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Individual, social, and environmental factors associated with active transportation commuting during the COVID-19 pandemic

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ABSTRACT

Objective: Physical inactivity is a major public health concern. Though active transportation through bicycling and walking can increase physical activity and thereby positively affect health, factors that influence people’s decisions to commute using active transportation modes remain underexplored and often fail to capture equity-related barriers. Increases in active transportation during the COVID-19 pandemic call for a better understanding of these influences. This study examines the commute mode choices of essential workers in Philadelphia, Pennsylvania, USA to explore the extent to which active transportation to work is explained by individual, social, and environmental factors and whether active transportation choices reflect inequalities.

Methods: Drawing on the theory of planned behavior and the social-ecological model, this study utilizes data from an online survey (N = 213) completed between June and August 2020. Bivariate analyses compare respondents who commuted using active transportation modes to those who did not using chi-square and ANOVA tests. A series of logistic regression models using forward stepwise selection, controlling for demographic characteristics and commute distance, identify salient individual, social, and environmental factors associated with active transportation.

Results: Nearly half of respondents changed their commute mode during the pandemic, most often to limit exposure to COVID-19. The full model, accounting for 54% of variation in active transportation commuting, indicated significantly lower odds of active transportation use among non-white (Odds Ratio [OR]: 0.155) respondents and those who reported time constraints (OR: 0.450), concerns about safety from traffic (OR: 0.482), and greater satisfaction with community support for bicycling and pedestrian issues (OR: 0.551) and significantly higher odds among those who reported safety concerns around germs (OR: 1.580).

Conclusions: Structural and social investments that make bicycling and walking safer commuting alternatives during COVID-19 could protect essential works and contribute to sustained behavior change. Community engagement is essential for implementation efforts.

1. Introduction

Over one-third of U.S. adults do not participate in any regular physical activity (National Center for Health Statistics, 2012).

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Compared to adults who get regular physical activity, those who do not are more likely to suffer from numerous diseases, including cancer, coronary heart disease, diabetes, and stroke (Vuori, 2004), leading some researchers to conclude that physical inactivity is one of the most important public health problems of our time (Blair, 2009; Sallis et al., 2004). Recent research on active transportation suggests that transportation modalities such as bicycling and walking can increase physical activity and thereby positively affect health (Schauder and Foley, 2015) which could translate to direct and indirect cost savings by reducing chronic diseases and improving overall health (BBC Research & Consulting, 2016; Whitfield et al. 2017).

The months following the onset of the COVID-19 pandemic saw increased use of active transportation in cities across the United States, potentially contributing to improved health through physical activity as well as limiting exposure to COVID-19. Yet, who is using active transportation modes and why remains underexplored, especially within the American social and structural context. People of color and low-income communities represented a disproportionate share of traffic fatalities associated with active transportation prior to the pandemic (Smart Growth America, 2019). Since the outbreak, ethnic and racial minority groups have experienced high rates of death associated with COVID-19 due to the likelihood of minority individuals to be living and working in places that predispose them to worse outcomes (Tai et al., 2020) and their increased use of public transportation (McLaren, 2020).

As U.S. cities balance efforts to promote physical activity with keeping communities safe in the wake of COVID-19, addressing equity-related concerns is critical. Sallis et al. (2004) suggest that multi-level ecological models may improve explanatory models for transportation and physical activity behaviors and “lead to more effective change strategies to enhance health and quality of life” (p. 261). To that end, this study addresses the extent to which active transportation choices during COVID-19 are explained by individual determinants, the social context, and the built environment and the extent to which these choices reflect inequalities. Understanding the complex interaction of individual decision-making regarding active transportation within the wider social and spatial context can inform more equitable ways to promote its use and associated benefits.

2. Background and significance

Despite increasing recognition that active transportation can positively impact health, research that examines specific factors that influence people’s decisions to use active transportation is underexplored. The theory of planned behavior and the social-ecological model are often used to understand the nuances that impact this decision-making, but researchers have not reached a consensus on appropriate measures. Furthermore, some argue that important constructs that may foster inequalities in active transportation outcomes are often missing from this body of literature. The subsections that follow provide further detail on this context and the limitations of existing research to highlight the significance of the present study.

2.1. Frameworks for understanding active transportation choices

The theory of reasoned action posits that people act in a sensible and reasoned manner such that the primary determinant of performing a given behavior (or not) is the intention to perform that behavior. Growing from this body of work, the theory of planned behavior adds two more determinants: social influence and issues of control. This expanded theory postulates that performing a given behavior is a result not just of one’s intention, but also social pressure to perform (or not perform) the behavior and one’s sense of self-efficacy or ability to perform it (Ajzen, 1991). Chaney et al. (2014) used this theory to explore the variance in active transportation decisions among college students, determining that these three constructs (i.e., intention, social influence, and self-efficacy) alone accounted for nearly 12% of the variance in active transportation use, increasing to 44% when demographic and control variables were included in the final model. Yet, their study included a very specific population—college students at a large, Midwestern University—who likely differ in very important ways from the larger population. Further, active transportation use included only bicycle trips measured using respondents’ recall of their frequency at a point-in-time that occurred during the spring semester, possibly overstating their findings.

The social-ecological model provides further nuance to this conceptualization. The ecological systems approach advanced by Bronfenbrenner (2005) proposes that one’s environment is defined by experiences that take place within social and cultural practices and institutions, with actions nested within hierarchical levels starting from the individual-level and radiating outwards toward the society-level. Since its conception, this approach has been adapted for many purposes, including factors that influence physical activity within communities (Ozdemir, 2013). The resulting social-ecological model of health behavior denotes the limitations of individual knowledge and attitudes on behavior in favor of explanations which include larger social and environmental influences that are conditioned by where one lives and works (Bornstein and Davis, 2014). Using the social-ecological perspective, Shields (2015) examined factors contributing to campus bicycling among college students, and found individual determinants, including bicycle-specific issues (e.g., concerns about general bicycle maintenance) and personal appearance (e.g., looking “silly” while wearing a helmet), and factors related to the built environment, including barriers (e.g., busy roads) and facilitators (e.g., bicycle lanes), were predictors of bicycling, while social factors (e.g., concerns about interacting with car drivers) were not statistically significant. Similar to Chaney et al. (2014), this work focused on college students’ use of bicycling and, even more specifically, campus bicycling behaviors on a largely residential campus, making the findings less generalizable.

Recent research has incorporated the theory of planned behavior into the social-ecological model to explain active transportation decisions. Drawing on a framework that included both the theory of planned behavior and the social-ecological model, Willis et al. (2015) identified 24 studies that considered factors that contribute to bicycle mode choice between 2005 and 2012. Their review classified findings into four distinct areas: perceptions, including both perceived benefits among bicyclists (e.g., health, economic, environmental) and perceived barriers among those who did not bicycle (e.g., lack of skills, health problems) as well as perceived
safety from traffic and crime; attitudes towards bicycling and other modes; habits; and the social environment, including subjective norms (i.e., encouragement from one’s social circle), descriptive norms (i.e., behavior of one’s social circle), community opinions, and workplace environment. However, the authors noted a need for further research to identify the most effective methodologies to capture and analyze these factors. Further, the focus of the review and generalizability was limited; the authors restricted the review to bicycle mode choice for any purpose and only five of the 24 studies were based in the U.S., while the others were based primarily in European and Australian cities with a strong bicycle use culture.

Drawing on a similar framework and examining both bicycling and walking to work, Bopp et al. (2013) found significant relationships between using active transportation modes and individual (e.g., demographics, medical conditions, self-efficacy, behavioral beliefs, and perceived behavioral control), social (e.g., coworker and spouse beliefs and behaviors, community supports for bicyclists, and workplace support), and physical factors (e.g., bicycle lanes, sidewalks, speed/volume of traffic along route). Overall, they found 70% of the variance in commuting through active transportation modes was explained with their full model.

While the theory of planned behavior and the social-ecological model offer useful lenses for understanding active transportation behavior, work in this area is happening across multiple disciplines and spaces, lacking a unified conceptualization. Recently, Goetschi et al. (2017) aimed to remedy this deficiency by proposing a comprehensive conceptual framework of active travel behavior through the Physical Activity through Sustainable Transport Approach (PASTA). PASTA provides a “first-of-its-kind effort to systematically combine behavioral concepts, structural features, and a large number of determinants identified in the literature as part of a single, comprehensive framework to inform future works” (p. 293–4). Including behavioral decision and choice processes, structural scales and relationships, and content and topical domains, PASTA is certainly thorough. However, as with much of the work in this area, it was developed primarily within a European lens and may be missing dimensions specific to the U.S. context, particularly related to social and cultural issues.

2.2. Transportation equity and (in)complete streets

Sheller (2015) acknowledges how transportation choices are inherently socially and culturally embedded within sociable practices of modal use, including privileging cars over other forms. Using the City of Philadelphia, Pennsylvania as a case study, she promotes an equity perspective that is missing from much of the current work towards understanding active transportation choices. Sheller argues that transportation inequalities are embedded in forms of racial coding with the “creation of bike lanes, complete streets, or other ‘green’ modifications of the urban environment … associated by some Philadelphians with gentrification, or the displacement of poor people from their long-time neighborhoods as wealthier (often white) newcomers move into re-made urban places” (p. 84). Sheller is not alone in her judgment. In response to the Complete Streets movement, which views streets as public spaces that should be designed for all users, Zavestoski and Agyeman (2014) likewise make a case that the movement could instead lead to incomplete streets that fail to ensure all street users have access to safe streets regardless of age, ability, income, ethnicity, race, and mode of travel.

