels of GHG emissions. Active transportation—walking, biking, skating, etc.—is the most environmentally-friendly option, but comes at the cost of taking too much time and is increasingly abandoned with increasing distance from one's destination (Kotoula et al. 2018). Public transportation includes buses, mass rapid transit, trains, etc. that

have the benefit of relatively affordable prices and lower gas consumption at the cost of convenience and privacy. Private motorized vehicles are the most common option for many in OECD countries as it grants people privacy and the convenience of traveling when- and wherever they please, but it is also the greatest polluter in the transportation sector (Sims et al. 2014, California Air Resources Board 2019). Even with the growing gig economy (Uber, Lyft, etc.) and technological advancements that create more electric and fuel-efficient vehicles, GHG will continue to be emitted until "sustainable" technology reaches zero carbon emissions for the entirety of the growing world population and economies (Amatuni et al. 2020). Technological fixes like these are often considered "Band-aid" solutions because they simply put a Band-aid over the issue rather than addressing its true cause (Childress 2019). In the case of the transportation sector's extensive GHG emissions, the root cause in its simplest form is the transported person or goods being too far from their destination. This issue can then be traced back to greater issues like globalization, lack of local job opportunities, and restrictions on one's housing choice.

Each person's housing choice is primarily defined by the availability of housing (owned or rented) and individual SES. The luxury of having comfortable options is only available by overcoming both hurdles, which are exceedingly difficult in an increasingly hostile housing market. Both the housing price-to-income and housing price-to-rent ratios for more than half the countries worldwide have increased, and the US is among the worst of them (IMF 2020). Lack of available housing, rising housing costs, and the inelastic demand for housing has created generations of financially-stressed homeowners and renters, particularly those identifying as members of marginalized communities such as Black Indigenous people of color (BIPOC) and LGBTQ+ (JCHS 2020, Aurand et al. 2020). The overrepresentation of BIPOC, LGBTQ+, and other marginalized groups of housing-stressed households is indicative of the continued influence of systemic racism and discrimination across society that trickle into the issue of environmental justice. Unaffordable housing causes low-income households and households from other marginalized groups to seek out more affordable housing at the cost of greater distance from their workplace (Green and Lee 2016) and increasing distance causes them to rely more on GHG-emitting modes of transport like buses and private passenger vehicles, thereby increasing their carbon footprint. Especially for financially stressed, already marginalized people

who have little choice but to travel long distances for work, this becomes an environmental justice issue as their carbon footprints are forcibly increased.

My research aims to understand the effect of housing cost on an individual's carbon footprint, specifically sourced from commuting to and from regularly visited locations (e.g. school, workplaces). The study area is centered in Berkeley, a city greatly affected by spikes in housing costs over time. Given that the study population is the University of California, Berkeley's (UC Berkeley) undergraduate students—some of whom commute from places outside of Berkeley—the specific bounds of the study area are dependent on students' responses. To understand the connection between housing cost and carbon footprint from commuting, I answer the following questions through my research: (1) Why do students choose to live close to or far from campus? (2) What is the relationship between the cost of housing and the distance of housing from the university campus? And, (3) how does the distance between housing accommodation and destination affect students' transport mode choices? I survey UC Berkeley undergraduate students about their housing preferences and mode choice, specifically factors that influence their mode choice.

BACKGROUND

Climate change and transportation

The California Air Resources Board (2019) reports that in 2017 California's transportation sector accounted for nearly 41% of the state's GHG emissions, which is by far the largest source of GHG emissions in the state. Passenger vehicles emitted 68% of this reported value, while heavy-duty vehicles, such as buses, emitted nearly 21% of this value. This relationship holds true at the county level as well. Studies of GHG emissions in Alameda County show not only that the transportation sector consistently emits the most GHG, but also that passenger vehicles and buses contributed to nearly 77% of the county's CO_2 emissions within this sector in 2011 (Claire et al. 2015). The transportation sector in the city of Berkeley accounted for 59% of the city's GHG emissions in 2018 (City of Berkeley 2020). Furthermore, between 2000-2016, Berkeley's transportation sector's emissions was the only one to increase among all sectors (Burrough 2020). Determining how to substantially decrease statewide GHG

emissions will require understanding the factors that influence people's mode choice, some of which are housing location and cost.

Transport mode choice

Mode choice is heavily influenced by several factors, including but not limited to an individual's proximity to destination, lifestyle habits, and SES. Prior to the COVID-19 lockdown in the United States, college students' most popular modes of transport were active (e.g. walking, biking), public (e.g. bus, mass rapid transit), and private motorized vehicles (Kotoula et al. 2018). Students living in college towns, such as Berkeley, are more likely to be multi-modal—using multiple modes of transport in one trip—and the average student's likelihood of choosing to walk increases with decreasing distance from campus (Zhou et al. 2018, Kotoula et al. 2018). Proximity to destination is generally key to determining people's mode choice, but there are outliers to this trend. Car owners and cyclists are likely to use their respective vehicles given any distance due to both its convenience and the positive utility of travel time, which is defined as the enjoyment of travel time itself by the commuter (Whalen et al. 2013). Those who are more committed to active lifestyles are also more likely to travel by bicycle and enjoy their travel time through this mode of transport (Zhou 2016).

Regarding the influence of SES on mode choice, a study by Green and Lee (2016) finds that there is a negative linear relationship between income level and walking to workplaces, and middle- and higher-income commuters are less likely to use public transportation. Students who prioritize rent affordability when determining where to live off-campus are more likely to not only live closer to bus stops, but also ride buses (Zhou et al. 2018). Men are more likely to use active transport, such as walking and particularly biking, than women, perhaps due to women's safety concerns (Zhou 2016).

Naturally, different modes of transport will emit varying levels of CO_2. Few studies, if any, examine the contributions of increased commute distances as a result of housing price increases to transportation footprints, much less ones focused on university students' commuting behavior in a city that is notorious for its exorbitant housing costs.

Studentification of the city of Berkeley

A large portion of Berkeley city residents are students at the University of California, Berkeley (UCB), and there are a multitude of factors that influence their housing choice. The most common and influential factors have been found to be housing cost and proximity to campus, although proximity to amenities like grocery stores, restaurants, etc. follow close behind (Cadima et al. 2020, Wode 2018).

The studentification of the city of Berkeley also plays no small role in influencing people's housing choice. "Studentification," a term coined by Darren R. Smith, is used to describe the combined phenomena of social, cultural, physical, and economic changes brought about by students moving into neighborhoods surrounding universities. Residences closer to a university campus are converted to "Houses of Multiple Occupation" (HMO) for rent at faster and more expensive rates than areas further from campus (Laidley 2014). Public universities often rely on the private rental sector to house students as the universities do not provide enough housing to accommodate all of their enrolled students (Laidley 2014). UC Berkeley only provides housing for first-year undergraduate students and a select few upperclassmen, causing most upperclassmen to turn to the private rental sector to find accommodation for the remaining years of their college education (HTF 2017). As most UCB students tend to reside in the city for the duration of their academic enrollment, they tend to rent housing instead of purchasing them, resulting in high housing turnover rates as each class graduates and leaves while new classes move in each year. These high turnover rates act as barriers to enacting change against exorbitant increases in rent over the years as landlords know they can afford to raise prices the closer a residence is to campus because there is no shortage of students needing housing accommodations (Laidley 2014). Median rent in Berkeley has consistently risen from $1,100 per month in 2012 to $1,800 per month in 2018 (Klein 2019). The period between 2017 to 2018 alone saw a $200 per month increase in median rent.

This suggests a worrisome trend that may affect low-income households and marginalized communities at disproportionately greater rates. Those who fall under this demographic tend to seek out more affordable housing at the cost of greater distance from their workplace (Green and Lee 2016). Increases in commute distance due to unaffordable housing may disproportionately increase CO_2 emissions among people of low socioeconomic status (SES), implicating a form of environmental injustice that has largely gone under the radar. These

longer commutes enlarge people's carbon footprint, which can be either improved or further exacerbated by people's mode choice.

METHODS

Population of interest

The target population of this study is undergraduate students enrolled in courses at the University of California, Berkeley during both the Spring 2020 and Spring 2021 semesters. The COVID-19 pandemic induced nationwide lockdowns in the United States during March 2020, which was in the middle of the Spring 2020 semester, causing students to not go to campus as often, if not entirely move away from Berkeley, for the nearly 2-year duration of virtual instruction. Students' housing choices and commuting behavior are the main subjects of interest of this study, and both were heavily impacted by the onset of the pandemic. As such, this study was adjusted to also examine the effect that COVID-19 has had on these two subjects by comparing student behavior at the start of both spring semesters, one prior to the pandemic lockdowns and the other in the midst of it.

To identify connections between housing cost and transportation footprint, I separated the undergraduate student population into two categories: commuters and non-commuters. For the purposes of this study, "commuters" are defined as students living outside a 3-mile radius of the UC Berkeley campus who regularly ride Bay Area Rapid Transit (BART) or motorized vehicles (car, carpool, Uber/Lyft, etc.) to travel from their residence to campus. "Non-commuters" are defined as all other students whose commute behaviors do not fall under this definition of "commuter."

Socio-demographic factors like age, gender, and income may influence students' housing and transportation mode choices, so knowing the student population's demographics may be helpful to identifying connections. According to an annual report by the UC Berkeley Office of Planning and Analysis, the undergraduate student body in Spring 2020 was approximately 53.5% women, 45.7% men, and 0.8% non-binary (OPA 2020). An estimated 44% of the undergraduate population received an average of $26,153 in need-based financial aid for the 2019-2020

academic year, covering an estimated average of 82% of students' financial needs. The report states that 27% of all undergraduates lived in university housing (i.e. apartments or residence halls), with first-year students making up a vast majority of that percentage since 94% of them lived in residence halls. Taking these population characteristics into account, I can not only assess the applicability of my research to the student population as a whole, but also gain a better understanding of the factors that affect students' housing location, mode choice, and transportation footprint.

Study area

This study centers on the city of Berkeley, California, specifically the area surrounding UC Berkeley. This college town was chosen because, at least prior to the COVID-19 lockdowns, the campus was regularly visited by students who lived in either Berkeley or nearby cities, making it a convenient point of comparison for the distance students regularly travel between their housing location and the campus given different transportation modes available for use. For the purposes of this study, Wheeler Hall was designated as the representative address for the UC Berkeley campus in all distance calculations because it is located at approximately the center of campus.

A unique aspect of UC Berkeley students' available transportation modes is that the university has partnered with Alameda-Contra Costa County Transit (AC Transit) to provide students with unlimited AC Transit bus rides throughout Berkeley and neighboring cities for a flat cost of $95.00 per semester, an required fee included in students' tuition (P&T 2021). The study area also extends throughout the Bay Area to the housing locations of students who live outside of Berkeley but still regularly commuted to campus for classes and other activities in Spring 2020.

Data collection

To gather data on undergraduate students' housing and transportation choices, I created and distributed an online Qualtrics survey to as many student groups as I could reach. Qualtrics is a cloud-based survey platform that allows users to design and distribute surveys as well as

analyze collected data with tools built into the platform (Qualtrics 2021). The survey included sections on students' living situations in February 2020 and February 2021, preferences for their campus commute, and general demographic information. The full survey instrument is available in Appendix D.

Survey content

Living situation in February 2020 compared to February 2021. The first section of my survey inquired about respondents' living situation in February 2020, which was just after the start of the spring 2020 semester but a month prior to the COVID-19 lockdowns in California. At that point in time, most UC Berkeley students were still living under pre-COVID-19 conditions: did not wear masks, social distance, nor make adjustments to their usual living arrangements.

Pre-COVID-19 responses were expected to reflect students' priorities and commuting behaviors before COVID-19 became a pressing concern. I asked for respondents' housing type (residence hall, housing cooperative, off-campus rental housing, off-campus housing owned by relatives or themselves, etc.), housing location, monthly housing costs, and square footage of personal space in their home covered by said costs (Figure 1). Responses to these questions allowed me to determine the approximate distance from students' housing to the UC Berkeley campus as well as estimate their housing cost per square foot of personal space (i.e. bedroom if the student does not live alone). Last, I asked respondents to rank on a five point scale from *Not important* to *Very important* the influence of factors such as housing quality, neighborhood safety, proximity to family, among others, on their housing choice in February 2020.

Figure 1. Diagrams of personal space square footage approximations. These diagrams show approximate room sizes to aid respondents in estimating the square footage of their personal living space.

The second section of this survey is essentially a duplicate of the first except all questions pertain to students' living situation in February 2021, the start of the second full semester of virtual instruction during the COVID-19 lockdown. There is an additional question in this section for respondents whose living situation in February 2021 was not exactly the same as in February 2020. These respondents were asked the reason for the change in their living situation between the two semesters in question.

