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COVID-19’s impact on older adults’ cycling behaviors in a small, auto-centric urban area

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ABSTRACT

Research has shown an increase in cycling during COVID-19. This study builds on previous work by exploring COVID-19’s impact on older cyclists (65+) residing in a small, auto-centric urban area. A survey (n = 198) demonstrated that, on average, cycling frequency decreased and average distance/trip increased. This suggests a less pronounced impact among older adults residing in a small urban area. However, interviews (n = 24) showed that cycling during the pandemic was associated with feelings of accomplishment, enjoyment, improved self-esteem, and increased freedom by allowing them to get out despite social distancing requirements. Further, among respondents reporting increased cycling (n = 76), most (79 %) plan to maintain cycling habits post-pandemic, citing reasons such as personal health, enjoyment, and the social aspect of cycling. These findings could support efforts promoting cycling among older adults, pointing to aspects for designing voluntary travel behavior change (VTBC) programs.

Introduction

The health benefits of cycling are well documented in the literature, ranging from advanced stamina and muscle strength to improved balance and cardiovascular function (Garrard et al., 2012; Oja et al., 2011). For older adults, such benefits could be particularly important in fostering healthy aging (Baldwin et al., 2019; Huy et al., 2009) and facilitating physiological improvements such as balance, flexibility, posture, and increased leg and muscle strength (Ilkeze et al., 2018; Rissel et al., 2013). Beyond health benefits, cycling can aid in extending older adults’ life-space area, help reduce social isolation, and be a viable form of transportation (Ryan et al., 2016; Van Cauwenberg et al., 2019; Zander et al., 2013). Although cycling may be associated with an increased risk of injury from a fall or crash, the benefits likely outweigh the risks (De Hartog et al., 2010). In addition, studies show that older adults tend to be safer cyclists with fewer cycling crashes and less risky cycling behaviors than cyclists of other age groups (Bernhoff & Carstensen, 2007).

Despite the benefits, older adults’ cycling habits vary by location. For example, cycling participation among older Americans aged 65+ is low, accounting for only 0.5 % of all transportation trips made by this group. Similar numbers can be seen in the U.K. where cycling accounts for only 0.5 % of all transportation trips made by this group.

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Despite the benefits, older adults’ cycling habits vary by location. For example, cycling participation among older Americans aged 65+ is low, accounting for only 0.5 % of all transportation trips made by this group. Similar numbers can be seen in the U.K. where cycling accounts for only 1 % of their trips (Pucher & Buehler, 2010). Conversely, in places with strong cycling cultures and supportive environments, cycling plays a much more vital role. For example, in 2008, the cycling mode share among older adults 65+ was 23 % in the Netherlands, 15 % in Denmark, and 9 % in Germany (Pucher & Buehler, 2010). Thus, the existing data and literature suggests that age itself does not prevent older adults from cycling and that cycling could increase among this cohort if the right support is provided. This might include making physical changes to the cycling environment or introducing strategies aimed at changing travel behaviors among older adults.

The 2019 outbreak of the coronavirus (COVID-19) caused a disruption to many aspects of our lives, including our transportation behaviors. Recent reports highlight mobility changes across the globe (Chinazzi et al., 2020; de Haas et al., 2020; Gao et al., 2020; Huang et al., 2020; Molloy et al., 2020). While some modes such as public transit faced reductions, others grew in popularity. Research has demonstrated an increase in cycling during the pandemic among the general population (Buehler & Pucher, 2021; Molloy et al., 2020), and one study points to COVID’s role in increased cycling levels among older adults aged 50+ (Kachadoorian, 2021). However, research also suggests situational differences in COVID’s impact on cycling based on aspects such as location, time of study, as well as variations in governmental responses to the
A growing literature explores COVID-19’s impact on cycling with varying results. Decreases in overall cycling levels are reported for areas that normally see higher levels of utilitarian cycling due to an overall reduction in travel (de Haas et al., 2020). Conversely, increases have been seen in areas with previous low cycling shares (Doubleday et al., 2021; Möllers et al., 2021), or in places that normally see a high share of transit trips due to a modal shift from transit to cycling (Doubleday et al., 2021; Huang et al., 2020; Teixeira & Lopes, 2020). Similarly, studies point to an increase in cycling levels when looking at “round-trips,” meaning trips that start and end at the same place such as a person’s home (de Haas et al., 2020). Thus, scholars argue that there is regional heterogeneity in COVID’s impact on cycling (de Haas et al., 2020; Möllers et al., 2021).