2.3. Philadelphia context

According to the 2018 Benchmarking Report on bicycling and walking in the U.S. (League of American Bicyclists, 2019), Philadelphia is one of the top ten cities with the highest active commuting rates in the country. While bicyclists make up a relatively small share of commuters (2.6%), their number has been steadily growing: between 2005 and 2016, the rate of bicycle commuters in Philadelphia increased by 144% (League of American Bicyclists, 2019; U.S. Census Bureau, 2019). People who walk to work make up a larger, more consistent share of commuters (8.4%; U.S. Census Bureau, 2019). When findings from Boston University’s Database of Road Transportation Emissions revealed that transportation emissions in the Philadelphia region increased by 22% between 1990 and 2017 (Popovich and Lu, 2019), the City announced a goal to increase these modes of transportation significantly by 2025 (Murphy, 2019). Additional investments in the City’s Indego bikeshare program, which has 121 stations and averages more than 2,000 daily riders, is one way the City aims to achieve this progress (Four Square Integrated Transportation Planning, 2018). Given the high rates of active transportation in Philadelphia, and the City’s commitment to increase upwards trends in these modes, Philadelphia offers a compelling case study to examine factors related to active transportation choices.

Philadelphia is also a majority-minority city: 43.6% of residents are Black and 15.2% are Latinx (U.S. Census Bureau, 2019). COVID-19 outcomes have disproportionately impacted minority communities in Philadelphia. The COVID-19 case rate per 10,000 residents is over two times greater among Black (220.7) residents and 1.8 times greater among Latinx (180.4) residents than white (100.6) residents (City of Philadelphia, 2020). While fewer people are commuting during the COVID-19 pandemic, employees of life sustaining businesses—including those in healthcare, social assistance, food service, and retail industries (Wolf, 2020)—must identify ways to safely commute to work. Philadelphia limited public transportation options in the wake of the pandemic due to concerns that transit workers and riders are at-risk for contracting the virus. Instead, the City issued guidance that people who needed to commute to work during the pandemic consider riding a bicycle or walking if they were able (City of Philadelphia, 2020a). Automated counters on Circuit Trails around the region indicated an unprecedented increase of 151% in bicycle traffic, on average, compared to the previous year (Tanenbaum, 2020), but it is unclear what portion of this increase may be due to the commute mode choices of Philadelphia’s estimated 792,000 essential workers in assisted living facilities, social service agencies, restaurants, grocery stores, and janitorial services agencies (Calefati, 2020).
2.4. Study aims

Overall, factors that influence people’s decisions to commute using active transportation modes remain underexplored. Moreover, equity-related barriers are not captured in most existing models. Amidst ongoing public safety concerns resulting from the COVID-19 pandemic, there is a need to explore the reasons why people choose to bicycle or walk to work. Addressing equity issues is crucial given that minority communities are disproportionately impacted by the virus. This study examines the extent to which active transportation to work by essential workers in Philadelphia during the COVID-19 pandemic is explained by individual, social, and environmental factors as well as the extent to which active transportation choices reflect inequalities.

3. Research design and methods

In their development of the PASTA framework, Götschi et al. (2017) contend that in addition to a detailed conceptual framework, “the development of a study-specific version is crucial,” (p. 292) and emphasize that data sources, sampling methods, and measures must reflect research objectives.

3.1. Design

Drawing on the theory of planned behavior and the social-ecological model, this correlational cross-sectional study utilizes data from an online survey to describe the impact of individual, social, and environmental factors on active transportation decisions. Fig. 1 shows the social-ecological model of factors influencing physical activity within communities (Özdemir, 2013) adapted for the present study. The survey was open to all essential workers (age 18 and over) who lived and worked in Philadelphia, actively commuted to work during the COVID-19 pandemic, and were physically able to bicycle and walk.

3.2. Recruitment procedures

According to the American Community Survey (ACS), the leading source for detailed population information on active commuting rates in the nation, in 2017 approximately 2.6% of Philadelphia residents commuted to work by bicycling and 8.4% commuted to work by walking (U.S. Census Bureau, n.d.a, U.S. Census Bureau, n.d.b). Given the small overall proportion of Philadelphia residents who commute through active transportation modes, the study utilized a targeted recruitment strategy to maximize variance on the dependent variable (i.e., active transportation to work). In addition, given the equity aims of the study, the recruitment strategy aimed to enroll respondents of diverse backgrounds. Targeted strategies included: working with local universities and non-profits (e.g., University of Pennsylvania, registered community organizations) to share the survey link through social media accounts and/or email correspondence; posting the survey link on online forums (e.g., Facebook and Reddit groups); hanging study flyers at bikeshare stations and bus stops throughout the City; and direct outreach at bicycling events (e.g., the Ride for Solidarity in recognition of cyclists recently killed in crashes). In order to describe the study sample, an item on the survey asked respondents how they learned about the survey.

The survey was conducted through the Qualtrics Online Survey Platform (Qualtrics, 2019) and took respondents approximately 15–20 minutes to complete. The survey included an informed consent that outlined the study purpose, data collection procedures, risks, and benefits. No identifying information was collected for research purposes, ensuring that all study data remained anonymous; however, respondents who provided an email address through a lottery option were eligible to win one of five $20 gift cards in appreciation of completing the survey. Study procedures were reviewed and approved by the University of Pennsylvania Institutional Review Board.

Between June and August 2020, 426 people accessed the survey. However, only half (N = 213) were eligible to participate. Of those who met eligibility criteria, over three-quarters (78.9%; N = 168) completed the entire survey. Recruitment methods identified by respondents included employer emails, community group newsletters/forums, Facebook, Reddit, and flyers shared at bikeshare

![Fig. 1. Social-Ecological Model adapted for Active Transportation.](image-url)
Table 1
Survey items.

| Measure                          | Item                                                                 | Response options                                                                                       | Reference          |
|----------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------|
| Demographic characteristics      |                                                                       |                                                                                                         |                    |
| Age                              | What is your age in years?                                           | Age in years                                                                                           | ACS                |
| Sex                              | What is your sex?                                                    | Male                                                                                                   | ACS                |
|                                  |                                                                      | Female                                                                                                 |                    |
|                                  |                                                                      | Other (Describe)                                                                                        |                    |
| Ethnicity                        | Are you of Hispanic, Latino, or Spanish origin?                      | No, not of Hispanic, Latino, or Spanish origin                                                        | ACS                |
|                                  |                                                                      | Yes, Mexican, Mexican American, Chicano                                                                |                    |
|                                  |                                                                      | Yes, Puerto Rican                                                                                      |                    |
|                                  |                                                                      | Yes, Cuban                                                                                             |                    |
|                                  |                                                                      | Yes, another Hispanic, Latino, or Spanish origin (Describe)                                           |                    |
| Race                             | What is your race? Please select all that apply.                     | White                                                                                                  | ACS                |
|                                  |                                                                      | Black or African American                                                                               |                    |
|                                  |                                                                      | American Indian or Alaska Native                                                                        |                    |
|                                  |                                                                      | Asian Indian                                                                                            |                    |
|                                  |                                                                      | Chinese                                                                                                |                    |
|                                  |                                                                      | Filipino                                                                                                |                    |
|                                  |                                                                      | Japanese                                                                                                |                    |
|                                  |                                                                      | Korean                                                                                                 |                    |
|                                  |                                                                      | Vietnamese                                                                                             |                    |
|                                  |                                                                      | Other Asian (Describe)                                                                                  |                    |
|                                  |                                                                      | Native Hawaiian                                                                                        |                    |
|                                  |                                                                      | Guamanian or Chamorro                                                                                  |                    |
|                                  |                                                                      | Samoan                                                                                                 |                    |
|                                  |                                                                      | Other Pacific Islander (Describe)                                                                       |                    |
|                                  |                                                                      | Some other race (Describe)                                                                              |                    |
| Education                        | What is the highest degree or level of school you have completed?   | No schooling completed                                                                                  | ACS                |
|                                  |                                                                      | Nursery or preschool through grade 12                                                                   |                    |
|                                  |                                                                      | Regular high school diploma                                                                             |                    |
|                                  |                                                                      | GED or alternative credential                                                                            |                    |
|                                  |                                                                      | Some college credit, no degree                                                                          |                    |
|                                  |                                                                      | Associate’s degree                                                                                      |                    |
|                                  |                                                                      | Bachelor’s degree                                                                                       |                    |
|                                  |                                                                      | Master’s degree                                                                                        |                    |
|                                  |                                                                      | Professional degree beyond bachelor’s degree                                                            |                    |
|                                  |                                                                      | Doctorate degree                                                                                        |                    |
| Marital status                   | What is your marital status?                                         | Now married                                                                                           | ACS                |
|                                  |                                                                      | Widowed                                                                                                |                    |
|                                  |                                                                      | Divorced                                                                                                |                    |
|                                  |                                                                      | Separated                                                                                              |                    |
|                                  |                                                                      | Never married                                                                                          |                    |
| Children under 18                | How many children under the age of 18 live with you?                | Number of children                                                                                     | –                  |
| Employment and commute details   |                                                                       |                                                                                                         |                    |
| Employment status                | What is your current employment status?                             | Part-time (less than 35 h per week)                                                                     | CPS                |
|                                  |                                                                      | Full-time (35 h or more per week)                                                                        |                    |
| Length of employment             | How long have you been with your current employer?                  | 0–6 months                                                                                             | Adapted from       |
|                                  |                                                                      | 6–12 months                                                                                           | Bopp et al. (2012) |
|                                  |                                                                      | 1–2 years                                                                                              |                    |
|                                  |                                                                      | 2–5 years                                                                                              |                    |
| Annual income                    | What is your annual income?                                          | Less than $30,000/year                                                                                  | Adapted from       |
|                                  |                                                                      | $30,000–$60,000/year                                                                                  | Bopp et al. (2013) |
|                                  |                                                                      | $60,001–$100,000/year                                                                                  |                    |
|                                  |                                                                      | More than $100,000/year                                                                                 |                    |
| Commute mode                     | How did you usually get to work LAST WEEK?                          | Car, truck or van                                                                                      | Adapted from       |
|                                  | If you usually used more than one method of transportation during the trip, indicate the one used for most of the distance. | Bus or trolley bus                                                                                     | ACS                |
|                                  |                                                                      | Streetcar or trolley care                                                                               |                    |
|                                  |                                                                      | Railroad                                                                                                |                    |
|                                  |                                                                      | Ferryboat                                                                                              |                    |
|                                  |                                                                      | Taxi cab                                                                                               |                    |
|                                  |                                                                      | Motorcycle                                                                                             |                    |
|                                  |                                                                      | Bicycle                                                                                                |                    |
|                                  |                                                                      | Walked                                                                                                 |                    |
|                                  |                                                                      | Other method                                                                                            |                    |