Modes of Transportation. The third section of this survey inquired about respondents' commuting behavior in February 2020 and February 2021. I asked respondents to select from a list of modes the primary and secondary forms of transportation they most frequently used to get to campus, how many times on average they visited campus per week and per day, and the average cost of a round trip from their home to the campus for each mode of transportation they selected. To approximate carbon emissions, respondents who chose "driving a vehicle" as one of their modes of transportation were asked the car type (gasoline, diesel, hybrid, electric) they

drove. I also asked respondents whether they commuted to campus more, equally, or less often in February 2021 compared to February 2020. Those who selected *More often* or *About the same* were directed to questions about their primary and secondary modes of transportation in February 2021 as well as the cost per round trip from their home to the campus. Those who selected *Less often* were asked why they did not visit campus as often in February 2021.

General demographics. In this final section, I asked respondents for their graduation year, college, and majors and/or minors. I also asked about their estimated annual household income, personal monthly income, age, ethnicity or race, and gender identification. The final question determined whether the respondent identifies as a member of the LGBTQ+ community.

Survey distribution

I distributed the survey using an anonymous link on social media platforms, through personal networks, and in several classes like Environmental Science, Policy, and Management (ESPM) 175 and ESPM 50AC: Introduction to Culture and Natural Resource Management. I also sent the survey link to many student organizations, including but not limited to the Berkeley Student Cooperative, UC Berkeley Basic Needs Center, and other volunteer organizations. These courses and organizations were selected primarily because they were responsive to my outreach and have a relatively diverse undergraduate student population. The survey was open from April 2nd, 2021, to May 21st, 2021, which marked the end of the Spring 2021 semester.

Data analysis

Pearson's chi-square test of independence: determining an association between annual household income, living situation, and housing cost

Using RCommander, I conducted Pearson's chi-square test of independence to determine whether there is a relationship between respondents' annual household income and living situation in February 2020 as well as between annual household income and monthly housing cost per square foot in February 2020. To obtain the chi-squared statistic in RCommander, I

called the "Two-way table" function and selected the "chi-square test of independence" at a 5% significance level.

Assessing housing preferences

To determine the influence that different factors have on students' housing choices both semesters, I asked respondents to rank the importance of ten factors: (1) housing quality, (2) housing cost, (3) neighborhood safety, (4) close to campus, (5) close to grocery stores or restaurants, (6) close to transportation amenities, (7) close to friends, (8) close to family, (9) parking availability, and (10) COVID-19 safety. The ranking was a five-point scale ranging from *Not important* to *Very important*. I assigned numerical values to each point on the scale (*Not important* = 1, *Somewhat unimportant = 2, Neutral* = 3, *Somewhat important* = 4, *Very important* = 5) in order to conduct a quantitative assessment of the importance of each factor. The quantified importance ranking as explained above will be termed the "importance value" for the remainder of this paper.

I conducted a preliminary assessment of all ten housing factors' average importance value in February 2020 and February 2021. This preliminary assessment involved taking the average value of each of the ten housing factors across all applicable respondents and subtracting 3, the neutral value, from it to determine its importance to respondents overall. This value was termed the "adjusted average importance value (AAIV)." Greater positive values indicate greater importance to students in the consideration of their housing location, while greater negative values indicate less importance to students. To compare AAIVs in February 2020 and February 2021, I calculated the difference in AAIV (DAAIV) by subtracting 2020's AAIV from 2021's AAIV.

To understand whether the degrees of change in the importance value of housing factors between February 2020 and 2021 were statistically significant, I conducted a paired t-test on all ten housing factors. The three conditions of conducting a paired t-test were met for some housing factors: (1) Responses of all subjects included in the sample were independent of each other; (2) the paired measurements of importance value of each housing factor were obtained from the same subject; (3) the measured differences in importance values were approximately normally

distributed except for housing quality and neighborhood safety. However, as the sample size is n > 10, a paired t-test could still be performed with viable results.

Calculating housing and transportation costs

I calculated each respondent's housing cost by dividing the approximate square footage of the personal space they paid for by the amount of money they pay for their living space per month, excluding utilities. This allowed me to obtain each respondent's monthly housing cost per square foot to make normalized cost comparisons across different housing types and locations.

I calculated respondents' transportation costs by using their estimate of the cost of a round trip between their home and the UC Berkeley campus via their primary transport mode and multiplying that by the number of times per week they visited the campus. This provided an estimate of the weekly cost of their campus commutes.

Calculating transportation footprints

Calculating respondents' carbon footprint from commuting to campus required using their reported home address, primary mode of transportation, and CO_2 emission estimates of said modes from official government websites like the US EPA and AC Transit. To maintain consistency in estimating the distance of respondents' housing location from campus, I set the campus address to Wheeler Hall, a building located approximately at the center of the UC Berkeley campus from all four sides and frequented by many students. I doubled the approximate distance between the campus and each respondent's home address in February 2020 to estimate the distance each respondent travels for a round trip of their typical school commute.

Transport modes have varying CO_2 emissions, and I made some assumptions on certain modes in order to complete these estimates. Due to AC Transit's mixed use of hydrogen fuel cell electric (FCEB), battery-electric (BEB), and hybrid diesel-electric buses in Berkeley, buses operated by AC Transit in this area emit varying levels of CO_2 (AC Transit 2021). FCEB and BEB do not emit CO_2 while hybrid diesel buses emit an estimated 36.6 metric tons CO_2 every 6 months (AC Transit 2021). As I cannot ascertain the types of buses used by the respondents, I

selected the bus types that are most commonly used by students in the area, which are FCEB and BEB, meaning these buses have zero CO_2 emissions (AC Transit 2020). The average CO_2 emission equivalent of a BART passenger mile is estimated to be 0.204 lbs (BART 2021).

The US EPA estimates that the fuel economy of the average passenger vehicle on the road is 22.0 miles per gallon of gasoline, emitting 0.891 lbs of CO_2 per mile traveled (EPA 2018). To calculate carpoolers' transportation footprint, I halved the CO_2 emissions per mile traveled of the average passenger vehicle to account for at least one other person in the vehicle, giving me the value of 0.446 lbs of CO_2 per mile traveled per carpooling respondent. Without knowing the make and model of hybrid vehicles, I cannot make an accurate estimate of their CO_2 emissions, so I estimated that the average hybrid vehicle in the US emits approximately half as much CO_2 as a traditional gasoline-/diesel-fueled vehicle knowing that the former certainly emits less CO_2 than the latter. Furthermore, using a 2015 Toyota Prius Plug-In Hybrid to approximate CO_2 emissions shows that this make and model of hybrid vehicles emits 0.441 lbs of CO_2 per mile traveled, which is approximately half of the emissions of the average passenger vehicle estimated by the US EPA.

Walking, biking, electric scooters, and skate- and longboarding are transport modes that do not emit CO_2.

Pearson's Product-Moment Correlation Coefficient: determining the correlation between housing and transportation cost, distance from campus, and transportation footprint

I used RCommander to conduct Pearson's correlation test to determine whether there were statistically significant correlations between monthly housing cost per square foot and three other variables: distance of respondents' homes from campus, transportation cost, and transportation footprint. Each of these tests had three groups of interest: non-commuters, commuters who had monthly housing costs, and commuters who did not have monthly housing costs due to not having to pay to live in their personal family home. Calculations for transportation cost included an additional fourth group: non-commuters without transportation costs. I could not calculate the correlation coefficient for commuters who did not have housing costs nor non-commuters who did not have transportation costs because vertical slopes are undefined. (See Figures 7b, 10, and 13 for visualizations).

To obtain the correlation coefficient in RCommander, I called the "Correlation Test" function under the following conditions: Pearson's product-moment, two-sided alternative hypothesis, and 5% significance level. I ran this test on all three to four respondent groups for all three variables being compared to respondents' estimated monthly housing cost per square foot.

RESULTS

By the time the survey closed to the public on May 21st, 2021, I received a total of 508 raw responses. Once incomplete, rushed, and incohesive responses were removed along with responses from students who were not enrolled in classes at UC Berkeley in both Spring 2020 and Spring 2021, 245 valid responses remained. These 245 responses were assigned unique identification codes (UID) to retain respondents' anonymity throughout analyses. Of these 245 respondents, 61% identified as female, 37% as male, and 2% as non-binary (Figure 2a). Compared to the overall undergraduate population's gender distribution, of 53.5%, 45.7%, and 0.8% respectively, there appears to be an overrepresentation of people identifying as female and non-binary among respondents. Most respondents (62.4%) were second-year students, which makes sense given that a large portion of respondents were from ESPM 50AC, a lower division course that many underclassmen take to fulfill their course requirements (Figure 2b). Third- and fourth-year students both made up approximately 18% of the respondents each. These are two indicators that this sample may not be representative of the overall university population.

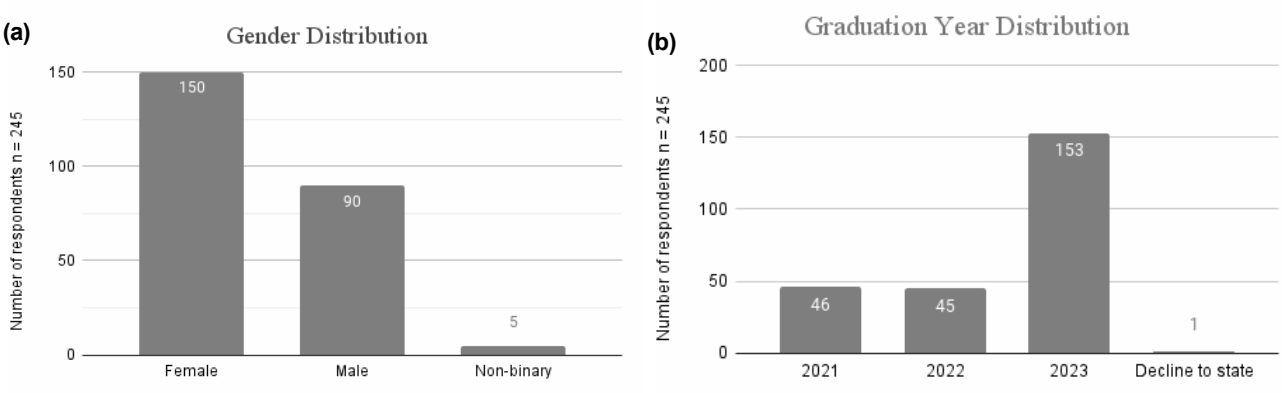

Figure 2. All 245 survey respondents distributed by gender and graduation year. (a) Gender: 61.2% identified as female. 36.7% identified as male. 2.0% identified as non-binary. (b) Graduation year: 62.4% second-year students. 18.3% third-year students. 18.8% fourth-year students. 0.4% declined to state.

Assessing students' living situation in February 2020 and February 2021

Comparison of living situation in February 2020 and February 2021

When comparing respondents' living situation in February 2020 and 2021, the most significant differences were an increase in students living in owned off-campus residences from 22 to 97 and a decrease from 123 to 26 of students living in residence halls or on-campus apartments. Some students moved out of housing cooperatives in 2021, but others moved in, keeping the total number of students in housing cooperatives steady at 10 during both semesters. Off-campus rental housing saw a slight increase from 88 to 106, while students living in Greek houses increased from 2 to 6 (Figure 3).

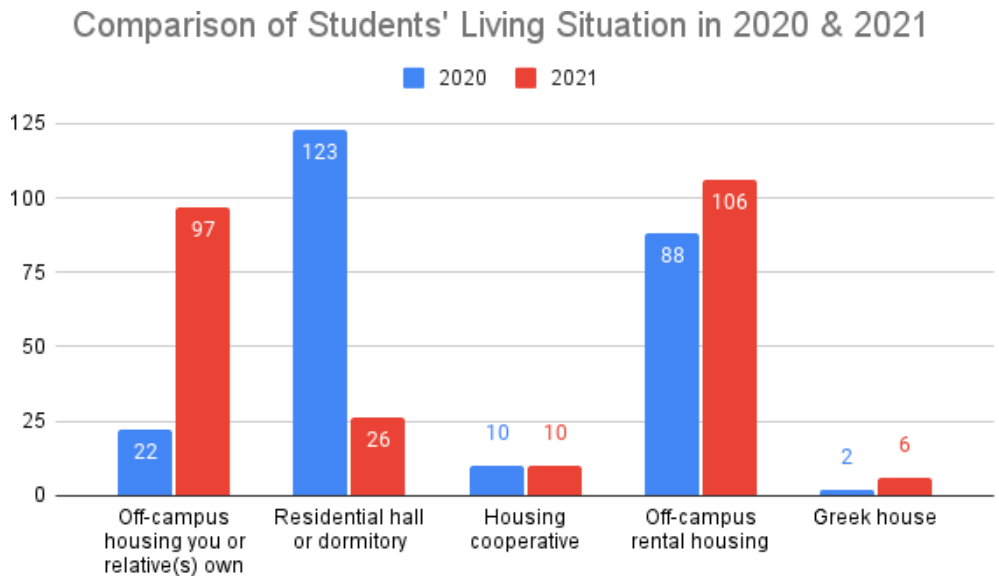

Figure 3. Comparison of students' housing type in February 2020 and 2021. N=245.