In a 2021 review, Buehler, and Pucher deliver a succinct overview of the available data related to COVID-19’s impact on cycling across the globe, comparing changes in percentages from 2019 to 2020. Based on their findings, both recreational and utilitarian cycling levels increased, with the largest increase occurring during the weekends. Cycling increased by an average of 16% in the U.S. compared to an average increase of 8% in Europe and 3% in Canada (Buehler & Pucher, 2021). Similarly, a survey by People for Bikes (2021) suggests that 4% of Americans aged 18 or older started cycling, or picked cycling back up, during the time of the pandemic, with 35% mentioning lack of time as the reason that deterred them from cycling before. Exercise, stress reduction and mental health, being outdoors, and socialization were the main reasons for cycling for both new and existing riders (People for Bikes, 2021).

In sum, the existing literature points to significant changes in global cycling levels since the beginning of the COVID-19 pandemic. However, a limitation with the existing literature is the sparse knowledge related to COVID’s impact on cycling in small urban and rural contexts. Further, the majority of these studies focus on Europe’s more cycling friendly environments or in places that normally see high levels of active transportation. Thus, there is a need to broaden the literature related to COVID’s impact on cycling behaviors in more difficult contexts.

Another limitation with the existing literature is the sparse knowledge related to whether these changes will last post-pandemic (Buehler & Pucher, 2021; de Haas et al., 2020; People for Bikes, 2021). From the existing literature, we know that city and local governments across the globe responded quickly to the increase in cycling by making changes to the cycling environment (Buehler & Pucher, 2021; Combs & Pardo, 2021). However, we do not know how much a continued interest in cycling can be contributed to changes in the cycling environment or whether a continuation relates to different types of settings and cyclists.

### Habits role in Mode-Choice decisions

While the previous section addressed COVID’s impact on cycling, this section presents the behavioral theory that can help us understand this change and the potential for future impacts to travel behaviors.

Within the field of psychology, “habits” are behavioral patterns performed in response to previous situations where the behavior was preformed repeatedly and consistently (Wood & Neal, 2007). The influence of habits on travel behavior is supported by Schneider’s (2013) theory of routine mode-choice decisions, indicating that daily travel decisions are predominantly influenced by habit and routine. However, the existing literature makes it evident that certain life events across the life-course, such as a new job, a move, or likely retirement for older adults, provides an opportunity for new travel habits to be formed, meaning that they provide an opportunity to break previous habitual patterns (Clark et al., 2016; Ralph & Brown, 2019). Similarly, as previously discussed, external events, such as global health outbreaks, can alter travel behaviors globally. Based on this logic, it is safe to assume that new travel habits could be developed among older adults, particularly if the right opportunity is presented.

Although changes to the physical environment and/or increasing the availability of alternatives to driving play an important role, strategies aimed at interrupting previous travel habits have proven instrumental in changing travel behaviors, particularly in situations where previous travel habits are strong (Eriksson et al., 2008; Verplanken et al., 1998). Soft transport policy measures, or voluntary travel behavior change (VTBC) programs, are strategies aimed at motivating individuals to change travel behaviors with the primary goal of reducing single occupant vehicle usage (Cairns et al., 2008). Beyond a reduction in car travel, VTBC programs also have the capacity to increase physical activity through increased levels of active transportation (Ahmed et al., 2020). However, as mode choices are often habitual, strategies aimed at breaking existing habits are considered essential to successful VTBC programs (Ffiji & Gärling, 2003). Stromberg and Karlsson (2016) sought a deeper understanding of factors that can promote travel behaviour changes away from cars and towards cycling (Stromberg & Karlsson, 2016). Participants were equipped with bicycles for a 6-month period with the stipulation that they would replace at least three days of car trips with cycling trips each week. After a short period, cycling became the normal mode of transportation where participants...
mentioned that utilitarian cycling had become a “new habit” (Strömberg & Karlsson, 2016). Further, participants attributed the mode shift to being encouraged to “try it out.” Although the study did not specifically target older adults, it is possible that “trying out cycling” could be instrumental in promoting cycling among older adults. In this way, the COVID-19 pandemic serves as a naturalistic “try it out” period for cycling.

Research methods

This study seeks to fill the above described gaps in the literature by addressing the following research questions:

Research question 1:

How did the COVID 19-pandemic change older adults’ cycling behaviors in a small, auto-centric small urban area?

Research question 2:

Do older adults intend to maintain these habits post-pandemic and in what ways do older adults intend to maintain these habits?

Case selection

Tallahassee is a mid-sized U.S city (pop.191,279) located in the Florida Panhandle and the city’s urban pattern follows that of an auto-centric city with a limited public transit system, post-World War II low-density development pattern, and a cycling commute mode share of 0.5 %. Thus, Tallahassee serves as a reasonable example through which to explore COVID-19’s impact on older adults’ cycling habits in a place that normally does not see high cycling levels, an environment that is not supportive of utilitarian cycling, and where minimal changes were made to the cycling environment during the time of the pandemic.