(continued on next page)
| Measure                              | Item                                                                 | Response options     | Reference                          |
|--------------------------------------|----------------------------------------------------------------------|----------------------|------------------------------------|
| Commute distance                     | How many miles did you travel to get from home to work LAST WEEK?    | Distance in miles    | Adapted from ACS                   |
| Commute mode change                  | Did the way you usually get to work change as a result of the COVID-19 pandemic? | Yes/no               | Adapted from ACS                   |
| Reason for commute mode change       | What is the main reason you changed the way you get to work as a result of the COVID-19 pandemic? | Open-ended           | –                                  |
| Essential employee                   | The term essential employee refers to an employee that performs work involving the safety of human life or the protection of property. Are you considered an essential employee? | Yes/no               | Essential Services Act of 2013      |
| Industry                             | In what industry do you work?                                        |                      | Natural resources and mining       |
|                                      |                                                                      |                      | Utilities                          |
|                                      |                                                                      |                      | Construction                       |
|                                      |                                                                      |                      | Manufacturing                      |
|                                      |                                                                      |                      | Wholesale trade                    |
|                                      |                                                                      |                      | Retail trade                       |
|                                      |                                                                      |                      | Transportation and warehousing     |
|                                      |                                                                      |                      | Information                        |
|                                      |                                                                      |                      | Financial and insurance            |
|                                      |                                                                      |                      | Real estates and renting and leasing|
|                                      |                                                                      |                      | Professional and business services  |
|                                      |                                                                      |                      | Educational services               |
|                                      |                                                                      |                      | Health care and social assistance  |
|                                      |                                                                      |                      | Arts, entertainment, and recreation|
|                                      |                                                                      |                      | Accommodation and food services    |
|                                      |                                                                      |                      | Repair and maintenance services    |
|                                      |                                                                      |                      | Personal and laundry services      |
|                                      |                                                                      |                      | Religious, grantmaking, civic,     |
|                                      |                                                                      |                      | professional, and similar organizations|
|                                      |                                                                      |                      | Public administration              |
| Individual determinants              |                                                                      |                      |                                    |
| Self-efficacy related to bicycling   | How confident are you with your cycling skills in urban areas?       | Likert scale: 1 = not at all confident to 4 = very confident | Adapted from Bopp et al. (2013)    |
| Self-efficacy related to walking     | How confident are you walking in urban areas?                        | Likert scale: 1 = not at all confident to 4 = very confident | Adapted from Bopp et al. (2013)    |
| Behavioral beliefs related to active | Items regarding active transportation beliefs:                       | Likert scale: 1 = strongly disagree to 7 = strongly agree      | Adapted from Bopp et al. (2013)    |
| transportation                       | Can help me to relieve stress                                       |                      |                                    |
|                                      | Improves my physical health                                         |                      |                                    |
|                                      | Helps me feel good mentally                                          |                      |                                    |
|                                      | Gives me more energy                                                |                      |                                    |
|                                      | May result in injury (reverse coded)                                 |                      |                                    |
|                                      | Is good for the environment                                          |                      |                                    |
|                                      | Helps me to save money                                               |                      |                                    |
|                                      | Helps me to look better                                              |                      |                                    |
| Barriers to active commuting         | To what extent do you feel that the following serve as a barrier to biking or walking to work? | Likert scale: 1 = not at all a barrier to 5 = very much a barrier | Adapted from Bopp et al. (2012)    |
|                                      | Time constraints/takes too long                                      |                      |                                    |
|                                      | Distance/too far                                                     |                      |                                    |
|                                      | Traveling to other places before/after work                          |                      |                                    |
|                                      | Health problems                                                      |                      |                                    |
|                                      | Traveling preferences of others traveling with you                  |                      |                                    |
|                                      | Concerns about appearance                                            |                      |                                    |
|                                      | Concerns about safety from traffic                                  |                      |                                    |
|                                      | Concerns about safety from crime                                    |                      |                                    |
|                                      | Concerns around bicycle maintenance                                 |                      |                                    |
|                                      | Lack of sidewalks                                                    |                      |                                    |
|                                      | Bad weather                                                          |                      |                                    |
|                                      | Difficult terrain                                                    |                      |                                    |
| Motivators to active commuting       | To what extent do you feel that the following serve as a motivator to biking or walking to work? | Likert scale: 1 = not at all a motivator to 5 = very much a motivator | Adapted from Bopp et al. (2012)    |
|                                      | Nice scenery on route to work                                        |                      |                                    |
|                                      | Economic concerns                                                   |                      |                                    |
|                                      | Traveling to other places before/after work                          |                      |                                    |
|                                      | Perceived health benefits                                            |                      |                                    |
|                                      | Traffic congestion                                                  |                      |                                    |
|                                      | Good weather                                                         |                      |                                    |
|                                      | Parking difficulties                                                 |                      |                                    |
3.3. Measures

The survey collected data across five areas: (1) demographic characteristics, (2) employment and commute details, (3) individual determinants, (4) the social context, and (5) the built environment. Data describe the variance in rates of active transportation; the impact of micro, meso, and macro factors on active transportation choices; and identify salient barriers and motivators to commuting through active transportation modes. Items on individual determinants, the social context, and the built environment were screened during a focus group discussion with a purposive sample \( (N = 5) \) of individuals of diverse backgrounds and commuting habits to provide a comprehensive understanding of work commute mode choices, which informed survey item modifications and additions \( \text{(Rubin and Babbie, 2011)} \). See Table 1 for a complete list of survey items.

3.3.1. Demographic characteristics

Demographic characteristics (i.e., age, sex, ethnicity, race, education level, and marital status) aligned with the ACS \( \text{(U.S.}

| Measure | Item | Response options | Reference |
|---------|------|------------------|-----------|
| Social context | Safe infrastructure such as well-maintained bike lanes or sidewalks and pedestrian crossings | Likert scale: 1 = strongly disagree to 7 = strongly agree | Adapted from Bopp et al. (2013) |
| Social norms related to active transportation | Family/friend normative beliefs around active transportation: My family and friends and I discuss issues related to biking and walking to work. I value what my family and friends think about the way I travel to/from work. I have an opinion on the way my family and friends travel to/from work. My family and friends influence my choice of how I travel to/from work. | Likert scale: 1 = strongly disagree to 7 = strongly agree | Adapted from Bopp et al. (2013) |
| Workplace norms related to active transportation | Coworker normative beliefs around active transportation: My coworkers and I discuss issues related to biking and walking to work. I value what my coworkers think about the way I travel to/from work. I have an opinion on the way my coworkers travel to/from work. My coworkers influence my choice of how I travel to/from work. | Likert scale: 1 = strongly disagree to 7 = strongly agree | Adapted from Bopp et al. (2013) |
| Employer supports for active transportation | Does your employer provide any of the following for employees who commute using active transportation? Incentives for active transportation Events related to active transportation, such as Bike to Work Day or active groups Flexible work hours Bike storage policies Bicycle parking Locker rooms Flexible dress code | Yes/no | Adapted from Bopp et al. (2013) |
| Overall employer support for active transportation | How much do you agree with the following statement? My employer supports active transportation to work. | Likert scale: 1 = strongly disagree to 7 = strongly agree | Adapted from Bopp et al. (2013) |
| Built environment | Bicycle/pedestrian friendliness near home Rate the bicycle/pedestrian friendliness of the neighborhood where you live | Likert scale: 1 = not at all bicycle/pedestrian friendly to 5 = very bicycle/pedestrian friendly | Adapted from Bopp et al. (2013) |
| Bicycle/pedestrian friendliness near work | Rate the bicycle/pedestrian friendliness of the neighborhood where you work | Likert scale: 1 = not at all bicycle/pedestrian friendly to 5 = very bicycle/pedestrian friendly | Adapted from Bopp et al. (2013) |
| Perceived support for active transportation | How satisfied are you with the current level of support for bicycling and walking within Philadelphia? City support for bicyclist and pedestrian issues Support from others in the community for bicyclist and pedestrian issues Maintenance of bike lanes and sidewalks in the neighborhood where you live | Likert scale: 1 = extremely dissatisfied to 5 = extremely satisfied | Adapted from Bopp et al. (2013) |