Reasons for change in living situation between February 2020 and February 2021

Given the open-ended question, "Why did your living situation change between February 2020 and February 2021," the most frequently cited reason for changes in students' living situation was COVID-19 with 97 respondents directly mentioning it in some way. Some respondents only wrote "COVID-19" as an answer while others explained that various combinations of virtual instruction, safety concerns, living with family, and/or saving money tied into the overarching threat of the pandemic pushed them to change their housing situation. The remaining 148 respondents did not mention COVID-19 in their answer. Of the 245 respondents, 67 of them had the exact same living situation between February 2020 and 2021. See Figure 4 for more reasons given by respondents and the number of times each reason was cited.

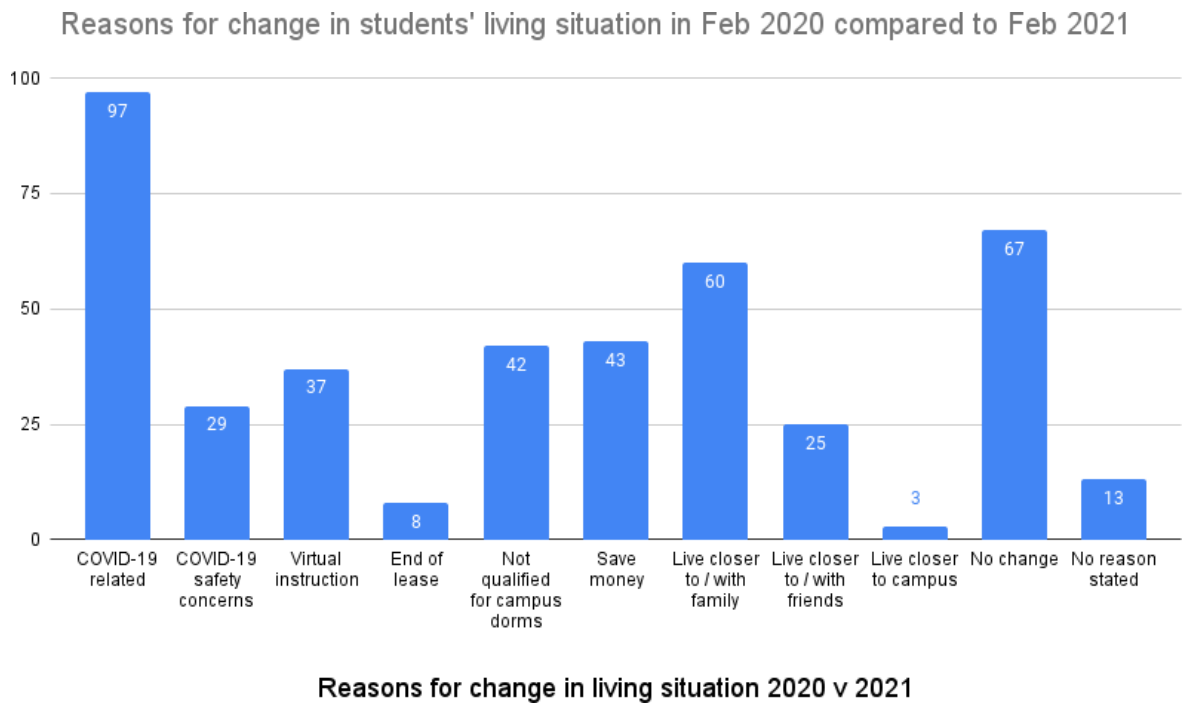

Figure 4. Bar chart of respondents' reason(s) for changes in their living situation between February 2020 and February 2021.N =245.

Distributions by annual household income

I found that approximately 34.7% of the respondents reported their annual household income to be "$150,000 or more" while the next most frequently selected income bracket was "Less than $25,000," representing 13.5% of respondents. The annual household income distribution of non-commuters and commuters were comparatively very similar (Figure 5).

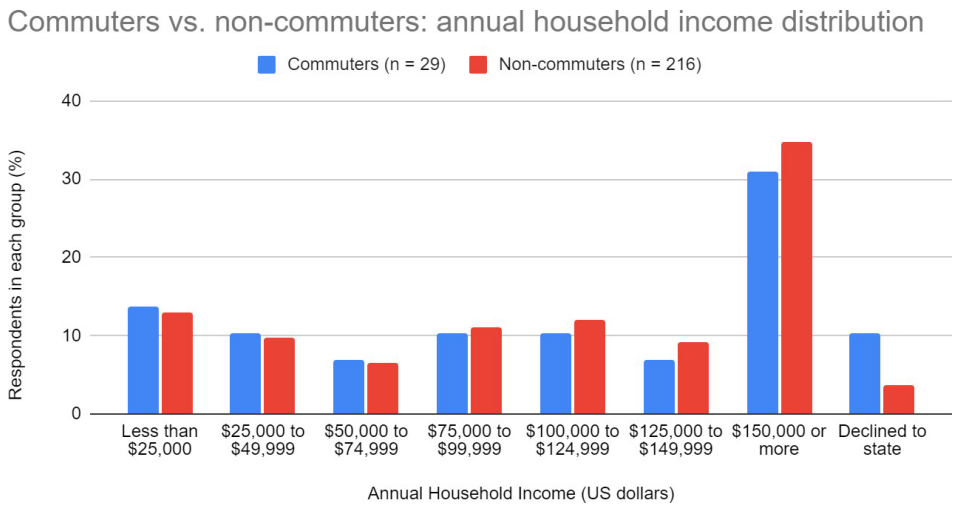

Figure 5. Bar chart comparing the distribution of annual household income for commuters and non-commuters. N=245

Feb 2020: Living situation and monthly housing cost distributed by annual household income

Despite 34.7% of respondents reporting their annual household income as "$150,000 or more" and each of the other income brackets representing around 10% of respondents, the distribution of respondents in each of the five housing categories in February 2020 was more or less similar across all income brackets (Figure 6a). The exceptions to this were Greek housing, which was only represented by the "$150,000" or more" income bracket, and housing cooperatives, which was not represented by respondents in the "$125,000 to $149,999" category nor those who declined to state their annual household income.

An examination of respondents' monthly housing cost per square foot distributed by annual household income also reveals a similarly uniform distribution of respondents of each of the six housing cost categories: $0; ($0, $10]; ($10, $20]; ($20, $30]; ($30, $40]; and ($40, $50]. For nearly all income brackets, the greatest percentage of respondents had monthly housing costs

per square foot in the ($10, $20] category. The only exception is the income bracket "$25,000 to $49,999," where this percentage is identical to the ($20, $30] category. See Figure 6b for a visual comparison of all income brackets and housing cost categories.

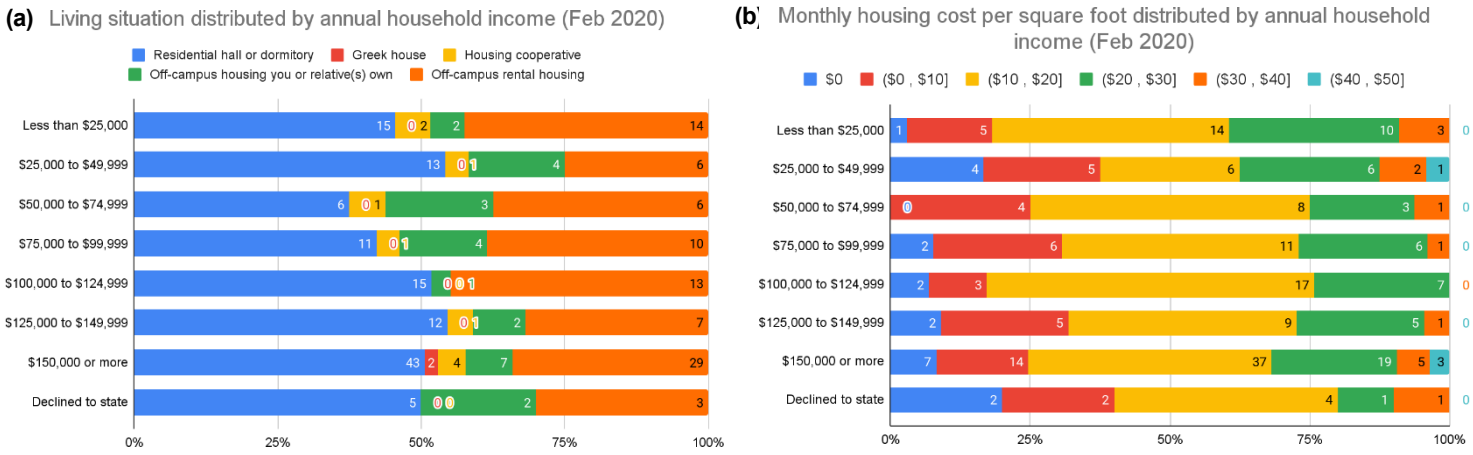

Figure 6. Stacked bar charts of respondents' (a) living situation and (b) monthly housing cost per square foot in February 2020 distributed by annual household income. N=245.

Using Pearson's chi-square test of independence to statistically examine whether there was a relationship between respondents' annual household income and choice of housing as well as their annual household income and monthly housing cost per square foot, I found that neither relations were statistically significant. There was no significant association between annual household income and living situation in February 2020, X^2 (28, N = 245) = 15.18, p = 0.9764. The association between annual household income and housing cost was also not statistically significant, X^2 (35, N = 245) = 22.24, p = 0.9536 (Appendix A).

Feb 2021: Living situation and monthly housing cost distributed by annual household income

I also used Pearson's chi-square test of independence to assess the relationship of these variables in February 2021 and did not find statistically significant associations. The association between annual household income and living situation in February 2021 was not significant, X^2 (28, N = 245) = 23.80, p = 0.6919, nor was the relationship between annual household income and monthly housing cost per square foot, X^2 (35, N = 245) = 43.72, p = 0.1481. There was a great decrease in the overall monthly housing cost per square foot in February 2021 regardless of

respondents' household income bracket because many moved in with their families during the pandemic and did not have to pay for housing (Appendix B).

Housing preferences

Preliminary assessment of importance value of housing factors in February 2020 and 2021

By calculating and comparing the adjusted average importance value (AAIV) for all ten housing factors, I found that the top three most important factors students considered in February 2020 were (1) closeness to campus, (2) housing cost, and (3) housing quality (Table 1). Closeness to campus was most highly valued at an average of 1.265, which is approximately 0.3 greater than the runner-up factor, housing cost, at 0.967. Housing quality, the third most important factor, had an average importance value of 0.861. The three least important housing factors in February 2020 were (1) parking availability, (2) closeness to family, and (3) COVID-19 safety.

Table 1. All ten housing factors and their average importance value to respondents in February 2020.

Housing Factor	Average importance value among respondents in 2020 (N = 245)	Adjusted average importance value (AAIV) in 2020*
Housing quality	3.861	0.861
Housing cost	3.967	0.967
Neighborhood safety	3.853	0.853
Close to campus	4.265	1.265
Close to transportation amenities	3.167	0.167
Close to grocery stores / restaurants	3.339	0.339
Close to friends	3.482	0.482
Close to family	2.127	-0.873
Parking availability	2.000	-1.000
COVID-19 safety	2.784	-0.216

∗ Adjusted average importance value (AAIV) was obtained by subtracting 3 (the value representing a ranking of *Neutral*) from the values in column 2. This moves the scale such that the more positive the importance value is, the more important it is to students. The more negative the importance value, the less important it is to students.

Due to human error, some respondents who answered that their housing situation in February 2020 and February 2021 were "Exactly the same" were not asked to rank the ten factors again in 2021, so their responses were excluded from this part of the study, dropping the number of respondents from 245 to 200. 32 respondents who answered "exactly the same" were able to access the ranking of the importance of housing factors in February 2021, so their responses were included in the remaining parts of the housing preference analysis.

Using the same method described in my assessment of the average importance value of each housing factor in February 2020, I assessed the average importance values of the same housing factors in February 2021 (Table 2). I found that there was a significant increase from 2020 to 2021 in the importance of the adjusted average importance value (AAIV) of (1) COVID-19 safety and (2) closeness to family with DAAIV of 1.016 and 0.843, respectively. The housing factors that had the greatest decrease in AAIV from 2020 to 2021 were (1) closeness to campus at -1.280 and (2) closeness to transportation amenities at -0.737.

Table 2. All ten housing factors and their average importance value to respondents in February 2021. Rightmost column is a comparison to February 2020's AAIV.