Data collection

Quantitative data was gathered using a self-reported cross-sectional online survey of older cyclists aged 65 and older (n = 330). The survey included four parts. The first set of questions asked about cycling behavior prior to the COVID-19 pandemic to establish a baseline. The second set of questions asked about COVID’s impact on said cycling behaviors. For participants who indicated an increase to cycling levels during the pandemic, a third set of questions asked about intentions to maintain cycling habits post-pandemic. A final set of questions asked about basic demographics. A copy of the final survey questionnaire and associated survey diagram has been included in the appendix.

A multistage sampling strategy, and snow-ball sampling, were utilized for the quantitative survey portion of this research study. The online survey was launched on February 19, 2021 and remained open for 120 days. Survey recruitment was done using advertisements on social media platforms, as well as through email distribution and organizational newsletters. For example, local cycling groups shared the survey with their members via social media and the local senior center included an invitation to the survey in their member newsletter.

Initial screening questions were used to identify individuals who cycled before the pandemic, individuals who started cycling, as well as individuals who did not ride either before or during the pandemic (non-cyclists). When the survey closed, 198 individuals who cycled before the pandemic, 13 individuals who started cycling, and 117 non-cyclists had completed the survey. For the current study, the analysis will focus on data gathered from the 198 previous cyclists in relation to COVID-19 impact on cycling habits, and the 198 previous cyclists + the 13 new cyclists in relation to maintaining habits post-pandemic.

Phenomenological phone interviews, with an emphasis on participants’ experiences of being an older cyclist during the COVID-19 pandemic (n = 24), helped further explore the initial quantitative results. Specifically, the interviews helped provide clarity as to why some individuals’ cycling habits were impacted by the pandemic, and others’ were unaffected.

A self-selecting sampling and a purposeful sampling process were used to identify participants for the qualitative phone interviews. Participants who completed the online survey were asked whether they would participate in a follow-up interview. Respondents who reported coincidental changes to their cycling habits were excluded from interviews due to time and resource constraints. After the self-selecting sampling process, where some individuals declined to participate, a total 24 semi-structured phenomenological phone interviews were conducted during the months of May and June 2021. An interview guide, informed by the findings from the quantitative survey, was used to present a series of open-ended questions to the participants. With participant approval, the phone interviews were recorded for note taking accuracy.

Survey sample characteristics

More males (57 %) than females (43 %) completed the survey. This finding coincides with the existing literature indicating that, within the U.S., more males than females cycle (Pucher & Buehler, 2010). The majority of the respondents fell into the 65–70 age group (54 %), with the 70–75 age group having the second largest representation (34 %).

Respondents were primarily white (94 %), educated, and of higher household income, with 43 % making more than $100,000/year. Roughly 30 % of the survey population had completed a 4-year college degree and 58 % had a graduate or professional degree. With the study’s focus on changes in cycling behavior during the pandemic and the findings indicating that most changes happened for those that were already cycling, the study design naturally skewed the sample or respondents towards a wealthier and whiter demographic that is typical among cyclists in the US, particularly when looking at recreational cycling (Dill & Voros, 2007; Moudon et al., 2005). When comparing the sample to other cycling research, we see that the sample aligns with the representation of older cyclists in other studies (Kachadoorian, 2021). Thus it is important to note that the survey sample characteristics point to the broader issue of diversity in cycling participation, and future research is needed to explore how to promote cycling among older, low-income populations, particularly in regard to encouraging older adults to pick up cycling where standard VTBC programs may not be enough.

When looking at employment and driver characteristics, 83 % were retired, 99 % had a valid Florida Driver’s License, and driving was their primary mode of transportation (97 %).

Regarding respondents’ time of residence in Tallahassee, 77 % of the respondents had lived in Tallahassee for 15 + years, and 6 % for their entire life. In an open-ended survey question, the respondents were asked where they lived prior to moving to Tallahassee. This question sought to identify whether the individual had recently relocated to Tallahassee from an area with a strong cycling culture or more supportive cycling environment, which could have impacted respondents’ cycling levels. Most moved to Tallahassee from other cities in Florida (50 %), followed by Georgia (8 %) and New York (5 %). As Florida as a whole is not considered to have a strong cycling culture, as indicated by the highest fatality rate per million residents (NHTSA, 2018) and low cycling commute share at 0.5 % (FDOT, 2016), it is not likely that the prior location of residence has a significant positive influence on the survey samples’ cycling levels.