Notes. ACS = American Community Survey; CPS = Current Population Survey.
Table 2
Sample characteristics.

| Demographic characteristics          | Non-active transportation commuter | Active transportation commuter | Total                  | p-value |
|---------------------------------------|------------------------------------|--------------------------------|------------------------|---------|
|                                       | N  % or M±SD                        | N  % or M±SD                    | N  % or M±SD           |         |
| Age (N = 168)                         | 82 37.6 ± 10.7                      | 86 36.1 ± 11.1                  | 168 36.9 ± 10.9        | .380    |
| Sex (N = 168)                         |                                    |                                |                        |         |
|                                       | Female                             | 65 79.3                         | 49 57.0                | 114 67.9|         |
|                                       | Male                               | 16 19.5                         | 35 40.7                | 51 30.4 | .945    |
|                                       | Other                              | 1 1.2                           | 2 2.3                  | 3 1.8   |         |
|                                       | Latinx (N = 168)                   | 4 4.9                           | 4 4.7                  | 8 4.8   | <.001   |
|                                       | Non-white race (N = 168)           | 28 34.1                         | 8 9.3                  | 36 21.4 | .600    |
| Education (N = 168)                  |                                    |                                |                        |         |
|                                       | High school diploma                | 9 1.10                          | 13 15.1                | 22 13.1 |         |
|                                       | Associate's degree                 | 8 9.8                           | 4 4.7                  | 12 7.1  | .380    |
|                                       | Bachelor's degree                  | 35 42.7                         | 32 37.2                | 67 39.9 | .945    |
|                                       | Master's degree                    | 19 23.2                         | 22 25.6                | 41 24.4 |         |
|                                       | Professional degree                | 4 4.9                           | 8 9.3                  | 12 7.1  | .945    |
|                                       | Doctorate degree                   | 7 8.5                           | 7 8.1                  | 14 8.3  |         |
| Marital status (N = 168)             |                                    |                                |                        | .668    |
|                                       | Married                             | 34 41.5                         | 36 41.9                | 70 41.7 |         |
|                                       | Widowed                             | 1 1.2                           | 0 0.0                  | 1 0.6   |         |
|                                       | Divorced                            | 5 6.1                           | 4 4.7                  | 9 5.4   |         |
|                                       | Separated                           | 1 1.2                           | 1 1.2                  | 2 1.2   |         |
|                                       | Never married                       | 41 50.0                         | 45 52.3                | 86 51.2 | .423    |
| Children under 18 (N = 166)          |                                    |                                |                        | .800    |
|                                       | Full-time                           | 83 79.0                         | 90 83.3                | 172 81.2|         |
| Time at current job (N = 213)        |                                    |                                |                        | .760    |
|                                       | 0-6 months                          | 8 7.6                           | 8 7.4                  | 16 7.5  |         |
|                                       | 6-12 months                         | 14 13.3                         | 9 8.3                  | 23 10.8 |         |
|                                       | 1-2 years                           | 17 16.2                         | 16 14.8                | 33 15.5 |         |
|                                       | 2-5 years                           | 28 26.7                         | 32 29.6                | 60 28.2 |         |
|                                       | More than 5 years                   | 38 36.2                         | 43 39.8                | 81 38.0 |         |
| Annual income (N = 168)              |                                    |                                |                        |         |
|                                       | Less than $30,000                   | 11 13.4                         | 10 11.6                | 21 12.5 |         |
|                                       | $30,000-$60,000                     | 32 39.0                         | 32 37.2                | 64 38.1 | .383    |
|                                       | 60,001-$100,000                     | 27 32.9                         | 26 30.2                | 53 31.5 |         |
|                                       | More than $100,000                  | 12 14.6                         | 18 20.9                | 30 17.9 |         |
| Commute mode (N = 213)               |                                    |                                |                        | <.001   |
|                                       | Car, truck or van                   | 62 59.0                         | -                      | 62 29.1 |         |
|                                       | Bus or trolley bus                  | 21 20.0                         | -                      | 21 9.9  |         |
|                                       | Streetcar or trolley car            | 2 1.9                           | -                      | 2 0.9   |         |
|                                       | Subway or elevated                  | 15 14.3                         | -                      | 15 7.0  |         |
|                                       | Railroad                            | 2 1.9                           | -                      | 2 0.9   |         |
|                                       | Taxicab                             | 1 1.0                           | -                      | 1 0.5   |         |
|                                       | Motorcycle                          | 1 1.0                           | -                      | 1 0.5   |         |
|                                       | Bicycle                             | 50 46.2                         | 65 60.2                | 65 30.5 |         |
|                                       | Walked                              | -                                | 43 39.8                | 43 20.2 |         |
|                                       | Other method                        | 1 1.0                           | -                      | 1 0.5   |         |
| Commute distance (N = 192)            |                                    |                                |                        | .030    |
|                                       | 8.9 ± 10.1                          | 97 5.5 ± 11.8                   | 192 7.2 ± 11.1         |         |
| Commute mode change (N = 193)        |                                    |                                |                        | .073    |
|                                       | Essential employee (N = 213)        | 84 80.0                         | 81 75.0                | 165 77.5| .383    |
| Industry (N = 213)                   |                                    |                                |                        | .306    |
| Utilities                             | 1 1.0                              | 2 1.9                           | 3 1.4                  |         |
| Construction                          | 2 1.9                              | 1 0.9                           | 3 1.4                  |         |
| Manufacturing                         | 2 1.9                              | 2 1.9                           | 4 1.9                  |         |
| Retail trade                          | 4 3.8                              | 9 8.3                           | 13 6.1                 |         |
| Transportation and warehousing        | 4 3.8                              | 1 0.9                           | 5 2.3                  |         |
| Information                           | 1 1.0                              | 0 0.0                           | 1 0.5                  |         |
| Real estate and renting and leasing   | 1 1.0                              | 2 1.9                           | 3 1.5                  |         |
| Professional and business services    | 7 6.7                              | 5 4.6                           | 12 5.6                 |         |
| Educational services                  | 8 7.6                              | 7 6.5                           | 15 7.0                 |         |
| Healthcare and social assistance      | 59 56.2                             | 59 54.6                         | 118 55.4               |         |
| Arts, entertainment, and recreation   | 4 3.8                              | 2 1.9                           | 6 2.8                  |         |
| Accommodation and food services       | 4 3.8                              | 13 12.0                         | 17 8.0                 |         |
| Repair and maintenance services      | 1 1.0                              | 0 0.0                           | 1 0.5                  |         |
| Religious, grantmaking, civic, professional, and similar organizations | 4 3.8 | 2 1.9 | 2 1.9 |
| Public administration                | 7 6.7                              | 3 2.8                           | 10 4.7                 |         |

Notes. M = Mean; SD=Standard Deviation; bold text indicates p ≤ .05.
Department of Commerce, 2017). The survey also included an item on the number of children under 18 in the respondent’s household.

3.3.2. Employment and commute details

Employment status used the same measure as the Current Population Survey (CPS; U.S. Department of Labor, n.d.). Length of employment and income level were informed by the work of Bopp et al. (2012) and Bopp et al. (2013). The dependent variable, primary means of transportation to work, included the same categories used on the ACS, apart from “work from home” as individuals who worked from home did not meet the study’s inclusion criteria (U.S. Department of Commerce, 2017). The measure of commute distance was adapted from an ACS item on commute time (U.S. Department of Commerce, 2017). An item asked if the respondent’s commute mode changed as a result of the COVID-19 pandemic. Among respondents who indicated a change in commute mode, items informed by the ACS assessed commute mode and distance prior to the pandemic (U.S. Department of Commerce, 2017) and an open-ended item elicited the main reason for mode change. Identification of “essential employees” used the definition from the Essential Services Act of 2013 (2013) and employment industries were adapted from the state’s Industry Operation Guidance that identified industries and sectors that could continue physical operations during the COVID-19 pandemic (Wolf, 2020).

3.3.3. Individual determinants

Items that demonstrated reliability by Bopp et al. (2012; 2013) measured self-efficacy, behavioral beliefs, barriers, and motivators related to active transportation, adapted for this study. Self-efficacy related to confidence bicycling and walking in urban areas was measured using a 4-point Likert scale (i.e., not at all confident to very confident), behavioral beliefs were measured using a 7-point Likert scale (i.e., strongly disagree to strongly agree), and barriers and motivators each used a 5-point Likert scale (i.e., not at all to very much). The number of response options in each scale reflect those used in the original items (Bopp et al., 2012, 2013).