Housing Factor	**Average importance value among respondents in 2021 (n = 200)**	**Adjusted average importance value in 2021 (AAIV)***	**Difference in AAIV between 2020 - 2021 (DAAIV) ⁑**
Housing quality	3.895	0.895	0.034
Housing cost	3.785	0.785	(-) 0.182
Neighborhood safety	3.590	0.590	(-) 0.263
Close to campus	2.985	-0.015	(-) 1.280
Close to transportation amenities	2.430	-0.570	(-) 0.737
Close to grocery stores / restaurants	3.285	0.285	(-) 0.054
Close to friends	3.305	0.305	(-) 0.177
Close to family	2.970	-0.030	0.843

Parking availability	2.510	-0.490	0.510
COVID-19 safety	3.800	0.800	1.016

∗ Adjusted average importance value (AAIV) was obtained by subtracting 3 (the value representing a ranking of *Neutral*) from the values in column 2. This adjusts the scale such that the more positive the importance value is, the more important it is to students. The more negative the importance value, the less important it is to students.

⁑ Difference in AAIV between 2020 and 2021 (DAAIV) was obtained by subtracting 2020's AAIV from 2021's AAIV and taking the absolute value of the difference. Greater values indicate greater changes in the average importance value of the housing factor between 2020 and 2021. A **(-) symbol** in front of the DAAIV indicates a decrease in importance of that value's magnitude between 2020 and 2021.

See the charts in Appendix C for a visualization of the differences in the importance ranking of each housing factor between the two spring semesters.

Paired t-test to compare changes in the importance value of housing factors in 2020 and 2021

Conducting a paired t-test on each of the ten housing factors in February 2020 and February 2021 at a significance level of $\alpha = 0.05$, I found that 6 of the 10 factors had *p*-values that indicated a significant overall change in students' living situation in February 2020 and 2021 (Table 3). The housing factors with the smallest *p*-values are (1) closeness to campus at p = 6.45E-23, (2) COVID-19 safety at p = 1.03E-18, and (3) Closeness to family at p = 4.24E-14. The remaining three housing factors with $p < 0.05$ are (4) closeness to transportation amenities, (5) parking availability, and (6) neighborhood safety. Closeness to grocery stores/restaurants and housing quality are the two factors that had largest *p*-values at 0.955 and 0.577, respectively. The remaining two factors, housing cost and closeness to friends, had *p*-values of 0.190 and 0.099, respectively.

Table 3. Paired t-test results of the importance value of housing factors in February 2020 and February 2021.

Housing Factor	**Average difference of paired values (2021 - 2020)**	**t-score**	***P*-value**
Housing quality	0.055	0.558198	0.577336
Housing cost	-0.120	1.315619	0.189816

Neighborhood safety	-0.250	2.983257	0.003209
Close to campus	-1.365	11.207728	6.45E-23
Close to transportation amenities	-0.735	6.935807	5.53E-11
Close to grocery stores / restaurants	0.005	0.056025	0.955378
Close to friends	-0.175	1.658972	0.098697
Close to family	0.945	8.140123	4.24E-14
Parking availability	0.650	5.921893	1.38E-8
COVID-19 safety	1.080	9.786329	1.03E-18
n = 200	degrees of freedom = 199		**α** = 0.05

Correlation between monthly housing cost per square foot and distance of residence from UC Berkeley campus

I used Pearson's correlation coefficient test in RCommander and found statistically significant negative correlations between housing cost and distance from the UC Berkeley campus for non-commuters and commuters with housing costs in February 2020. 216 respondents fell in the non-commuter category while commuters were further divided into those who paid for their housing accommodation (9) and those who did not (20). At a significance level of $\alpha = 0.05$, I found that non-commuters' housing cost and housing distance from campus had a negative correlation of $r(214) = -0.300$ and significant $p < 0.0001$. Commuters with housing costs had a strong negative correlation of $r(7) = -0.742$ with $p = 0.0221$. The correlation coefficient for commuters without housing costs could not be calculated due to the variables' undefined slope. Table 4 displays a summary of the correlation coefficient *r*, *t*-score, degrees of freedom, *p*-value, and 95% confidence interval for these correlation tests. Figure 7 displays scatter plots and regression lines of each of the aforementioned groups.

Table 4. Correlation statistics for housing cost and distance of respondents' homes from the UC Berkeley campus.

Respondent type	Correlation coefficient *r*	*t*-score	Degrees of freedom (d.f.)	*p*-value	95% confidence interval bounds
Non-commuters	-0.3000776	-4.5911	214	0.000007535	[-0.4171328, -0.1732294]
Commuters with housing costs	-0.7419181	-2.9276	7	0.0221	[-0.9419289, -0.1533611]

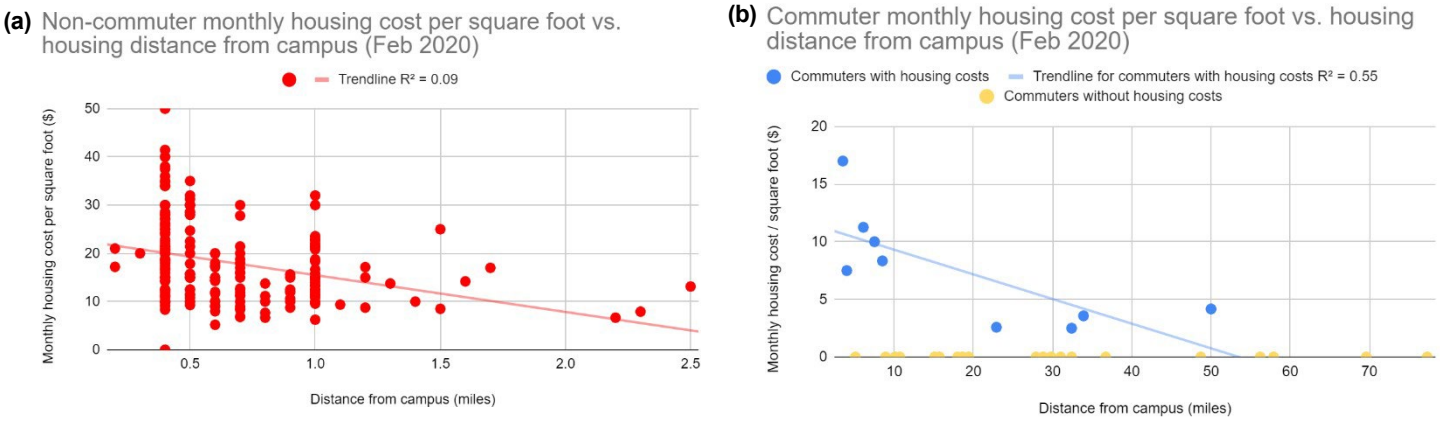

Figure 7. Simple linear regression model of the correlation between the distance of students' residence from the UC Berkeley campus (miles) and their monthly housing cost per square foot (US dollar) in February 2020. (a) Model for non-commuters. n=216. (b) Model for commuters with and without housing costs. n=29.

Transport mode choice in February 2020

In February 2020, a total of 216 and 29 respondents were categorized as non-commuters and commuters, respectively. Figure 8a depicts the percentage of each transportation mode that is used by commuters and non-commuters. 90.3% of non-commuters chose walking as their primary, or most often used, mode of transportation while driving a vehicle was most popular among commuters, with 51.7% of them choosing this mode. The second most popular for non-commuters was riding the bus, while the second most frequently used by commuters was the BART. Biking, riding motorcycles/electric scooters, skateboarding, and carpooling were each the primary mode for two non-commuters. No respondents chose taxi services like Uber or Lyft as their primary mode of transportation.

The most frequently selected secondary mode of transportation for non-commuters in February 2020 is the bus with 45.4% of them selecting this option, followed by 24.1% selecting "N/A", meaning these respondents did not use any other form of transportation aside from their

primary mode in February 2020. As for commuters, 34.4% chose "N/A" and 24.1% selected BART as their preferred secondary mode (Figure 8b).

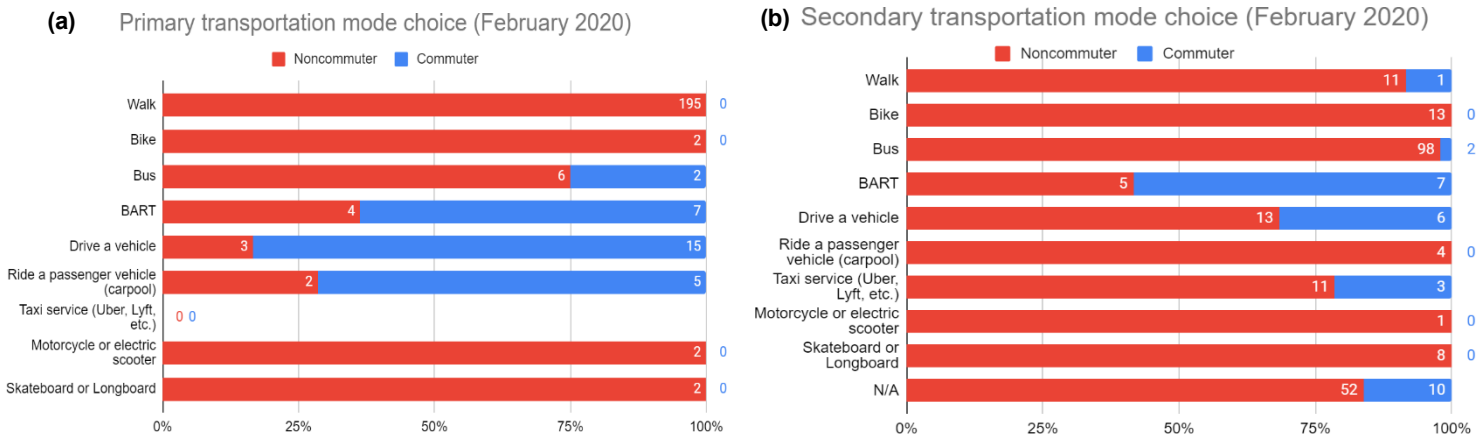

Figure 8. Bar chart of the most often used transportation modes for commuters compared to non-commuters in February 2020. (a) Primary transport mode. N=245. (b) Secondary transport mode. N=245.

Regardless of whether respondents were commuters or non-commuters, the top two most influential factors in determining their travel mode choice(s) were (1) the distance of their home from the UC Berkeley campus and (2) the convenience of their chosen transportation (Figure 9). 47 of the 216 non-commuters cited the inexpensiveness of walking, riding the bus, or biking/riding electric scooters as reasons for choosing to use said modes of transportation, whereas only 2 out of 29 commuters mentioned the relative cheapness of riding the BART compared to rideshares or driving their own vehicles as reasons for using this mode. 2 commuters also prioritized "independence" in determining their mode choice, meaning they valued being able to travel at any time and to any place with their own vehicles, while this reason was not mentioned by any non-commuters. In descending order of frequency, non-commuters chose their modes of transportation due to the desire to exercise (e.g. walking, biking), accessibility of certain modes, enjoyment of their commute, and desire to help the environment by minimizing GHG emissions.

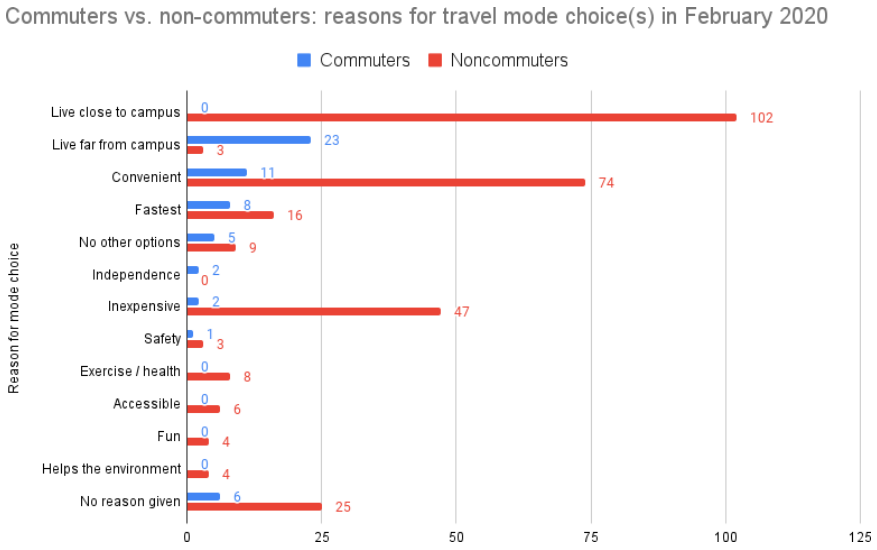

Figure 9. Bar chart of commuters' and non-commuters' reasons for choosing their mode(s) of transportation for their campus commute in February 2020. N=245.

Correlation between monthly housing cost per square foot and cost of campus commute

Using Pearson's correlation test on the monthly housing cost per square foot and estimated weekly travel costs of 236 respondents divided into four groups, I found a negative correlation coefficient r = -0.406 for non-commuters with travel costs and r = -0.260 for commuters with housing costs, although neither were statistically significant (Table 5). The remaining two groups were non-commuters without travel costs and commuters with travel costs, both of which had incalculable correlation coefficients. 9 respondents were removed from this part of the study because they did not provide enough information to estimate their weekly travel costs. The data points of all four groups are displayed in the simple linear regression model in Figure 10.