Data analysis

A detailed analysis of the survey data was conducted where frequency of responses and confidence intervals of the population proportions were calculated. In order to explore sample averages, a series of one-sample t-tests and ANOVA (analysis of variance) tests were used to statistically assess as set of research hypotheses related to the COVID-19 pandemic’s impact on cycling:
1). Older adults’ average frequency of cycling remained constant.
   1a). The average frequency does not vary across groups

2). Older adults’ average distance of cycling remained constant.
   2a). The average distance does not vary across groups

3). Older adults do not plan to maintain their new cycling habits post-pandemic.
   3a). Their average intent to maintain habits does not vary across groups

A one-sample test assesses the direction of a hypothesis by determining the number of standard deviations in a t-distribution that a sample means deviates from a fixed value, usually zero. But within the present study, because 3 represents constant level or no change to respondents’ average cycling frequency/average trip distance, the fixed value, or test value, was set to 3. Analysis of variance (ANOVA) was then performed for each research hypothesis in order to identify differences in responses based on a series of control variables including basic demographics (age, gender, income, and education) and cycling characteristics prior to the pandemic (frequency, average distance, and bicycle type).

The 24 interview transcripts were analyzed using an inductive thematic analysis approach following Braun and Clarke’s step by step guide (2006). The fundamental principle behind thematic analysis is to identify, analyze and report patterned responses that portray something important in relation to the research questions (Braun & Clarke, 2006).

Findings and discussion

The subsequent section will focus on the findings from the quantitative portion of this study but will provide anecdotes from the qualitative analysis that support these findings. Combined, they provide us with a fuller understanding of COVID-19’s impact on participants’ cycling habits, and their intent to continue new cycling habits post-pandemic.

Cycling characteristics prior to the COVID-19 pandemic

The majority of respondents who cycled before the pandemic rode a conventional two-wheeled bicycle (89 %). E-bikes have the second largest representation (5.2 %), followed by recumbent bicycles (4.6 %). Most cycled on a weekly basis (61 %), followed by 3–5 times per week (30 %). Similarly, the average trip distance varied from as low as a few blocks up to 40 + miles, with 2–5 miles (20 %) and 5–10 miles (21 %) being the most frequently reported distances. When asking participants about their main reasons for cycling prior to the pandemic (check all that apply question), exercise (81 %) and recreation/enjoyment (73 %) were the two most frequently reported trip purposes, followed by to be social or for companionship (44 %).

Cycling frequency

As presented in Table 1, the quantitative findings suggest that 41 % of older adults who cycled prior to the pandemic reported no major changes to their cycling frequency. Roughly 33 % reported decreased frequency and 26 % reported increased frequency during the COVID-19 pandemic.

One factor that could help explain constant, or no significant changes in cycling levels, might be the type of cycling in which the study participants engage. From the qualitative interviews it was evident that respondents whose’ cycling habits had remained constant attributed this to cycling for recreation in ways that were unaffected by the pandemic. For example, by riding the same route in their local neighborhood on regular, or daily, basis. Thus, the pandemic did not change this cycling routine. This finding indicates a heterogeneous response among cyclists based on type of cyclists such as irregular vs regular cyclists:

“So, you know the kinds of bike riding that I’ve done. It just hasn’t been impacted. When I wanted too, when the weather was good, you know I didn’t sit there and worry, Should I go out or not? I just did my usual bike riding” (Carol, age 70–75, Personal Conv., May 2021).

When looking at sample averages, the t-test presented in Table 2 suggests a slight decrease in average cycling frequency among the study participants during the COVID-19 pandemic (Mean = 2.82, Mean Difference = -0.177, Standard Deviation = 1.194; t-value = 0.039). Note that the “mean difference” in Table 2 (and subsequent t-test results) refers to the absolute difference between the sample mean and 3, which is the Likert scale value indicating no change. Thus, a negative value in this case points to a reduction, on average, in cycling frequency. This finding was unexpected as it deviates from previous research, which points to an increase in cycling levels (Buehler & Pucher, 2021; de Haas et al., 2020; Rachadoorian, 2021; Teixeira & Lopes, 2020). However, as mentioned by other researchers (Möllers et al., 2021), the situational context in which this study is embedded likely played a role in the difference in research findings. For example, it is possible that the small, urban context, the low cycling levels, as well as the existing cycling environment contributed to a decrease rather than an increase in cycling. In addition, it is possible that retirement status of the sample population (83 % being retired) could have played a role in the outcome, where changes to remote work did not affect the sample population as for those still in the workforce.

Similarly, changes to the social aspect of cycling seemed to have negatively impacted older adults’ cycling frequency. As shown in Table 3, the most frequently reported reasons for cycling less (check all that apply question) were “group rides/events being cancelled” (27 %) or “no longer having anyone to ride with” (22 %). The “other” category (45 %) primarily comprised of reasons not related to the pandemic such as cycling less often due to health issues, weather concerns, no longer being interested in cycling, or cycling safety concerns due to increase in age and fear of severe injury.