3.3.4. Social context

Family/friend and coworker normative beliefs around active transportation and workplace support for active transportation commuters were adapted from Bopp et al. (2013). Social norms related to family/friends and co-workers used a 7-point Likert scale as did overall employer support for active transportation (i.e., strongly disagree to strongly agree). Specific employer supports were measured dichotomously (i.e., yes/no).

3.3.5. Built environment

Survey items adapted from Bopp et al. (2013) measured respondent perceptions of City and community support for active transportation and bicycle and pedestrian friendliness. These items used a 5-point Likert scale (i.e., extremely dissatisfied to extremely satisfied).

3.4. Analyses

Bivariate analyses compared respondents who commuted using active transportation modes to those who did not using chi-square and ANOVA tests. Though theory and data indicate that parametric methods do not require the assumption of normality when examining differences between means (Norman, 2010), normality plots of residuals demonstrated that the residuals for each of the variables analyzed using ANOVA approached normality with skewness and kurtosis of less than one standard error, suggesting that the values were not significantly different from the expected value of zero in a normal distribution. In addition, for all but two variables, the results of the Levene’s Test of Equality of Error Variance were not significant, suggesting that the equality of variance condition was satisfied. For the two variables with significant results, Independent Samples t Tests suggested no differences in means or significance values when equal variance was not assumed.

A series of logistic regression models using forward stepwise selection estimated individual, social, and environmental factors associated with active transportation to work, controlling for demographic characteristics and commute distance, to identify the most salient factors contributing to active transportation commute mode choice. In models, age and commute distance were entered as continuous measures. Sex (i.e., female or male), ethnicity (i.e., Latinx or non-Latinx), and race (i.e., non-white or white) were included as dichotomous measures. Analyses were conducted using the Statistical Package for the Social Sciences, version 25.

4. Results

4.1. Sample characteristics

Survey respondents ranged in age from 22 to 72 years old. The majority were female (67.9%), non-Latinx (95.2%), and white (78.6%) and held at least a bachelor’s degree (60.1%). About half had never been married (51.2%) and nearly one-quarter had children (24.1%). Most were employed full time (81.2%) and two-thirds had been employed in their current position for two years or more (66.2%). Over three-quarters reported that they were essential employees (77.5%), most frequently working in the following industries: health care and social assistance (55.4%), accommodation and food services (8.0%), education (7.0%), retail (6.1%), and professional and business services (5.6%). A little more than half earned an annual income of $60,000 or less (52.4%) (See Table 2).

The most common commute mode at the time of survey completion was bicycling (30.5%), followed by driving (29.1%), walking (20.2%), and taking public transit (18.7%). However, nearly half of respondents reported changing their commute mode due to the COVID-19 pandemic (48.2%). For those who changed their commute mode, the most common commute mode prior to the pandemic
### Table 3

Individual, social, and environmental perspectives by commute mode choice.

|                                 | Non-active transportation commuter | Active transportation commuter | Total | p-value |
|---------------------------------|-------------------------------------|---------------------------------|-------|---------|
|                                 | % or M:SD                            | % or M:SD                        | % or M:SD |         |
| **Individual (N = 178)**        |                                     |                                 |       |         |
| Confidence bicycling            | 2.41 ± 1.01                          | 3.02 ± 1.04                      | 2.72 ± 1.07 | <.001   |
| Confidence walking              | 3.66 ± .57                           | 3.72 ± .54                       | 3.69 ± 55 | .511    |
| Active transportation beliefs   |                                     |                                 |       |         |
| Relieves stress                 | 5.57 ± 1.28                          | 6.04 ± 1.27                      | 5.81 ± 1.29 | .014    |
| Improves physical health        | 6.19 ± 1.05                          | 6.42 ± .84                       | 6.31 ± .95 | .095    |
| Improves mental health          | 5.80 ± 1.19                          | 6.25 ± .98                       | 6.03 ± 1.10 | .007    |
| Improves physical appearance    | 5.17 ± 1.44                          | 5.43 ± 1.59                      | 5.31 ± 1.52 | .254    |
| Improves energy                 | 5.28 ± 1.30                          | 5.64 ± 1.41                      | 5.47 ± 1.37 | .077    |
| Results in injury               | 5.05 ± 1.61                          | 5.17 ± 1.47                      | 5.11 ± 1.53 | .581    |
| Good for the environment        | 6.47 ± 1.19                          | 6.66 ± 1.56                      | 6.57 ± .92 | .152    |
| Saves money                     | 6.26 ± 1.10                          | 6.47 ± 1.03                      | 6.37 ± 1.07 | .187    |
| **Increases productivity**      | 4.16 ± 1.45                          | 4.99 ± 1.39                      | 4.59 ± 1.47 | <.001   |
| Barriers to active transportation use |                                 |                                 |       |         |
| Time constraints/takes too long | 3.88 ± 1.27                          | 2.23 ± 1.27                      | 3.03 ± 1.51 | <.001   |
| Distance/too far                | 3.78 ± 1.25                          | 2.27 ± 1.25                      | 3.00 ± 1.46 | <.001   |
| Traveling to other places before/after work | 3.27 ± 1.28 | 2.66 ± 1.24 | 2.96 ± 1.29 | .002 |
| Health problems                 | 2.07 ± 1.05                          | 1.86 ± 1.19                      | 1.96 ± 1.23 | .213    |
| Traveling preferences of others traveling with you | 2.22 ± 1.30 | 2.13 ± 1.26 | 2.17 ± 1.28 | .637 |
| Concerns about appearance       | 2.64 ± 1.44                          | 2.33 ± 1.38                      | 2.48 ± 1.42 | .140    |
| Concerns about safety from traffic | 4.13 ± 1.12 | 3.64 ± 1.22 | 3.88 ± 1.19 | .006 |
| Concerns about safety from crime | 3.06 ± 1.33 | 2.61 ± 1.28 | 2.83 ± 1.32 | .023 |
| Concerns around bicycle maintenance | 2.86 ± 1.24 | 2.39 ± 1.17 | 2.62 ± 1.23 | .010 |
| Lack of sidewalks               | 3.14 ± 1.49                          | 2.27 ± 1.30                      | 2.69 ± 1.46 | <.001   |
| Bad weather                     | 4.35 ± 1.72                          | 3.89 ± 1.03                      | 4.11 ± .92 | .001    |
| **Difficulty terrain**          | 3.13 ± 1.30                          | 2.50 ± 1.24                      | 2.80 ± 1.30 | .001    |
| Motivators to active transportation use |                                 |                                 |       |         |
| Nice scenery on the route to work | 3.45 ± 1.26 | 3.68 ± 1.09 | 3.57 ± 1.18 | .191 |
| Economic concerns               | 3.37 ± 1.21                          | 3.88 ± 1.07                      | 3.63 ± 1.16 | .003    |
| Traveling to other places before/after work | 2.65 ± 1.13 | 3.10 ± 1.11 | 2.88 ± 1.14 | .008 |
| Perceived health benefits       | 3.95 ± 0.78                          | 4.22 ± 0.87                      | 4.09 ± 0.84 | .036    |
| Traffic congestion              | 3.45 ± 1.25                          | 3.87 ± 1.28                      | 3.67 ± 1.28 | .030    |
| Good weather                    | 4.16 ± .94                           | 4.14 ± 1.00                      | 4.15 ± .97 | .883    |
| Parking difficulties            | 3.43 ± 1.44                          | 3.66 ± 1.51                      | 3.55 ± 1.48 | .295    |
| Safe infrastructure             | 3.97 ± 1.14                          | 4.04 ± 1.07                      | 4.01 ± 1.10 | .637    |
| Safety concerns around germs    | 3.30 ± 1.31                          | 3.75 ± 1.33                      | 3.53 ± 1.34 | .025    |
| Social (N = 174)                |                                     |                                 |       |         |
| Family/friends                  |                                     |                                 |       |         |
| Discuss active transportation to work | 4.30 ± 1.94 | 5.03 ± 1.62 | 4.68 ± 1.82 | .007 |
| Value their thoughts on commute to work | 4.35 ± 1.87 | 4.48 ± 1.78 | 4.41 ± 1.82 | .633 |
| Hold an opinion on how they commute to work | 3.98 ± 1.80 | 4.44 ± 1.77 | 4.22 ± 1.80 | .086 |
| Influence commute choices       | 3.58 ± 1.81                          | 3.40 ± 1.72                      | 3.49 ± 1.76 | .494    |
| Coworkers                       |                                     |                                 |       |         |
| Discuss active transportation to work | 4.02 ± 1.91 | 4.77 ± 1.76 | 4.41 ± 1.87 | .008 |
| Value their thoughts on commute to work | 3.36 ± 1.90 | 3.40 ± 1.81 | 3.38 ± 1.85 | .879 |
| Hold an opinion on how they commute to work | 3.15 ± 1.83 | 3.63 ± 1.81 | 3.40 ± 1.83 | .085 |
| Influence commute choices       | 2.65 ± 1.73                          | 2.63 ± 1.47                      | 2.64 ± 1.60 | .930    |
| Employer                        |                                     |                                 |       |         |
| Incentives for active transportation | 9.5                | 9.3                        | 9.4    | .947    |
| Hosts events related to active transportation | 4.8                | 10.2                       | 7.5    | .133    |
| Flexible work hours             | 15.2                                | 15.7                          | 15.5  | .919    |
| Bicycle storage policies        | 14.3                                | 17.6                          | 16.0  | .510    |
| Bicycle parking                 | 46.7                                | 52.8                          | 49.8  | .372    |
| Locker rooms                    | 11.4                                | 10.2                          | 10.8  | .770    |
| Flexible dress code             | 18.1                                | 24.1                          | 21.1  | .285    |
| Supports active transportation to work | 3.71 ± 1.60 | 4.00 ± 1.54 | 3.86 ± 1.57 | .232 |
| Environmental (N = 168)         |                                     |                                 |       |         |
| Bicycle/pedestrian friendliness near home | 3.74 ± 1.02 | 3.74 ± 1.03 | 3.74 ± 1.02 | .999 |
| Bicycle/pedestrian friendliness near work | 3.45 ± 1.18 | 3.51 ± 1.17 | 3.48 ± 1.17 | .739 |
| Satisfaction with city support  | 2.73 ± 1.07                          | 2.62 ± 1.07                      | 2.67 ± 1.06 | .484    |
| Satisfaction with support from community | 3.00 ± .98 | 2.72 ± .97 | 2.86 ± .98 | .065 |
| Satisfaction with maintenance of infrastructure near home | 2.52 ± 1.20 | 2.29 ± 1.05 | 2.40 ± 1.13 | .180 |
| Satisfaction with maintenance of infrastructure near work | 2.54 ± 1.20 | 2.52 ± 1.12 | 2.53 ± 1.16 | .941 |