Table 5. Correlation statistics for housing cost and travel costs of a round trip from respondents' homes from the UC Berkeley campus.

Respondent type	Correlation coefficient *r*	*t*-score	Degrees of freedom (d.f.)	*p*-value	95% confidence interval bounds
Non-commuters with travel costs	-0.4061527	-1.1759	7	0.2781	[-0.8429118, 0.3532539]
Commuters with housing costs	-0.2596408	-0.65857	6	0.5346	[-0.8151689, 0.5446895]

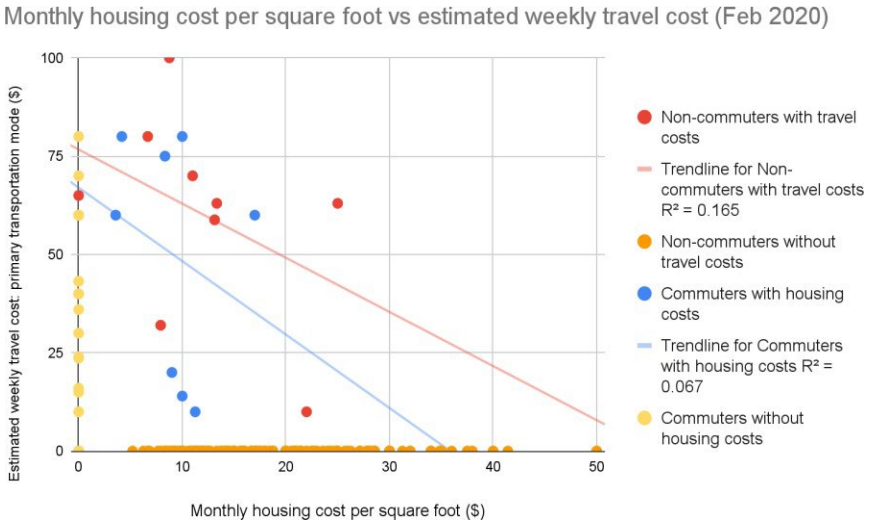

Figure 10. Simple linear regression model of monthly housing cost per square foot and estimated weekly travel costs in US dollars in February 2020. Compares non-commuters with and without travel costs as well as commuters with and without housing costs. (n = 236)

Transportation footprint assessment

Using simple linear regression, I found there to be a positive correlation between the amount of CO_2 emitted from respondents' commutes (expressed in pounds) and the distance of a round trip from the UC Berkeley campus to respondents' homes in February 2020. For non-commuters, or students who live within a 3-mile radius of the UC Berkeley campus, there is a small positive correlation of $r = 0.346$. For commuters, there is a strong positive correlation of $r = 0.789$ (Figure 11).

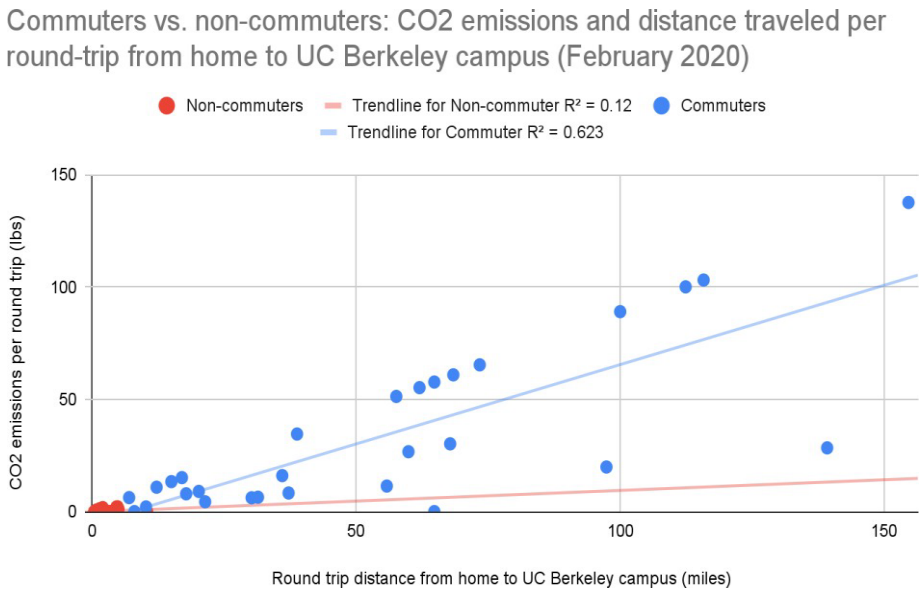

Figure 11. Simple linear regression model of commuters vs. non-commuters' CO_2 emissions per round-trip campus commute in February 2020. N=245.

I found that respondents who commuted via gasoline-fueled vehicles had the greatest CO_2 emissions, followed by hybrid-electric vehicles, and BART (Figure 12). Bus-riders, bikers, skaters, and pedestrians had no direct CO_2 emissions from their regular commute to campus.

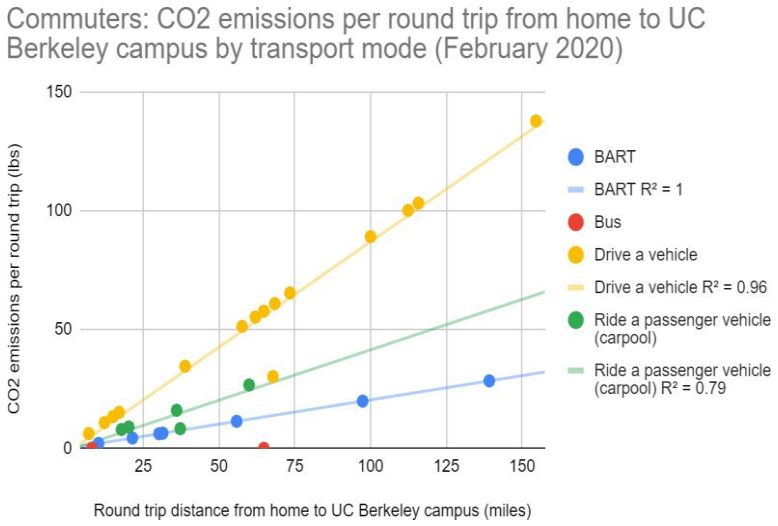

Figure 12. Simple linear regression model of commuters' CO_2 emissions per round-trip from home to UC Berkeley campus by transport mode in February 2020.

Correlation between monthly housing cost per square foot and transportation footprint

Using a simple linear regression model of respondents' monthly housing cost per square foot and carbon emissions per round-trip commute between their home and the UC Berkeley campus in February 2020, I found a slight negative correlation between these two variables among all groups, although none were statistically significant (Table 6). Using Pearson's correlation coefficient test in RCommander, I obtained the results in Table 6, which displays the correlation coefficient *r*, *t*-score, *p*-value, and the 95% confidence interval at a significance level of $\alpha = 0.05$. The correlation coefficient of commuters without housing costs is unavailable due to its undefined slope (Figure 13).

Table 6. Correlation statistics for housing cost and CO2 emissions from respondents' campus commute.

Respondent type	Correlation coefficient *r*	*t*-score	Degrees of freedom (d.f.)	*p*-value	95% confidence interval bounds
Non-commuters	-0.09546299	-1.4029	214	0.1621	[-0.22607494, 0.03852087]
Commuters with housing costs	-0.3558016	-1.0073	7	0.3473	[-0.8249834, 0.4037165]

Out of 29 commuters, 19 (65.5%) reported not paying for housing in February 2020, and 2 (6.9%) were estimated to not have any carbon emissions for their round-trip campus commutes. In contrast, out of 216 non-commuters, only 2 (0.9%) reported not paying for housing in February 2020, and 207 (95.8%) did not emit any carbon during their round-trip campus commutes. The 2 non-commuters who did not pay for housing lived with relatives located close enough to campus to not require motorized transportation when commuting to campus.

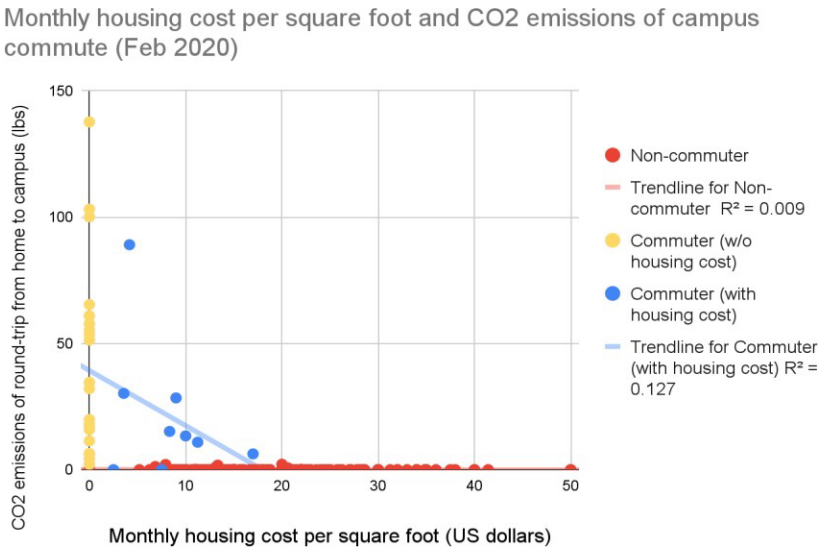

Figure 13. Simple linear regression model of monthly housing cost per square foot and CO2 emissions from a round-trip campus commute in February 2020. Compares non-commuters (n=216) and commuters with (n=9) and without housing costs (n=20). N=245.

DISCUSSION

From personal to commercial usage, the transportation sector in the United States contributes the most to climate change-inducing GHG emissions (US EPA 2015). Understanding how and why people choose their mode(s) of transportation are critical to informing not only climate change policies, but also environmental justice initiatives as socioeconomic disparities may account for differences in resource accessibility and influence decision-making trends (McGreavy et al. 2020). The objective of this study was to determine the association between individuals' housing cost and transportation footprint among UC Berkeley undergraduates to see whether socioeconomic levels may have an impact on students' mode choice. I found a significant negative correlation between students' monthly housing cost per square foot and the distance of their housing location from the UC Berkeley campus prior to the university's switch to virtual instruction in early 2020. At that time, students' mode choice appeared to be most influenced by their commute distance to campus, closeness to which was one of the most highly valued factors in choosing their housing accommodation. Students' transportation footprint was overall negatively associated with their monthly housing cost, though these were not statistically significant findings.

Living situation and housing preferences in 2020 vs. 2021

February 2020: Convenience drives students' housing decisions

The high adjusted average importance value (AAIV) of living close to campus prior to virtual instruction indicates students' prioritization of convenience over all other factors in choosing their housing accommodation. Prior to the implementation of online learning in March 2020 due to the pandemic, 88% of respondents were non-commuters, and respondents on average most highly valued closeness to campus in deciding where to live, followed by housing cost and housing quality. Living closer to campus allowed students easier access to classes, on-campus social and professional events, and communities of peers, all of which contribute to creating a more positive college experience (Laurent et al. 2020, Wode 2018). Students cared the least for parking availability, followed by closeness to family, COVID-19 safety concerns, and closeness to transportation amenities. Parking availability and closeness to transportation amenities ranked low among all the housing factors, likely because most respondents were non-commuters who lived close enough to campus to walk to class, eliminating the need for motorized transport (Schneider and Willman 2019). Living closer to family ranked second lowest because students' family homes are typically far from the UC Berkeley campus, and students most highly valued living closer to campus (Eluru et al. 2012, Schneider and Willman 2019). In February 2020, COVID-19 had not yet become a pressing concern in the United States (CDC 2022), so it makes sense for it to rank low as a housing consideration at that point in time.

An exception to these trends is commuters, or those who lived outside a 3-mile radius of campus. They most highly valued housing costs and either did not have to pay for housing in February 2020 because they lived in their family home or had decreasing housing costs with increasing distance of their home from campus. This indicates that living further from campus was cheaper and thus more highly valued among commuters than non-commuters, a finding that is corroborated by the results of the 2016 study by Green and Lee on adults who frequently commute to work. While the demographic in Green and Lee's study is older than the population surveyed in my research, working adults and university students share similarities in their commute behavior in that they often make independent decisions on when and how to reach their destination (i.e., office and campus, respectively). Given this commonality between the two

demographics, there is reasonable basis to apply some findings from Green and Lee's 2016 study to this project's study population.

February 2021: COVID-19 drives students' housing decisions

By February 2021, a year into COVID-19 lockdown, respondents' priorities in selecting their housing had changed in response to the circumstances. The switch to virtual instruction, COVID-19 safety concerns, and unavailability of campus dormitories incentivized many students to move away from campus and back to their family home. The most important housing factors were now housing quality, COVID-19 safety, and housing cost. The least important factors were closeness to transportation amenities, parking availability, and closeness to family. The AAIV of living close to campus dropped the most significantly (-1.280) while COVID-19 safety concerns saw the greatest increase (+1.106).