Another possible reason that warrants further exploration is whether the age of the survey respondents contributed to a decrease, rather than an increase, in cycling frequency. For example, as older adults are considered one of the main risk groups for contracting COVID-19, it is likely that a fear of exposure negatively impacted older adults’ cycling frequency. As shown in Table 4 above, 22 % of the those who decreased their cycling frequency reported “feeling uncomfortable riding due to social distancing” as one of the main reasons for cycling less. Similarly, during the qualitative interviews it was evident that a fear of exposure to the COVID-19 virus made some older adults alter their cycling, both in terms of the type of riding, but also with whom they ride. For some, Table 1

| Item Category | Percent | N 95 % COI |
|---------------|---------|------------|
| Did you cycle more often during the COVID-19 pandemic? | I’m cycling much less often | 19.7 % | 39 | 14.2 % | 25.2 % |
| | I’m cycling somewhat less often | 13.1 % | 26 | 8.4 % | 17.8 % |
| | No change/Same as before | 41.4 % | 82 | 34.6 % | 48.3 % |
| | I’m cycling somewhat more often | 16.7 % | 33 | 11.5 % | 21.9 % |
| | I’m cycling much more often | 9.1 % | 18 | 5.1 % | 13.1 % |
| Total | | 100 % | 198* |

* Participants who cycled prior to the pandemic (does not include those who started cycling (n = 13)).
Table 2
One-Sample T-Test Results - Changes to Average Cycling Frequency.

| Item | N  | SD   | Mean | Mean Difference | 95% CI of Mean Difference | t-Statistic | p-value |
|------|----|------|------|----------------|--------------------------|-------------|---------|
| Did you cycle more often during the COVID-19 pandemic? | 198 | 1.194 | 2.82 | -0.177 | -0.34 to -0.01 | -2.083 | 0.039 |

Note: One Sample t-test; * p-value ≤ 0.05, test value = 3 meaning constant level or no change.

Table 3
Reasons for Cycling Less Often.

| Item | Category                                                                 | Percent of Cases (n = 64) | N** | 95% CI of Pop. Proportion |
|------|-------------------------------------------------------------------------|---------------------------|-----|--------------------------|
| What were your main reasons for bicycling less often? (Select up to 3) | The facilities I normally use are closed | 10.9% | 7 | 3.3% to 18.6% |
| | I now feel uncomfortable riding due to social distancing | 21.9% | 14 | 11.7% to 32.0% |
| | Streets/paths have become too busy with other cyclists | 7.8% | 5 | 1.2% to 14.4% |
| | I normally ride on the sidewalk and there are now too many people on them | 9.4% | 6 | 2.2% to 16.5% |
| | Events/group rides have been cancelled | 26.6% | 17 | 15.7% to 37.4% |
| | I no longer have anyone to ride with | 21.9% | 14 | 11.7% to 32.0% |
| | I no longer commute to work / volunteering | 1.6% | 1 | 0.0% to 4.6% |
| | Other (please specify) | 45.3% | 29 | 33.1% to 57.5% |

*Negative values has been set to 0.0%.
** Multiple response, thus the number is larger than the actual number of participants who cycled less often (n = 64).

Table 4
ANOVA - Average Cycling Frequency by Cycling Characteristics Prior to COVID.

| Item | Frequency Before | Distance Before | Bike Type |
|------|------------------|-----------------|-----------|
|      | F | p-value | F | p-value | F | p-value |
| Did you cycle more often during the COVID-19 pandemic? | 2.053 | 0.089 | 5.295 | 0.000* | 0.470 | 0.757 |

*p-value ≤ 0.05.

Table 5
Mean Comparison - Average Cycling Frequency by Distance Before COVID.

| What was your average trip length before the pandemic? | Category | N | Mean | Std. Deviation | Std. Error |
|-------------------------------------------------------|----------|---|------|----------------|------------|
| Did you cycle more often during the COVID-19 pandemic? | A few blocks | 7 | 1.57 | 0.976 | 0.369 |
| | No more than 2 miles | 21 | 2.19 | 1.123 | 0.245 |
| | Between 2 and 5 miles | 39 | 2.56 | 1.273 | 0.204 |
| | Between 5 and 10 miles | 40 | 2.98 | 1.291 | 0.204 |
| | More than 10 but fewer than 15 | 28 | 3.18 | 0.863 | 0.163 |
| | More than 15 but fewer than 25 | 19 | 3.79 | 1.084 | 0.249 |
| | More than 25 but fewer than 40 | 31 | 2.77 | 0.920 | 0.165 |
| | 40 or more miles | 9 | 2.44 | 0.726 | 0.242 |
| | Total | 194 | 2.81 | 1.191 | 0.086 |

exposure to the virus meant a complete cessation of cycling, particularly among those for which cycling was not their “passion” and felt that cycling was an unnecessary or risky activity:

“I didn’t ride a lot….but somebody mentioned that, with bicycling you can fall off and get hurt. If you did happen to do that, you might end up in the emergency room, in the hospital, or somewhere with lots of other people around. And that wouldn’t really be good in the world of COVID. So I decided that it probably would be better for me to do other kinds of exercise, rather than bicycle riding. At that time, that just kind of made sense, bicycle riding wasn’t like, my passion, it was just another kind of exercise that I liked….So I really didn’t do as much bicycle riding during the pandemic, as I would have if there was no pandemic” (Mary, age 65–70, Personal Conversation, June 2021).