Notes. M = Mean; SD=Standard Deviation; bold text indicates p ≤ .05.
Table 4
Individual, social, and environmental perspectives associated with active transportation to work (N = 165).

|                         | Control | Confidence and beliefs | Barriers | Motivators | All individual | Social | Environmental | Full |
|-------------------------|---------|------------------------|----------|------------|----------------|--------|---------------|------|
| Age                     | Adj R² = .221 | OR (95% CI) | Adj R² = .311 | OR (95% CI) | Adj R² = .505 | OR (95% CI) | Adj R² = .508 | OR (95% CI) | Adj R² = .294 | OR (95% CI) | Adj R² = .543 | OR (95% CI) |
| Age                     | .981 (.951–1.012) | .972 (.940–1.005) | .984 (.948–1.002) | .989 (.958–1.022) | .986 (.949–1.024) | .975 (.944–1.007) | .981 (.951–1.012) | .986 (9.49–1.025) |
| Female                  | .351 (.165–.748) | .487 (.212–1.117) | .620 (.251–1.532) | .324 (.149–.703) | .484 (.191–1.228) | .378 (.171–.832) | .355 (.165–.762) | .476 (.182–1.245) |
| Latinx                  | 1.731 (.292–10.256) | 2.199 (.336–14.414) | 1.583 (.262–9.558) | 1.788 (.295–10.835) | 1.699 (.261–11.056) | 3.488 (.518–23.480) | 1.533 (.262–8.957) | 1.615 (.240–10.875) |
| Non-white               | .204 (.081–.515) | .284 (.108–.750) | .170 (.055–.527) | .225 (.088–.576) | .200 (.065–.621) | .189 (.070–.506) | .184 (.070–.529) | .155 (.045–.525) |
| Commute in miles        | .962 (.922–1.003) | .956 (.912–1.002) | .965 (.925–1.008) | .963 (.923–1.005) | .966 (.929–1.005) | .959 (.921–.998) | .963 (.924–1.003) | .965 (.932–1.000) |
| Confidence bicycling    | –       | 1.550 (1.083–2.217) | –       | –       | –       | –       | –       | –       |
| Increases productivity   | –       | 1.393 (1.058–1.834) | –       | –       | –       | –       | –       | –       |
| Time constraints         | –       | .416 (.299–.578) | –       | .463 (.343–.626) | –       | –       | .450 (.327–.618) | –       |
| Health problems          | –       | 1.537 (1.039–2.274) | –       | .529 (.357–.782) | –       | –       | .482 (.316–.734) | –       |
| Concerns about safety from traffic | – | .489 (.323–.741) | – | 1.408 (1.036–1.915) | – | – | – | – |
| Economic concerns        | –       | –       | 1.456 (1.057–2.006) | – | – | 1.580 (1.119–2.231) | – | – |
| Safety concerns around germs | – | – | – | – | 1.421 (1.129–1.788) | – | – |
| Family and friends discuss active transportation to work | – | – | – | – | – | – | – |
| Family and friends influence commute choices | – | – | – | – | .745 (.587–.945) | – | – |
| Satisfaction with support from community | – | – | – | – | .686 (.479–.982) | – | .551 (.351–.866) |

Notes. Adj = Adjusted; OR=Odds Ratio; CI=Confidence Interval; bold text indicates p ≤ .05.
was taking public transit (72.8%). Some respondents also reported changing their commute mode from driving (9.8%), bicycling (7.6%), and walking (4.3%). On an open-ended item, respondents described the main reason for changing their commute mode. They most often mentioned safety and limiting potential exposure to COVID-19. In particular, respondents reported concerns over safety and cleanliness on public transit. Several described the inability of local transit officials to enforce safety rules and others mentioned specific transit riders, such as people experiencing homelessness and “methadone clinic clients,” who they felt put them at an increased risk for contracting the virus. Others reported changes to public transit schedules that prompted them to commute using a different mode. Several mentioned changes in traffic patterns—for bicyclists, less traffic and road closures made bicycling safer, while for drivers, fewer cars made parking easier—and other mentioned using active transportation to improve their health. Finally, changes to employment responsibilities (e.g., the need for a car to make deliveries) or living situation (e.g., moving in with a partner) also impacted commuting habits.

4.2. Bivariate results

Respondents who commuted using active transportation at the time of survey completion were more often male (40.7% vs. 19.5%, \( p = .008 \)) and white (90.7% vs. 65.9%, \( p \leq .001 \)) and less often had children (12.9% vs. 35.8%, \( p = .001 \)) than those who commuted using other modes. On average, their commute was over three miles shorter than those who did not commute using active transportation (5.5 miles vs. 8.9 miles, \( p = .30 \)). On items related to confidence and beliefs around active transportation, active transportation commuters reported greater confidence bicycling in urban areas (3.02 vs. 2.41, \( p = .001 \)) and the belief that active transportation relieves stress (6.04 vs. 5.57, \( p = .014 \)), improves mental health (6.25 vs. 5.80, \( p = .007 \)), and increases productivity (4.99 vs. 4.16, \( p = .001 \)) than non-active transportation commuters. Non-active transportation commuters endorsed greater barriers to using active transportation to commute to work than those who bicycled or walked, including: time constraints (3.88 vs. 2.23, \( p \leq .001 \)), distance (3.78 vs. 2.27, \( p \leq .001 \)), traveling to other places before/after work (3.27 vs. 2.66, \( p = .002 \)), concerns about safety from traffic (4.13 vs. 3.64, \( p = .006 \)), concerns about safety from crime (3.06 vs. 2.61, \( p = .023 \)), concerns about bicycle maintenance (2.86 vs. 2.39, \( p = .010 \)), lack of sidewalks (3.14 vs. 2.27, \( p \leq .001 \)), bad weather (4.35 vs. 3.89, \( p = .001 \)), and difficult terrain (3.13 vs. 2.50, \( p = .001 \)). In contrast, active transportation commuters indicated greater support for motivators to bicycling and walking than non-active transportation commuters, including: economic concerns (3.88 vs. 3.37, \( p = .003 \)), traveling to other places before/after work (3.10 vs. 2.65, \( p = .008 \)), perceived health benefits (4.22 vs. 3.95, \( p = .036 \)), traffic congestion (3.87 vs. 3.45, \( p = .030 \)), and safety concerns around germs (3.75 vs. 3.30, \( p = .025 \)). Active commuters also more readily agreed that they discussed active transportation to work with both family/friends (5.03 vs. 4.30, \( p = .007 \)) and coworkers (4.77 vs. 4.02, \( p = .008 \)) than non-active transportation commuters (See Table 3).