Although living close to family ranked third least important among all factors, it also had the second greatest increase in AAIV (+0.843) between February 2020 and 2021. This seemingly contradictory result may be explained by the fact that 97 respondents (39.6%) moved back into their family home in 2021—nearly 4.5 times greater than the number of respondents who lived in their family home in 2020—but 106 respondents (43.3%) still lived in off-campus rental housing near Berkeley, a 7% increase from the previous year. Additionally, 141 respondents (57.6%) still lived in Berkeley or its neighboring cities (Oakland, El Cerrito, Emeryville, etc.) in February 2021. Considering how many students still lived in rental housing in Berkeley or neighboring cities in February 2021, they most likely did not live close to their family nor would they have highly valued this factor in making their housing decision then (Eluru et al. 2012, DeWeese et al. 2022).

Looking into reasons for changes in respondents' living situation between the two years, 97 respondents cited COVID-19 as a reason for the change in their living situation while 67 (27.3%) reported no change at all. There was a significant drop in the number of students living in the campus dormitories between the two years because more than half of the respondents were first-years in February 2020 and no longer qualified to live in the dormitory when they were second-year students in February 2021. They either moved back to their family home or to off-campus rental housing. 43 respondents (17.6%) reported the desire to save money as a reason for

changing their living situation, and a majority of these respondents (93.0%) moved back to their family home.

Predicting Housing Cost and Living Situation using Annual Household Income

An individual's financial status typically influences major financial decisions like housing type and location (Aurand et al. 2020, Despard et al. 2016), yet this expectation was broken by the lack of a pattern between respondents' annual household income and living situation and monthly housing cost per square foot. Analyzing these variables using Pearson's chi-square test of independence, I found that they are independent of each other in both February 2020 and 2021. Based on this result, it appears that, regardless of students' socioeconomic level, they are willing to pay higher costs to live closer to the UC Berkeley campus in February 2020. This finding opposes the expected financial decision-making and associated behaviors of low-income households expressed in the National Low-Income Housing Coalition's 2020 report. However, this discrepancy may be explained by students' (and their family's) willingness to invest more in expenses relating to obtaining a higher education with the expectation that it will pay off in the future if the degree(s) obtained will lead to steady, high-paying jobs (Laidley 2014, Despard et al. 2016). The biggest change in February 2021 was that many students moved into their family homes and did not have to pay for housing costs, greatly lowering overall monthly housing cost per square foot across all eight income brackets used in this study.

There was a similar distribution of non-commuter and commuter students in each of the 8 income brackets used in this study. The main distinguishing feature between commuters and non-commuters was that a greater percentage of commuters did not pay for housing in February 2020 compared to non-commuters, but results from Pearson's chi-square test of independence found that the relationships between the variables annual household income and living situation and housing cost were still independent. These results suggest that factors other than an individual's household income influence how much they are willing to pay to live close to or far from campus. Findings from studies by Despard et al. (2016), Cedeno et al. (2020), and Kotoula et al. (2018) suggest that adequate access to financial aid and scholarships, campus resources, and convenient transport modes are some factors that may influence students' willingness to pay more to live closer to campus.

Relationship between housing cost and housing distance from campus

Regardless of respondents' classification as a commuter or non-commuter, I found statistically significant negative correlations between monthly housing cost per square foot and distance of an individual's residence from the UC Berkeley campus in February 2020. Non-commuters had a correlation of $r(214) = -0.300$ and highly significant $p < 0.0001$. The greatest concentration of non-commuters lived around 0.4 miles from campus and had monthly housing costs ranging from \$0 (respondent lived in a relative's home) to \$50 per square foot (Figure 7a). Commuters with housing costs had a correlation of $r(7) = -0.742$ and $p = 0.0221$. A scatter plot of commuters with housing costs reveals two clusters, one within 10-miles of campus with monthly housing costs between \$6 to \$17 and the other around 35-miles away from campus with housing costs less than \$5 per square foot (Figure 7b). These findings fall in line with the studentification phenomenon that has long occurred in the city of Berkeley, wherein housing costs of residences near universities are significantly higher than those in areas further away from them (Smith 2002, Laidley 2014).

Despite both non-commuters and commuters having negative correlations between monthly housing cost and distance from campus, the different scales of these results reveal the differing priorities of the two groups (Ha et al. 2020). Non-commuters have much higher costs compared to commuter students, which had 20 students who did not have to pay for housing compared to just 1 student among non-commuters who did not have housing costs. It should be noted, however, that commuters have much higher travel costs than non-commuters, highlighting a trade-off between transportation and housing costs and which of the two that members of each group prioritize (Figure 10) (Zhou and Schweitzer 2011, Ha et al. 2020). However, there must be more research into this relationship to confirm its generalizability both within and outside of this undergraduate Berkeley population as well as whether this is a causative relationship.

Students' choice of transport mode and their corresponding transportation footprint

Commute distance determines students' transport mode choice

Both commuters and non-commuters' transport mode choices were most greatly influenced by the distance of their residence from the UC Berkeley campus, followed by the convenience of their chosen mode(s). Non-commuters—respondents who lived within a 3-mile radius of campus—most often used active transport modes that do not emit GHG (e.g. walking, riding FCEB or BEB buses, biking, or skate- and longboarding) to commute to campus. Their third most commonly cited reason for choosing their primary transport mode was that it was inexpensive or free. On the other hand, commuters most frequently drove their own vehicle, rode BART, or carpooled in a passenger vehicle. Commuters' third most frequently cited reason for their choice in primary transport mode was that it was the fastest option available to them, indicating that they value speed in reaching campus across longer distances. These findings align with previous studies regarding university student commute behavior (Zhou et al. 2018, Kotoula et al. 2018).

A small percentage of non-commuters (< 4%) mentioned the exercise they get from and accessibility of active transport modes as reasons for selecting said modes. An even smaller percentage (<2%) brought up the positive utility of travel time and their desire to help the environment as other reasons for choosing active transport modes (Whalen et al. 2013). Of the 13 non-commuters who rode their bike to campus, 3 cited exercise and the positive utility of travel time as reasons for biking, which aligns with Zhou's findings in his 2016 study on college students' active transport modes. Notably, none of these reasons were mentioned by commuters, suggesting that commuters' mode choice may not be as strongly influenced by reasons like enjoying their commute and lessening their transportation footprint as they are by their goal to reach their destination in a speedy and timely manner (Zhou et al. 2018, Kotoula et al. 2018).

I did not examine respondents' mode choice in February 2021 because most students no longer commuted to campus either due to living too far away or, with virtual instruction and COVID-19 safety measures in place (Berkeley News 2020), they had no reason to visit campus.

Transportation footprint of commuters vs non-commuters

Commuters have a far greater transportation footprint than non-commuters due to the impracticality of using active, non-GHG-emitting transport modes for their campus commute. There was a positive correlation between the distance of a round-trip commute from an individual's residence to campus and their transportation footprint. The most carbon expensive transport modes were driving a passenger vehicle, followed by carpooling (EPA 2018), and riding the BART (BART 2021), all of which were used by commuters and non-commuters alike. However, given that commuters traveled greater distances to reach campus, their transportation footprints per round trip were greater than non-commuters. None of the 29 commuters used active transport modes as their primary way of reaching campus, so all except the 2 commuters who rode buses emitted CO2 on their campus commutes. Of the 29 commuters, 27 (93.1%) used passive, GHG-emitting transport modes while 201 of the 216 non-commuters (93.1%) used active, non-GHG-emitting transport modes. This results in commuters having a far greater transportation footprint than non-commuters in their pursuit of faster, more convenient transport modes for their campus commutes (Zhou and Schweitzer 2011). The direct contrast between the two groups indicates that commute distance, mode choice, and CO2 emissions are all intricately related to not only each other, but also students' priorities in their housing decisions that ultimately affect their commute distance.

Like my mode choice analysis, I did not examine respondents' transportation footprint in February 2021 because most students no longer commuted to campus that semester.

Relationship between housing cost and transportation footprint

For both non-commuters and commuters, there was a negative correlation between their monthly housing cost per square foot and transportation footprint from their round-trip campus commutes, but this was not a statistically significant finding. The common ground between these two variables was distance from campus; CO2 emissions per round-trip were greatly influenced by distance from campus (and mode choice), and monthly housing costs were found to have a statistically significant relationship with distance from campus (Laidley 2014, Smith 2005). An examination of Figure 13 reveals that commuters who did not pay for housing not only traveled

further but also emitted more CO2 per round-trip from their residence to campus, while non-commuters spent more on housing costs than commuters but emitted far less CO2 per round-trip campus commute (Ha et al. 2020, Eluru et al. 2012, DeWeese et al. 2022).

Given that non-statistically significant findings of a negative correlation between housing cost and transportation footprint in this study were based on very few respondents (9) categorized as commuters with housing costs, it may be impractical and unreasonable to generalize this result to the undergraduate population at UC Berkeley, much less other university populations and beyond. These findings could suggest that there is generally no correlation between these variables or that there needs to be another study of these variables with more representation of the commuters with housing costs population to verify or disprove these results.

Limitations

The first limitation of my research is that it does not have internal validity. I did not obtain a sample population that is representative of the university population. This is exemplified by the fact that more than half of the respondents were second-year students when they submitted their survey response, meaning the majority were first-year students in February 2020 and lived in residence halls as most first-years students do. Analyses pertaining to students' living situation in 2020 and 2021 and potentially mode choice as well may have been skewed. Capturing this amount of the underclassmen population makes sense given that these respondents were mostly from the lower division ESPM 50AC course. Furthermore, the pool of commuter students is very small (n=29, or 12% of the sample population). Drawing broad stroke conclusions regarding commuters' preferences and behaviors based on these few individuals may lead to inaccurate generalizations of the university population. Another indication that the sample population is not representative of the target population is that there were far more female-identifying than male-identifying respondents, roughly a 2:1 ratio compared to the university's nearly 1:1 ratio.

There were a number of challenges in the study design that limited broad utility of responses. The order of the sections of the survey may have caused confusion for respondents as over 40 responses were eliminated from analysis because they answered the first housing section of the survey based on their living situation in February 2021 as opposed to February 2020,

leaving many potential subjects out of the sample population. Some respondents who answered that their living situation was exactly the same in February 2020 and 2021 were not asked to rank the importance value of housing factors in February 2021. Most commuters answered that they had the exact same living situation, so I was not able to obtain meaningful comparisons of factors influencing housing preferences between non-commuters and commuters across these timeframes. These errors could be remedied by conducting more rigorous pre-pilot inquiry into the survey design to create a more efficient and user-friendly survey.

In the interest of minimizing the length of this long survey to encourage response completion, I did not ask respondents as many questions as needed to make accurate estimations regarding travel and housing costs, CO2 emissions from their commute, etc. For example, it should be noted that calculations for monthly housing cost per square foot may have been inaccurate for some respondents because they were asked to estimate the square footage of personal space they paid for in February 2020, which was approximately 1.25 years before they took the survey in April/May 2021. Monthly housing cost calculations for respondents who had roommates may also be significantly higher than respondents who lived alone because the amount of personal space available to each would be drastically different given similar housing costs. Inquiring about this information in future studies would greatly improve my confidence in the accuracy of future housing cost, transportation cost, and CO2 emission estimates.

Future Directions

I recommend future research on the topic of the relationship between an individual's financial status and transportation footprint to further explore factors other than housing costs, such as carbon consciousness, commute time, or neighborhood characteristics, that may have an impact on an individual's transport mode choice. It may be useful to study other populations and age groups, like graduate students or working adults, to see how housing costs and carbon emissions trends may change among different ages and areas. Knowing that there was a significant correlation between housing cost and distance from campus, it could also be helpful to investigate potential effects of redlining and studentification on housing costs and transport mode choice in other populations. To take this a step further, it may be productive to examine the

barriers to motivating an individual to not only become more conscious of but also take action to lessen their transportation footprint.

Broader implications

The purpose of this study was to determine whether there was a relationship between undergraduate students' housing costs and transportation footprint, but it also became a study of the ramifications of trade-offs made in students' housing decisions. The trade-off in this case was between housing costs and transportation costs. Non-commuters were willing to pay more to live closer to campus and save money on transportation costs (and commute time, which was not examined in this study), while commuters were the opposite. Transportation costs and CO2 emissions were much greater for passive transport modes, which commuters used for their campus commutes far more frequently than non-commuters (Zhou and Schweitzer 2011, Schneider and Willman 2019). The lack of mention of environmental concerns by the overwhelming majority of respondents indicates that students were choosing their housing and transport mode with their finances and convenience in mind rather than their transportation footprint. To effectively decrease GHG emissions, it is critical to examine the various reasons and socioeconomic restrictions that may affect the accessibility of affordable housing and sustainable transportation options to different communities (McGreavy et al. 2020). With careful consideration of and appropriate measures taken to address socioeconomic barriers to sustainable climate action, we will have a better chance at pumping the brakes on the detrimental effect that the US' transportation sector has on climate change (US EPA 2015).