These findings coincide with a study conducted in the Netherlands–65 (Mary, age 65–70, Personal Conversation, June 2021).
The sample is smaller than the previous 198 for cycling frequency because 34 individuals did not answer this particular question.

**Frequency Distribution of Ordinal Likert-Scale Data**

Table 8

| Did you cycle more often during the COVID-19 pandemic? | Age | Gender | Income | Education |
|------------------------------------------------------|-----|--------|--------|-----------|
| Did you cycle more often during the COVID-19 pandemic? | F   | p-value | F    | p-value  | F   | p-value  |
| Did you cycle more often during the COVID-19 pandemic? | 1.362 | 0.249 | 0.052 | 0.819 | 2.634 | 0.004* | 1.043 | 0.386 |

*p-value ≤ 0.05.

Table 7

Mean Comparison – Average Cycling Frequency by Income Group.

What was your annual household income before taxes in the most recent tax year?

| Category | N | Mean | Std. Deviation | Std. Error |
|----------|---|------|---------------|------------|
| Less than $10,000 | 2 | 3.00 | 0.000 | 0.000 |
| $10,000 - $19,999 | 4 | 2.00 | 1.155 | 0.577 |
| $20,000 - $29,999 | 7 | 2.43 | 1.134 | 0.429 |
| $30,000 - $39,999 | 11 | 2.73 | 1.191 | 0.359 |
| $40,000 - $49,999 | 11 | 2.99 | 0.944 | 0.285 |
| $50,000 - $59,999 | 19 | 3.05 | 1.508 | 0.346 |
| $60,000 - $69,999 | 12 | 1.67 | 0.888 | 0.256 |
| $70,000 - $79,999 | 19 | 2.95 | 1.079 | 0.247 |
| $80,000 - $89,999 | 7 | 2.86 | 0.900 | 0.340 |
| $90,000 - $99,999 | 10 | 2.70 | 0.949 | 0.300 |
| $100,000 - $149,999 | 46 | 3.04 | 1.032 | 0.152 |
| $150,000 or more | 32 | 3.34 | 1.335 | 0.236 |
| Total | 180 | 2.84 | 1.204 | 0.990 |

The increase in cycling frequency than respondents of other income groups ($F(11,168) = 2.634, p-value = 0.004$). Table 7 indicates that the group mean was lowest for respondents with a family income of $60,000 - $69,999, meaning these individuals were more likely to report a decrease in their cycling frequency. Based on the existing literature, it is likely that socio demographic differences in cycling characteristics could help explain this finding. For example, research shows that individuals with higher household incomes are more likely to cycle for exercise and recreation compared to lower income groups, where utilitarian cycling represents a higher share of cycling (Pucher et al., 2011). Further, as utilitarian cycling is known to have decreased during the pandemic due to a reduction in overall travel (de Haas et al., 2020; Möllers et al., 2021), it is likely that the difference in income groups could be partially explained by a decrease in utilitarian cycling. However, the present study did not seek to differentiate in utilitarian vs recreational cycling during the data collection and thus, cannot provide any further insight into this. This is a noted limitation of the existing study. ANOVA tests showed no other significant differences in the means among socio-demographic groups such as age, gender, and education.

**Average distance per trip**

As shown in Table 8, the majority of participants who cycled prior to the pandemic reported no major changes to their average trip distance during the time of the pandemic (65%). However, when looking at sample averages a moderately significant t-test, presented in Table 9, suggests a slight increase in respondents’ average distance per cycling trip ($Mean = 3.1, Mean difference = 0.104, Standard deviation = 0.788; p-value = 0.094$). This finding corresponds with another study conducted in the Netherlands where the average distance of cycling “round trips” or “tours” (meaning that they start and end at the same place) increased by 30% during the time of the pandemic (de Haas et al., 2020).

Some factors that could have contributed to an increase in trip distances are reductions to other obligations and increased time-flexibility as a result of social distancing practices, lockdowns, and self-isolations. When asking participants about their main reason for cycling longer distances, “having more time to ride” represented 37% of the cases. This was also evident from the themes that emerged during the phone interviews where participants mentioned having more time to ride but also pointed to increased flexibility in finding cycling companions. Some mentioned that cycling was one of the few things to do during the pandemic. Thus, in some cases the restrictions to other activities spurred an increase in cycling.