4.3. Logistic regression results

In the model including simple demographic controls and commute distance to describe active transportation commute mode choice, both sex and race were statistically significant, with females (Odds Ratio [OR]: 0.351; 95% Confidence Interval [CI]: 0.165-0.748) and non-white respondents (OR: 0.204; 95% CI: 0.081-0.515) having lower odds of commuting using active transportation modes. In the model including measures of confidence and beliefs around active transportation, non-white respondents (OR: 0.284; 95% CI: 0.108-0.750) continued to have significantly lower odds of commuting using active transportation modes while those who reported greater confidence in bicycling (OR: 1.550; 95% CI: 1.083-2.217) and the belief that active transportation increases productivity (OR: 1.393; 95% CI: 1.058-1.834) had significantly increased odds of commuting using active transportation. In the model accounting for barriers, respondents of non-white race (OR: 0.170; 95% CI: 0.055-0.527) had even lower significant odds of commuting using active transportation. Time constraints (OR: 0.416; 95% CI: 0.299-0.578) and concerns about safety from traffic (OR: 0.489; 95% CI: 0.323-0.741) were also associated with significantly lower odds of commuting using active transportation modes. Interestingly, when controlling for other factors, respondents who endorsed higher barriers related to health problems (OR: 1.537; 95% CI: 1.039-2.274) had significantly higher odds of commuting to work using active transportation modes, possibly reflecting a commitment to using active transportation to improve health. In the model accounting for motivators, both female (OR: 0.324; 95% CI: 0.149-0.703) and non-white (OR: 0.225; 95% CI: 0.088-0.576) respondents had significantly lower odds of commuting using active transportation, while economic concerns (OR: 1.408; 95% CI = 1.036-1.915) significantly increased the odds of active commuting. Finally, in the model accounting for controls and all individual determinants (i.e., confidence and beliefs, barriers, and motivators), non-white (OR: 0.200; 95% CI: 0.065-0.621) respondents had significantly lower odds of commuting using active transportation modes, and time constraints (OR: 0.463; 95% CI: 0.343-0.626) and concerns about safety from traffic (OR: 0.529; 95% CI: 0.357-0.782) also decreased the odds of commuting using active transportation modes while safety concerns around germs (OR: 1.456; 95% CI: 1.057-2.066) increased the odds of bicycling or walking to work (See Table 4).

In the model including controls and measures of social context, female (OR: 0.378; 85% CI: 0.171-0.832) and non-white (OR: 0.189; 95% CI: 0.070-0.506) respondents continued to have decreased odds of using active transportation. Commute distance (OR: 0.959; 95% CI: 0.921-0.998) was also a small, but significant control. Discussing active transportation choices with family/friends (OR: 1.421; 95% CI: 1.129-1.788) was associated with increased odds of bicycling or walking to work, while the influence of family/friends on commute choices (OR: 0.745; 95% CI: 0.587-0.945) was associated with decreased odds of bicycling or walking to work, possibly reflecting additional responsibilities that make active transportation less preferable. In the model accounting for the built environment, non-white race (OR: 0.184; 95% CI: 0.070-0.479) and greater satisfaction with support from the community for bicyclist and pedestrian issues (OR: 0.686; 95% CI: 0.479-0.982) were associated with lower odds of commuting using active transportation modes.
concerns around germs (OR: 1.580; 95% CI: 1.119-0.482; 95% CI: 0.316-0.734) were associated with lower odds of commuting using active transportation, while the motivator of safety concerns around germs (OR: 1.580; 95% CI: 1.119-2.31) was associated with increased odds of commuting using active transportation. Finally, those who reported greater satisfaction with support from the community for bicyclist and pedestrian issues (OR: 0.551; 95% CI: 0.351-0.866) had lower odds of bicycling or walking to work (See Table 4).

The control model alone accounted for about 22% of variation in the model (Adjusted $R^2 = 0.221$), whereas the model including all individual determinants accounted for over 50% of variation (Adjusted $R^2 = 0.508$) and the model including all micro, meso, and macro measures accounted for 54% of variation (Adjusted $R^2 = 0.543$). Findings demonstrate that integrating individual, social, and environmental factors provides a better overall understanding of active transportation choices (See Table 4).

5. Discussion

This study was targeted towards essential employees commuting to work in Philadelphia, Pennsylvania during the COVID-19 pandemic. The majority considered themselves “essential,” and there were no significant differences in employment status, length of employment, or income between those who commuted using active transportation modes and those who did not. However, there were significant differences in commute mode choices by sex and race, suggesting that these characteristics contribute to commute decisions. Results further suggest that children pose additional responsibilities that make commuting using active transportation modes less preferable. While it was unsurprising that active transportation commuters reported fewer barriers and more motivators to bicycling and walking to work and described discussing active transportation with both family/friends and coworkers more often than non-active transportation commuters, there were only slight, and not statistically significant, differences in perceptions of the built environment among active and non-active transportation commuters, demonstrating awareness of spatial concerns that may contribute to transportation choices among active and non-active commuters alike. This suggests that increased support for active transportation could improve commuter perceptions of active transportation as a suitable commute choice.

Overall, regression results suggest that sex is a less permanent marker of active transportation choices than race: non-white respondents were far less likely to use active transportation across all models. Further, aside from time constraints, safety was a principal concern among essential employees. Safety from germs was a main contributor to changes in active transportation commute modes during the COVID-19 pandemic and a significant predictor of active transportation commute mode choice, while concerns about safety from traffic was associated with decreased odds of commuting using active transportation.

A stated goal of the Healthy People Initiative is to increase active transportation to improve health outcomes (U.S. Department of Health and Human Services). Given the increased likelihood of active transportation commuting in the wake of COVID-19, the pandemic could serve as an opportunity to make structural and social investments that make bicycling and walking safer alternatives during the pandemic and contribute to sustained behavior change in the future. Investments should include protection from traffic, found here to be a significant barrier to active transportation use. Cities across the United States have already responded to this call: New York, New York created open streets and added new temporary bicycle lanes to allow for greater social distancing (City of New York, 2020); Oakland, California created slow streets with soft closure barriers to close streets to through traffic (City of Oakland, 2020); and Philadelphia advocates created a Recovery Streets Coalition to promote Open Streets, Calm Streets, expanded outdoor dining, food vending, and Play Streets, and additional protected bike lanes (Bicycle Coalition of Greater Philadelphia, 2020). While these initiatives may be helpful in the short-term, more can be done. In comparison to these temporary measures, several European countries invested millions of euros in new bicycling infrastructure to improve commuter access and restart economic growth following quarantine re-openings (Alderman, 2020). The cost savings associated with increased bicycling and walking in the U.S. (Whitfield et al., 2017; BBC Research & Consulting, 2016) suggest that the benefits of making these structural investments will outweigh the costs.

Despite the need for quick action, intentional community engagement, particularly in minority communities, should be an integral part of implementation efforts. Without it, street redesigns could “deepen inequity and mistrust in communities that have been disenfranchised and underserved for generations” and residents who view street use as a liability, as highlighted by the Black Lives Matter and Defund the Police movements (Thomas, 2020, para. 2). Results shown here indicate that active transportation commuters report less satisfaction with community support for active transportation choices. Without community engagement, infrastructure investments may be underutilized and ineffective in promoting long-term change. Unfortunately, the needs, wants, and aspirations of communities are often overlooked in urban planning. A new approach could include community engagement during design, implementation, and deployment that involves stakeholder input from both those at the top and bottom to make urban planning decisions more collaborative (Fredericks et al., 2016). Lessons from Complete Streets initiatives suggest an approach that helps to frame interventions in terms that resonate with decisionmakers and community members using a health, injury prevention, and equity lens as well as increasing collaboration and supporting data collection and evaluation efforts (Sansone et al., 2019).

Additionally, ensuring access to active transportation options and addressing safety concerns could further promote its use. For example, the newly funded Lil’ Philly Safety Village in Philadelphia will offer bicyclists of all ages the opportunity to learn about bicycling infrastructure, street design, and signage in a fun and interactive environment (LoBasso, 2020). Initiatives like this have the potential to increase support for bicyclist and pedestrian issues by bringing community members together around active transportation.
This work contributes to a growing body of literature that recognizes the importance of integrating micro, meso, and macro factors into active transportation frameworks. However, most active transportation research is conducted in Europe. American studies often lack robust sampling and/or methodological techniques. The importance of bringing awareness to active transportation decision-making in the U.S. is even more imperative during the COVID-19 pandemic. The struggle of essential workers to identify safe routes to work, particularly those in minority communities who face increased mortality due to the virus, also underscores the need to promote greater equity.

5.1. Strengths and limitations

While the sample analyzed here maximized variation on the dependent variable (i.e., active transportation to work) as intended and engaged a broader sample than most active transportation research in the U.S., it was still limited. Equity issues were a specific aim of this work, yet minority respondents were underrepresented. This may be due to insufficient recruitment efforts, but it may also reflect the inability of people without Internet access and/or the ability to respond to a survey in English to complete the survey. Additionally, though this study drew on measures that demonstrated reliability in previous work, the field lacks unified concepts, making comparisons across studies challenging and limiting the generalizability of findings, especially through comparison of results both pre- and post-COVID. Lastly, this work asked respondents to reflect on the built environment in the neighborhoods where they lived and worked. Future analyses will account for additional measures of bicycling and walking accessibility at these neighborhood levels. In addition, identifying profiles of commuters using individual, social, and environmental measures can inform future active transportation initiatives.

6. Conclusion

Physical inactivity is a major public health concern. While active transportation can increase physical activity and positively affect health, traffic fatalities among bicyclists and pedestrians are on the rise. Moreover, the COVID-19 pandemic may exacerbate health risks, especially in minority communities. This study demonstrates that exploring individual, social, and environmental factors together provides a better overall understanding of active transportation choices. As U.S. cities search for opportunities to promote physical activity and safety, they should consider both structural and social investments to increase active transportation through infrastructure and community engagement efforts. Present initiatives too often reflect a continued ignorance of the legacy of racism and community disinvestment. The COVID-19 pandemic demonstrates the urgent need for more equitable solutions that can enhance health and quality of life for all Americans.