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APPENDIX A: Chi-square independence test results (February 2020)

Table 7. Chi-square test for independence results of respondents' living situation in February 2020 and annual household income.

Annual Household Income	Dormitory	Greek house	Housing cooperative	Off-campus housing owned by self or relative(s)	Off-campus rental housing
Less than $25,000	15	0	2	2	14
$25,000 to $49,999	13	0	1	4	6
$50,000 to $74,999	6	0	1	3	6
$75,000 to $99,999	11	0	1	4	10
$100,000 to $124,999	15	0	0	1	13
$125,000 to $149,999	12	0	1	2	7
More than $150,000	43	2	4	7	29
Declined to state	5	0	0	2	3

$X^2 = 15.182$ df = 28 p-value = 0.9764

Table 8. Chi-square test for independence results of respondents' monthly housing cost per square foot in February 2020 and annual household income.

Annual Household Income	$0	($0, $10]	($10, $20]	($20, $30]	($30, $40]	($40, $50]
Less than $25,000	1	5	14	10	3	0
$25,000 to $49,999	4	5	6	6	2	1
$50,000 to $74,999	0	4	8	3	1	0
$75,000 to $99,999	2	6	11	6	1	0
$100,000 to $124,999	2	3	17	7	0	0
$125,000 to $149,999	2	5	9	5	1	0
More than $150,000	7	14	37	19	5	3
Declined to state	2	2	4	1	1	0

$X^2 = 22.243$ df = 35 p-value = 0.9536

APPENDIX B: Chi-square independence test results (February 2021)

Table 9. Chi-square test for independence results of respondents' living situation in February 2021 and annual household income.

Annual Household Income	Dormitory	Greek house	Housing cooperative	Off-campus housing owned by self or relative(s)	Off-campus rental housing
Less than $25,000	4	0	2	9	18
$25,000 to $49,999	1	0	1	9	13
$50,000 to $74,999	0	0	1	9	6
$75,000 to $99,999	4	0	2	9	11
$100,000 to $124,999	2	2	1	11	13
$125,000 to $149,999	5	0	1	7	9
More than $150,000	10	3	2	37	33
Declined to state	0	1	0	4	5

$X^2 = 22.803$ df = 28 p-value = 0.6919

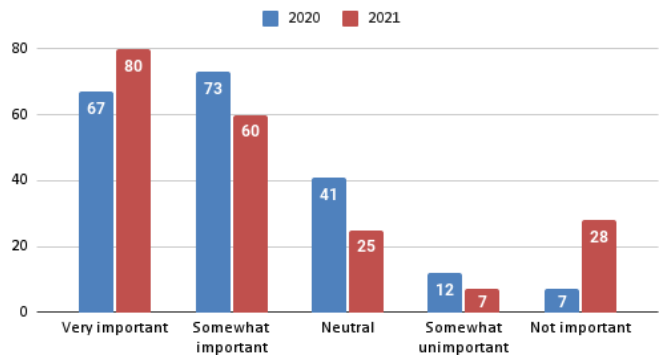
Table 10. Chi-square test for independence results of respondents' monthly housing cost per square foot in February 2021 and annual household income.

Annual Household Income	$0	($0, $10]	($10, $20]	($20, $30]	($30, $40]	($40, $50]
Less than $25,000	8	10	8	6	1	0
$25,000 to $49,999	8	10	6	0	0	0
$50,000 to $74,999	7	5	4	0	0	0
$75,000 to $99,999	8	8	5	5	0	0
$100,000 to $124,999	12	7	9	1	0	0
$125,000 to $149,999	9	6	5	1	0	1
More than $150,000	39	17	26	2	1	0
Declined to state	4	4	2	0	0	0

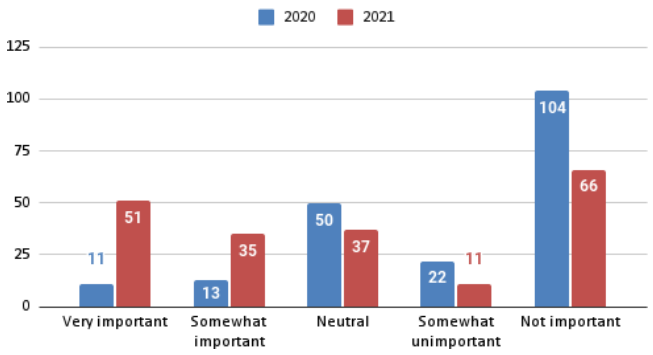
$X^2 = 43.718$ df = 35 p-value = 0.1481

APPENDIX C: Difference in importance of housing factors (2020 vs 2021)

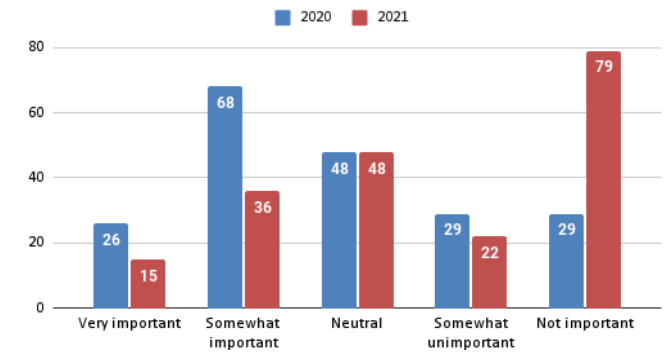
(a)



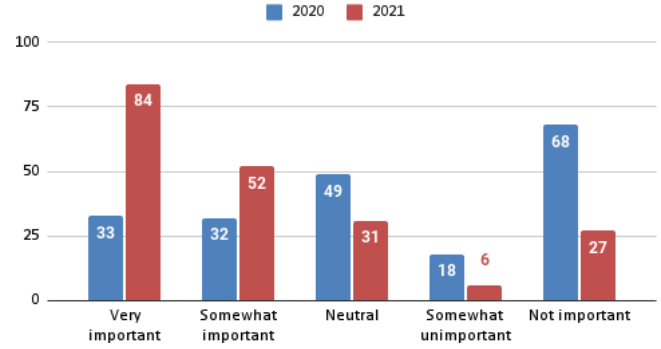
(b)



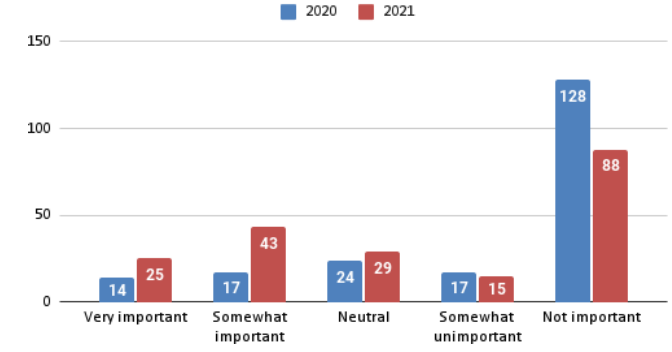
(c)



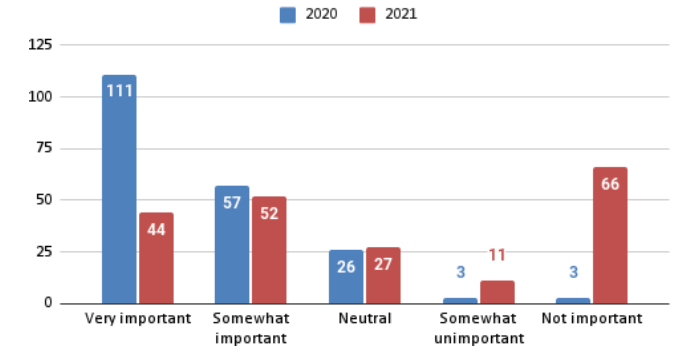
(d)



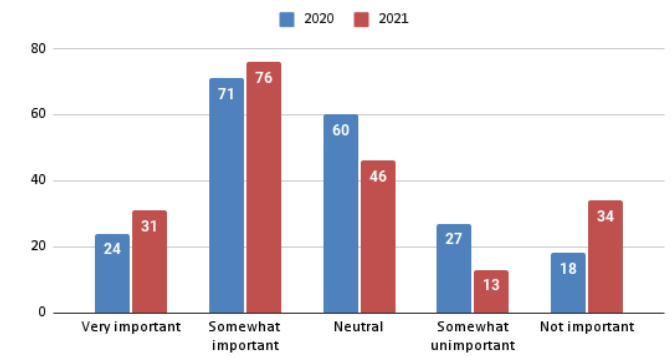
(e)



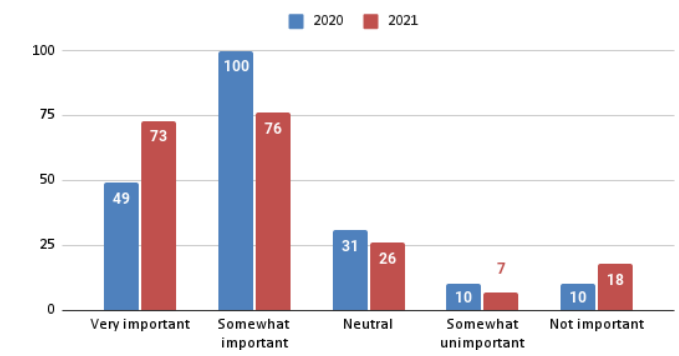
(f)



(g)



(h)



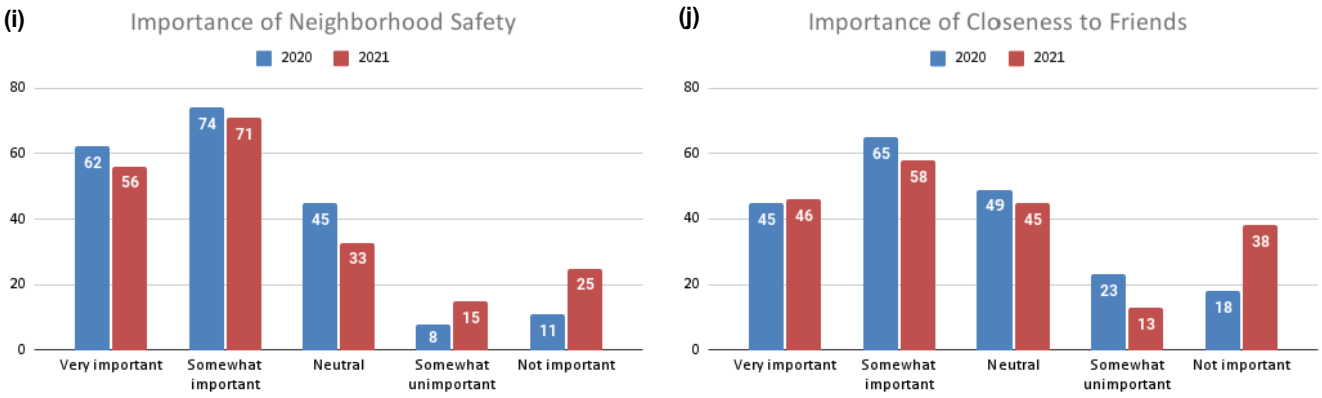


Figure 14. Bar chart comparisons of the importance of each of the ten housing factors in February 2020 and February 2021. n=200.

APPENDIX D: Online Qualtrics survey

Start of Block: Introduction

Hello! My name is Natlie, and I am an undergraduate student at UC Berkeley studying forms of environmental justice for my senior capstone research project.

I'm interested in learning more about UC Berkeley undergraduate students' carbon footprint in relation to their housing location and transportation costs. This survey should take about 10 minutes to complete. Your responses are confidential and will only be used within my capstone project.

Feel free to reach out to me at natylee@berkeley.edu for any questions or concerns. Any and all feedback is greatly appreciated, thank you!

End of Block: Introduction

Start of Block: Living situation in February 2020 (Spring semester pre-Covid-19 lockdowns)

The following questions refer to your living situation in **February 2020**, prior to the UC Berkeley campus turning to virtual instruction due to the COVID-19 lockdowns in California.

Q1. What best describes your living situation in **February 2020**?

- ○ Residential hall or dormitory (1)
- ○ Housing cooperative (2)
- ○ Off-campus rental housing (3)
- ○ Off-campus housing you or a relative owns (4)
- ○ Other (please describe) (5) _____

Q2. What city and state did you live in in **February 2020**?
Example: Berkeley, CA

_____

Q3. Approximately how many miles away from the UC Berkeley campus was your housing location in **February 2020**? Please give your best estimate.

- ○ Less than 1 mile (pretty close to campus)Less than 1 mile (pretty close to campus) (1)
- ○ 1 - 2 miles (within Berkeley) (2)
- ○ 2 - 5 miles (within adjacent cities to Berkeley) (3)
- ○ 5 - 15 miles (within reach of San Francisco and San Leandro) (4)
- ○ Greater than 15 miles (5)
- ○ Out of state (6)

Q4. What was your street address or nearest cross street?