Another factor that might have contributed to an increase in average distances is a reduction in vehicle traffic stemming from remote work and school/office closures. It is possible that this, in turn, allowed older adults to explore new, longer routes that they didn’t previously consider riding. In addition, with less traffic on the roadway, regular recreational trips could likely travel at faster speeds, resulting in an increase in overall cycling distance. However, the existing study showed mixed result related to this. Only 9% of those indicating increased cycling...
distance gave “there are less cars on the road” as the reason (Table 10). However, some of the interviewees mentioned being able to explore new routes, which increased their average trips distance. As one example:

“So it was just that, all of a sudden, you could ride on the streets, feel safe, get a good workout. So my cycling increased tremendously during the initial part of the pandemic” (Deborah, age 65–70, Personal Conversation, June 2021).

ANOVA tests showed no significant differences in the means among sociodemographic groups or based on respondents’ cycling characteristics prior to the pandemic.

Maintain habits post-pandemic

As shown in Table 11, the findings suggest that most older adults who reported positive changes to their cycling habits, including new cyclists, plan to maintain these “new” habits post-pandemic (79%). Similarly, Table 12 presents the results from the t-test which suggest that respondents on average plan to maintain their new cycling habits post-pandemic (Mean = 4.16, Mean difference = 1.156, Standard deviation = 0.99, p-value = less than 0.001). This indicates that incentivizing older adults to “try out cycling” could lead to new habit formations. Further, this finding coincides with a national study looking at people of all age groups where new cyclists expressed intent to keep cycling in the coming year (People for Bikes, 2021). Although, in the present study an intent to maintain their new cycling habits post-pandemic (79%) compared to men for women was 4.47 compared to the group mean for men of 3.87. This finding was unexpected and could indicate that “trying out cycling” might have a greater influence on new habit formation for women. As stated in the existing literature, women are often less likely to cycle compared to men (Pucher & Buehler, 2008, 2010; Sahlqvist & Heesch, 2012) and women are also more likely to report barriers to cycling, including both physical and social barriers (Grimes et al., 2020; Van Bekkum et al., 2011). Consequently, Sahlqvist & Heesch (2012) argue that promoting cycling among women and other underrepresented cohorts, such as older adults, should be made a priority in order to reduce the cycling gender-gap. Thus, the findings from the present study suggest that encouraging older women to “try out cycling” might not only prove instrumental in promoting cycling among this cohort but could help reduce the gender-gap in overall cycling participation. However, additional research is warranted to further explore this concept in greater detail.

ANOVA tests showed no other significant differences in the means among sociodemographic groups or based on respondents’ cycling characteristics prior to the pandemic.

Overall, there was a consistent theme of positivity among the

As presented in Table 13, ANOVA suggests a significant difference in the means among males and females regarding respondents’ plans to maintain their new cycling habits post-pandemic (F(1,73) = 7.317, p-value = 0.008). Table 14 indicate that women were more likely to respond strongly agree (5) when asked if they plan to maintain their new cycling habits post-pandemic compared to men. The group mean for women was 4.47 compared to the group mean for men of 3.87. This finding was unexpected and could indicate that “trying out cycling” might have a greater influence on new habit formation for women. As stated in the existing literature, women are often less likely to cycle compared to men (Pucher & Buehler, 2008, 2010; Sahlqvist & Heesch, 2012) and women are also more likely to report barriers to cycling, including both physical and social barriers (Grimes et al., 2020; Van Bekkum et al., 2011). Consequently, Sahlqvist & Heesch (2012) argue that promoting cycling among women and other underrepresented cohorts, such as older adults, should be made a priority in order to reduce the cycling gender-gap. Thus, the findings from the present study suggest that encouraging older women to “try out cycling” might not only prove instrumental in promoting cycling among this cohort but could help reduce the gender-gap in overall cycling participation. However, additional research is warranted to further explore this concept in greater detail.

ANOVA tests showed no other significant differences in the means among sociodemographic groups (age, income, and education), and no significant differences were found by cycling characteristics prior to the pandemic.
opportunity to break previous habitual patterns occurs. In sum, it is safe to assume that changing incentives could lead to new mode choice decisions, it is safe to assume that changing incentives could lead to new mode choice habits among this cohort.