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References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211.
Alderman, L., 2020. ‘Corona Cycleways’ become the new post-confinements commute: as European cities emerge from quarantines, bicycles are playing a central role in getting the work force moving again. The New York Times. Retrieved from https://www.nytimes.com/2020/06/12/business/paris-bicycles-commute-coronavirus.html.
BBC Research & Consulting, 2016. Economic and health benefits of bicycling and walking. Report prepared for the Colorado Office of Economic Development and International Trade. Retrieved from https://choosecolorado.com/wp-content/uploads/2016/06/Economic-and-Health-Benefits-of-Bicycling-and-Walking-in-Colorado-4.pdf.
Bicycle Coalition of Greater Philadelphia, 2020. Recovery streets. Retrieved from https://bicyclecoalition.org/programs/vision-zero/recovery-streets/.
Blair, S.N., 2009. Physical inactivity: the biggest public health problem of the 21st century. Br. J. Sports Med. 43 (1), 1–2.
Bopp, M., Kaczynski, A.T., Besenyi, G., 2012. Active commuting influences among adults. Prev. Med. 54 (3-4), 237–241.
Bopp, M., Kaczynski, A.T., Campbell, M.E., 2013. Social ecological influences on work-related active commuting among adults. Am. J. Health Behav. 37 (4), 543–554.
Bornstein, D.B., Davis, W.J., 2014. The transportation profession’s role in improving public health. Institute of Transportation Engineers Journal 84 (7), 18.
Bronfenbrenner, U., 2005. Ecological models of human development. In: Guvain, M., Cole, M. (Eds.), Readings on the Development of Children. Worth Publishers, New York, NY, pp. 3–8.
Calefati, J., 2020, April 21. Still going in to work in Pennsylvania amid the coronavirus? Chances are, you’re a low-wage worker, data show. Philadelphia Inquirer. Retrieved from https://www.inquirer.com/politics/essential-grocery-work-home-pennsylvania-true-false-20200421.html.
Chaney, R.A., Bernard, A.L., Wilson, B.R.A., 2014. Characterizing active transportation behavior among college students using the theory of planned behavior. Int. Q Community Health Educ. 34 (3), 283–294.
City of New York, 2020, May 13. Mayor de Blasio adds 12 more miles of open streets and nine miles of new temporary protected bike lanes. Retrieved from https://www1.nyc.gov/office-of-the-mayor/news/342-20-mayor-de-blasio-adds-12-more-miles-open-streets-nine-miles-new-temporary-protected-bike.

City of Oakland, 2020, April 11. Oakland slow streets. Retrieved from https://www.oaklandca.gov/projects/oakland-slow-streets.

City of Philadelphia, 2020 April 13. Guidance for people who are going to work during COVID-19. Retrieved from https://www.phila.gov/media/20200413154442/Guidance-for-people-who-are-going-to-work-during-COVID-19-4_13.pdf.

City of Philadelphia, 2020 August 24. City of Philadelphia COVID-19 overview. Retrieved from https://www.phila.gov/programs/coronavirus-disease-2019-covid-19/testing-and-data/explore-covid-19-datasets.

Essential Services Act of 2013, S.724, 2013. Retrieved from https://www.congress.gov/bill/113th-congress/senate-bill/724/text?format=txt.

Four Square Integrated Transportation Planning, 2018, October. Indego 2018 business plan update. Report prepared for Indego and the City of Philadelphia. Retrieved from http://www.phillytoxis.com/wp-content/uploads/2018/10/2018_IndegoPlan_Final.pdf.

Fredericks, J., Caldwell, G.A., Tomitsch, M., 2016. Middle-out design: collaborative community engagement in urban HCI. In: Proceedings of the 28th Australian Conference on Computer-Human Interaction, pp. 200–204.

Götschi, T., de Nazelle, A., Irland, C., Gerike, R., Pasha Consortium, 2017. Towards a comprehensive conceptual framework of active travel behavior: a review and synthesis of published frameworks. Current environmental health reports 4 (3), 286–295.

League of American Bicyclists, 2019. Bicycling and walking in the United States: 2018 benchmarking report. Retrieved from https://bikeleague.org/benchmarking-report.

LoBasso, R., 2020, October 12. Kaboom! Philly is getting its first bicycle traffic park! Bicycle Coalition of Greater Philadelphia. Retrieved from https://bicyclecoalition.org/kaboom-philly-is-getting-its-first-bicycle-traffic-park/.

Maccen, J., 2020. ‘Safe streets are not safe for Black lives: a transportation planner warns pedestrian-friendly street redesigns that happen without diverse public input can end up harming the communities they serve. Bloomberg CityLab. Retrieved from https://www.bloomberg.com/news/articles/2020-06-08/-safe-streets-are-not-safe-for-black-lives.

Murphy, D.C., 2019. As congestion worsens in Philly, car-related emissions spike. WHYY. Retrieved from https://whyy.org/articles/as-congestion-worsens-in-philly-car-related-emissions-spike/.

National Center for Health Statistics, 2012. Healthy People 2010 Final Review. Hyattsville, MD.

Norman, G., 2010. Likert scales, levels of measurement and the “laws” of statistics. Adv. Health Sci. Educ. 15 (5), 625–632.

Ozdemir, A., 2013. Designing landscapes for child health. Advances in Landscape Architecture. IntechOpen, pp. 227–262.

Popovich, N., Lu, D., 2019. The most detailed map of auto emissions in America. The New York Times. Retrieved from https://www.nytimes.com/interactive/2019/10/10/climate/driving-emissions-map.html?smid=nytcore-ios-share.

Qualtrics, 2019. Retrieved from https://www.qualtrics.com/.

Rubin, A., Babbie, E., 2011. Research methods for social work. Brooks/Cole, Cengage Learning, Belmont, CA.

Sansone, C., Sadowki, J., Chirqui, J.F., 2019. Public health engagement in complete streets initiatives: examples and lessons learned. Institute for Health Research and Policy, University of Illinois at Chicago, Chicago, IL. Retrieved from: https://go.uic.edu/CompleteStreetsPH.

Sheller, M., 2015. Racialized mobility transitions in Philadelphia: connecting urban sustainability and transport justice. City Soc. 27 (1), 70–91.

Shields, M.M., 2015. Investigating campus cycling environment of a large southeastern university from an ecological perspective. Doctoral dissertation, University of Alabama Libraries.

Smart Growth America, 2019. Dangerous by design: the most vulnerable. Retrieved from https://smartgrowthamerica.org/dangerous-by-design/.

Tait, D.B.G., Shah, A., Doubeni, C.A., Sia, I.G., Wieland, M.L., 2020. The disproportionate impact of COVID-19 on racial and ethnic minorities in the United States. Clin. Infect. Dis. 72 (4), 703–706.

Tanenbaum, M., 2020. Philly sees boom in cyclists, 471% increase on Kelly Drive Trail during Coronavirus restrictions. Philly Voice. Retrieved from https://www.phillyvoice.com/philly-cycling-coronavirus-kelly-drive-trail-covid-19-bicycle-coalition-covid-19/.

Thomas, J., 2020. Safe streets are not safe for Black lives: a transportation planner warns pedestrian-friendly street redesigns that happen without diverse public input can end up harming the communities they serve. Bloomberg CityLab. Retrieved from https://www.bloomberg.com/news/articles/2020-06-08/-safe-streets-are-not-safe-for-black-lives.

U.S. Census Bureau. (a) American Community Survey (ACS). Retrieved from https://www.census.gov/programs-surveys/acs.

U.S. Census Bureau. Fact finder. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_1YR_S001&prodType=table.

U.S. Census Bureau. Quick facts: Philadelphia county, Pennsylvania. Retrieved from https://www.census.gov/quickfacts/philadelphiacounty pennsylvania.

U.S. Department of Commerce, 2017. The American community survey. Retrieved from https://www2.census.gov/programs-surveys/acs/methodology/questionnaires/2017/quest17.pdf#.

U.S. Department of Health and Human Services. Increase the proportion of adults who walk or bike to get places. Retrieved from https://health.gov/healthypeople/2020goals/objectives-and-data/browse-objectives/physical-activity/increase-proportion-adults-who-walk-or-bike-get-places-pa-10.

U.S. Department of Labor. Labor force statistics from the current population survey. Retrieved from https://www.bls.gov/cps/lfcharacteristics.htm#emp.

U.S. Department of Labor statistics for people who are going to work during COVID-19. Retrieved from https://www.phila.gov/media/20200413154442/Guidance-for-people-who-are-going-to-work-during-COVID-19-4_13.pdf.

Willis, D.P., Mankaugh, K., El-Genidy, A., 2015. Cycling under influence: summarizing the influence of perceptions, attitudes, habits, and social environments on cycling for transportation. International Journal of Sustainable Transportation 9 (8), 565–579.

Wolf, T., 2020, April 1. Industry operation guidance. Retrieved from https://www.scribd.com/document/454418385/04-01-20-Industry-Operation-Guidance.

Zavestoski, S., Agyeman, J., 2014. Complete Streets: what’s missing? In: Zavestoski, S., Agyeman, J. (Eds.), Incomplete Streets. Routledge, London, pp. 21–34.