_____

Q5. How many other people did you live with? If you lived by yourself, please write 0.

_____

Skip To: Q7 If Condition: How many other people did y... Is Equal to 0. Skip To: Approximately how much did this housi....

Q6. Approximately how much did this housing arrangement cost for **all members of the household** combined each month (in US dollars)? Exclude utilities.

- ○ Less than $1,000 (1)
- ○ $1,000 - $1,500 (2)
- ○ $1,500 - $2,000 (3)
- ○ $2,000 - $2,500 (4)
- ○ $2,500 - $3,000 (5)
- ○ $3,000 - $4,000 (6)
- ○ $4,000 - $5,000 (7)
- ○ More than $5,000 (8)

Q7. Approximately how much did this housing arrangement cost for **you** each month (in US dollars)? Exclude utilities.

_____

Display This Question:

If What best describes your living situation in February 2020? = Residential hall or dormitory

Or What best describes your living situation in February 2020? = Housing cooperative

Or What best describes your living situation in February 2020? = Off-campus rental housing

Please use the image below as a reference for the next question.

The bed shown is an average twin size bed, which is 38" x 75" (approximately 20 square feet).

Display This Question:

If Please use the image below as a reference for the next question. The bed shown is an average t... Is Displayed

Q8. Approximately how big was the personal space you paid for in your housing arrangement (in square feet)? Select the choice that most closely resembles the size of your space.

If you share a room with others, please choose the graphic that most closely resembles the space in the room delegated to you.

- ○ Less than 70 ft² (1)
- ○ About 70 ft² (2)
- ○ About 80 ft² (3)
- ○ About 100 ft² (4)
- ○ About 120 ft² (5)
- ○ More than 120 ft² (6)
- ○ Other (7) _____

Q9 How important were each of the factors shown below in influencing your choice to live where you did in February 2020?

	Not important (1)	Somewhat unimportant (2)	Neutral (3)	Somewhat important (4)	Very important (5)
Housing quality (e.g. age of building, cleanliness, etc.) (1)	○	○	○	○	○
Housing cost (2)	○	○	○	○	○
Utilities provided (3)	○	○	○	○	○
Neighborhood safety (4)	○	○	○	○	○
Close to campus (5)	○	○	○	○	○
Close to transportation amenities (i.e. BART, bus stops) (6)	○	○	○	○	○
Close to grocery stores or restaurants (7)	○	○	○	○	○
Close to friends (8)	○	○	○	○	○
Close to family (9)	○	○	○	○	○
Parking availability (10)	○	○	○	○	○
COVID-19 safety concerns (11)	○	○	○	○	○

End of Block: Living situation in February 2020 (Spring semester pre-Covid-19 lockdowns)

Start of Block: Living situation in February 2021 (Spring semester during Covid-19 lockdowns)

The following questions refer to your living situation in **February 2021**, when the UC Berkeley campus had already turned to virtual instruction.

Q10 What best describes your living situation in **February 2021**?

- ○ Residential hall or dormitory (1)
- ○ Housing cooperative (2)
- ○ Off-campus rental housing (3)
- ○ Off-campus housing you or relative(s) own (4)
- ○ Exactly the same as in February 2020 (5)
- ○ Other (please describe) (6) _____

Skip To: End of Block If What best describes your living situation in February 2021? = Exactly the same as in February 2020

Q11. Why did your housing situation change between February 2020 and February 2021?

_____

_____

_____

_____

_____

Q12. What city and state did you live in in **February 2021**?
Example: Berkeley, CA
If you lived outside of the United States, please write the city and country.

_____

Q13. Approximately how many miles away from the UC Berkeley campus was your housing location in **February 2021**? If you lived outside of California, please select "out of state."

- ○ Less than 1 mile (pretty close to campus) (1)
- ○ 1 - 2 miles (within Berkeley) (2)
- ○ 2 - 5 miles (within adjacent cities to Berkeley) (3)
- ○ 5 - 15 miles (within reach of San Francisco and San Leandro) (4)
- ○ Greater than 15 miles (5)
- ○ Out of state (6)

Q14. What was your street address or nearest cross street?

_____

Q15. How many other people did you live with? If you lived by yourself, please write 0.

_____

Skip To: Q17 If Condition: How many other people did y... Is Equal to 0. Skip To: Approximately how much did this housi....

Q16. Approximately how much did this housing arrangement cost for **all members of the household** each month (in US dollars)?
If applicable, include costs covered by housemates.

- ○ Less than $1,000 (1)
- ○ $1,000 - $1,500 (2)
- ○ $1,500 - $2,000 (3)
- ○ $2,000 - $2,500 (4)
- ○ $2,500 - $3,000 (5)
- ○ $3,000 - $4,000 (6)
- ○ $4,000 - $5,000 (7)
- ○ More than $5,000 (8)

Q17. Approximately how much did this housing arrangement cost for **you** each month (in US dollars)?

_____

Display This Question:

If What best describes your living situation in February 2021? = Residential hall or dormitory

Or What best describes your living situation in February 2021? = Housing cooperative

Or What best describes your living situation in February 2021? = Off-campus rental housing

Please use the image below as a reference for the next question.

The bed shown is an average twin size bed, which is 38" x 75" (approximately 20 square feet).

Display This Question:

If Please use the image below as a reference for the next question. The bed shown is an average t... Is Displayed

Q18. Approximately how big was the personal space you paid for in your housing arrangement (in square feet)? Select the choice that most closely resembles the size of your space.

If you share a room with others, please choose the graphic that most closely resembles the space in the room delegated to you.

- ○ Less than 70 ft² (1)
- ○ About 70 ft² (2)
- ○ About 80 ft² (3)
- ○ About 100 ft² (4)
- ○ About 120 ft² (5)
- ○ More than 120 ft² (6)
- ○ Other (7) _____

Q19. How important were each of the factors shown below in influencing your housing choice?

	Not important (1)	Somewhat unimportant (2)	Neutral (3)	Somewhat important (4)	Very important (5)
Housing quality (e.g. age of building, cleanliness, etc.) (1)	○	○	○	○	○
Housing cost (2)	○	○	○	○	○
Close to campus (3)	○	○	○	○	○
Close to transportation amenities (e.g. BART, bus stops) (4)	○	○	○	○	○
Neighborhood safety (5)	○	○	○	○	○
Close to grocery stores or restaurants (6)	○	○	○	○	○
Close to friends (7)	○	○	○	○	○
Close to family (8)	○	○	○	○	○
Parking availability (9)	○	○	○	○	○
COVID-19 safety concerns (10)	○	○	○	○	○

End of Block: Living situation in February 2021 (Spring semester during Covid-19 lockdowns)

Start of Block: Modes of Transportation

Q20. How did you most often commute to the UC Berkeley campus in **February 2020**?

	Walk (1)	Bike (2)	Bus (3)	BART (4)	Drive a vehicle (5)	Taxi service (Uber, Lyft, etc.) (6)	Ride a passenger vehicle (carpool) (7)	Motorcycle or electric scooter (8)	Skateboard or longboard (9)	N/A (10)
Main form of transportation (1)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Secondary form of transportation (2)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q21. Why did you commute to campus using these forms of transportation?

_____

_____

_____

_____

_____

Q22. Approximately how much did a **round trip** between your housing location in **February 2020** and the UC Berkeley campus cost (in US dollars)?
If applicable, include bus and BART fares, fuel costs, and parking fees.

○ Main transportation (1) _____

○ Secondary transportation (2) _____

Q23. Are there types of transportation listed above that you would like to use more often? Why did you not use them more often?

_____

Q24 Approximately how many days a week did you go to campus in **February 2020**?

- ○ Every day (1)
- ○ 5 - 6 days a week (2)
- ○ 3 - 4 days a week (3)
- ○ 2 days or less (4)

Q25. On any day of the week, did you go to campus more than once per day?

- ○ No (1)
- ○ Yes, once a week (2)
- ○ Yes, 2 - 3 times a week (3)
- ○ Yes, 4 - 7 times a week (4)

Display This Question:

If How did you most often commute to the UC Berkeley campus in February 2020? = Drive a vehicle

Or How did you most often commute to the UC Berkeley campus in February 2020? = Motorcycle or electric scooter

Q26. What type of car did you drive to campus in **February 2020**?

- ○ Gasoline (1)
- ○ Diesel (2)
- ○ Hybrid (3)
- ○ Electric (4)

Q27. How often did you commute to the UC Berkeley campus in **February 2021** compared to **February 2020**?

- ○ More often (1)
- ○ About the same (3)
- ○ Less often (2)

Skip To: Q28 If How often did you commute to the UC Berkeley campus in February 2021 compared to February 2020? = More often

Skip To: Q30 If How often did you commute to the UC Berkeley campus in February 2021 compared to February 2020? = Less often

Skip To: Q28 If How often did you commute to the UC Berkeley campus in February 2021 compared to February 2020? = About the same

Q28. How did you most often commute to the UC Berkeley campus in **February 2021**?

	Walk (1)	Bike (2)	Bus (3)	BART (4)	Drive a vehicle (5)	Taxi service (Uber, Lyft, etc.) (6)	Ride a passenger vehicle (carpool) (7)	Motorcycle or electric scooter (8)	Skateboard or longboard (9)	N/A (10)
Main form of transportation (1)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Secondary form of transportation (2)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q29. Approximately how much did a **round trip** between your housing location in **February 2021** and the UC Berkeley campus cost (in US dollars)?
If applicable, include bus and BART fares, fuel costs, and parking fees.

- ○ Main transportation (1) _____
- ○ Secondary transportation (2) _____

Display This Question:

If How often did you commute to the UC Berkeley campus in February 2021 compared to February 2020? = Less often

Q30. Why did you not go to campus as often in February 2021?

- ☐ Live too far away (1)
- ☐ COVID-19 safety concerns (2)
- ☐ Did not have permission / campus access (3)
- ☐ No in-person classes (4)
- ☐ Already graduated (5)
- ☐ Other (6) _____

End of Block: Modes of Transportation

Start of Block: Demographic Information

Q31. Were you a UC Berkeley undergraduate student **during or prior to the Spring 2020 semester** (January - May 2020)?

- ○ Yes (1)
- ○ No (2)

Q32. What is your undergraduate graduation year?

- ○ 2020 (1)
- ○ 2021 (2)
- ○ 2022 (3)
- ○ 2023 (4)
- ○ 2024 (5)
- ○ 2025 (6)
- ○ Other (please specify) (7) _____

Q33. What is your college at UC Berkeley?

- ○ College of Chemistry (CoC) (1)
- ○ College of Environmental Design (CED) (2)
- ○ College of Engineering (BCE) (3)
- ○ College of Letters & Science (L&S) (4)
- ○ Haas School of Business (5)
- ○ Rausser College of Natural Resources (CNR) (6)

Q34. What is your major / minor? If you are not sure or do not have one, please write N/A.

- Major (1) _____
- Major 2 (2) _____
- Minor (3) _____
- Minor 2 (4) _____

Q35. Estimated annual household income

- Less than $25,000 (1)
- $25,000 to $49,999 (2)
- $50,000 to $74,999 (3)
- $75,000 to $99,999 (4)
- $100,000 to $124,999 (5)
- $125,000 to $149,999 (6)
- $150,000 or more (7)

Q36. What is your approximate **monthly** personal income (in US dollars)?
Include personal earnings, scholarships or fellowships, and other allowances (e.g. rent paid on your behalf, money from relatives. Please do your best to estimate). Do not include money for tuition.

- $1,000 or less (1)
- $1,000 - 2,000 (2)
- $2,000 - $3,000 (3)
- $3,000 - $4,000 (4)
- More than $4,000 (5)

Q37. What is your age?

- ○ Under 18 years old (1)
- ○ 18 - 24 years old (2)
- ○ 35 - 44 years old (3)
- ○ 45 - 54 years old (4)
- ○ 55 - 64 years old (5)
- ○ 65+ years old (6)
- ○ Prefer not to say (7)

Q38. What is your ethnic or racial background? (Select all that apply)

- ☐ Caucasian / White (1)
- ☐ Black / African American (2)
- ☐ Asian (3)
- ☐ Native Hawaiian or other Pacific Islander (4)
- ☐ American Indian / Native American (5)
- ☐ Prefer not to say (6)
- ☐ Other (please specify) (7) _____

Q39. Are you of Spanish, Hispanic, or Latino origin or descent?

- ○ Yes (1)
- ○ No (2)
- ○ Other (please describe) (3) _____

Q40. What gender do you identify with?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)
- ○ Other (please specify) (5) _____

Q41. Do you identify as a member of the LGBTQ+ community?

- ○ Yes (1)
- ○ Maybe (2)
- ○ No (3)
- ○ Prefer not to say (4)

End of Block: Demographic Information

Start of Block: End of Survey

Q42. If you are interested in participating in a brief follow-up interview / focus group for this survey, please enter your email address below:

_____

End of Block: End of Survey