Voluntary travel behavior change (VTBC) programs have been demonstrated to be an effective way of altering travel behaviors among the general population (Fuji et al., 2009; Moser & Bamberg, 2008; Richter et al., 2011). Similarly, education and training programs have positively affected older adults’ confidence and experience using other modes after they stop driving (Bryanton & Weeks, 2014; Musselwhite, 2010; Pellerito, 2009). Thus, the present study provides insight that could be used to design VTBC programs aimed at encouraging cycling among older adults. Such programs would not only have a positive effect on older adults’ travel behaviors but could also be a useful tool for integrated health, wellness, and active living programs by promoting physical activity through active transportation. Some main takeaways for policy might include:

**Policy implications**

Based on the findings from this study and the existing literature related to habits’ role in mode choice decisions, it is safe to assume that new travel habits could be formed among older adults, particularly if an opportunity to break previous habitual patterns occurs. In sum, it is safe to assume that changing incentives could lead to new mode choice habits among this cohort.

Establishing “Try It Out” Cycling Programs for Older Adults –

The findings from this study suggest that changing incentives and exposure to new experiences can lead to changed travel behavior among older adults. Thus, establishing opportunities for older adults to try out cycling might be instrumental for promoting cycling among this cohort. Such programs could be accomplished through partnerships with local senior centers, active living communities, 55+ communities, or even through assisted living facilities if the right support is provided for safe cycling. Similarly, providing older adults with opportunities to try out different types of bicycles such as e-bikes, tricycles, or recumbent bicycles should be promoted to increase cycling for all. Expanding bicycle share programs to include a wider variety of bicycles could be one way to accomplish this.

Cycling as Social Opportunities –

As the social aspect of cycling was a reoccurring theme within the study, promoting and encouraging senior group rides or cycling buddy programs should be established as part of a successful VTBC program. Similarly, encouraging gyms, senior centers, or active living communities to establish outdoor cycling programs for older adults might allow older adults to connect with other cyclists. For example, in the present study, interviewees spoke of social relationships’ role in serving as a motivator for starting cycling during the pandemic, cycling more frequently or longer, as well as for overcoming lack of motivation to keep cycling post-pandemic. Consequently, increasing opportunities for safe cycling in groups, such as senior group rides or cycling buddy programs, might be essential for promoting cycling among older adults long term.

**Targeting “Windows of Opportunities”** –

The findings suggest that, in some cases, the external life event or “window of opportunity” brought on by the COVID-19 pandemic led to the formation of new cycling habits among older adults. Thus, the findings add to the existing literature suggesting that certain life events can trigger a change of habits and thus lead to a change in travel behaviors. Establishing VTBC programs that promote active modes of travel during these external life events, such as retirement or a move, might be particularly useful. For example, cycling could be promoted during retirement in the form of receiving of a bicycle, or free bike share programs for older adults, similar to transit fares being subsidized, or even free, for those aged 65+. Another model would be to offer the above-mentioned “try it out” cycling programs during these external life events, in turn making them more effective. For example, by specifically targeting those who recently relocated to another area, moved into an active living community, or those entering retirement age, when establishing a “try it out” cycling program for older adults.
Continued Motivation and Repetition – VTBC programs based on motivation and repetition might be needed for older adults to form new, long-term travel habits. The findings from this study support the theory that social relationships can have an impact on individuals’ health behaviors over the life-course (Umberson et al., 2010). Further, it is likely that the social aspect of cycling could play a vital role in altering travel habits by offering continued motivation and repetition, which in turn are cited in the literature as critical components for new travel behaviors to become habitual (Lally & Gardner, 2013). Although offering and expanding social opportunities could aid in new habit formation, the existing literature also indicates that specific, attainable goals, followed by a goal implementation plan, might be needed for new travel habits to fully form (Garling et al., 2002; Garling & Schiutema, 2007). Thus, establishing some type of cycling program where older adults could be equipped with a bicycle that meets their needs, based on a stipulation to replace a set number of car trips with cycling trips, might be particularly useful for creating new cycling habits.

Conclusions

Although the majority of the survey respondents did not report any significant changes to their cycling habits during the COVID-19 pandemic, the findings suggest that, in some cases, new habits of cycling more often and longer distances were formed. Although future research is needed to explore differences between planned and actual outcome of maintaining habits post-pandemic, the findings from this research might serve as evidence that changing incentives and exposure to new experiences can lead to changed travel behavior among older adults. This study adds to the literature on regional heterogeneity in COVID-19’s impact on cycling, indicating a less pronounced impact among older adults residing in a small urban area. As the majority of the of the existing literature related to older cyclists has been conducted in Europe’s more cycling friendly cultures, the present study adds valuable knowledge related to cycling participation among older adults residing different contexts This in turn can be used to broaden our understanding of similarities and differences in cycling participation and promotion for various settings and age groups. In sum, the study suggests that encouraging cycling in small, auto-centric urban areas like Tallahassee might prove challenging but not impossible if older adults are exposed to positive cycling experiences.

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Kristin Gladwin: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Project administration. Michael Duncan: Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trip.2022.100675.

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