Research Brief:

The Changing Impacts of the COVID-19 Pandemic on Individuals and Households in the U.S.

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Smart Pandemic Management

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Introduction

This brief describes findings from a research effort to understand the changing impacts of the pandemic upon households from different places and backgrounds living in the United States. We investigated the effects of the pandemic along with pandemic-based restrictions and rules on people's behavior along with their mental and emotional health, social relations, and livelihoods. Unlike other research efforts, as far as we are aware this effort is the only one to join passive data from cell phones with survey information collected from the same individuals over time. We combined these data with a county-by-county inventory of pandemic rules and regulations regarding shelter-in-place, and mask wearing.

We have two sets of findings: one regarding attitudes and preferences, and the other regarding economic impacts of the pandemic.

Pandemic behavior and attitudes

1. Those not wearing masks move around more
2. Though conservatives are more risk-taking, their movement is similar to that of liberals
3. Unwillingness to be vaccinated has increased, and travel trends suggest COVID-19 transmission consequences

Economic impacts of the pandemic

4. Economically-impacted households are more depressed and have not been able to reduce their travel
5. Poor accessibility has affected more vulnerable households
6. More households are moving residences, largely for reasons of economic precarity

Below we describe our data collection efforts, and then describe the findings above in more detail.

Data

We merged three types of data, starting with basic demographic information along with survey responses and passive data from the mobile telephones of the survey respondents. Our respondents are drawn from a panel maintained by Embee Mobile, a private vendor and partner in this research. Embee Mobile enables us to repeatedly survey the same subjects with some churn and receive their passive mobile telephone data going back to 2019. We sampled from the panel maintained by Embee to conduct a survey as described below. Figure 1 illustrates our data collection timeline.

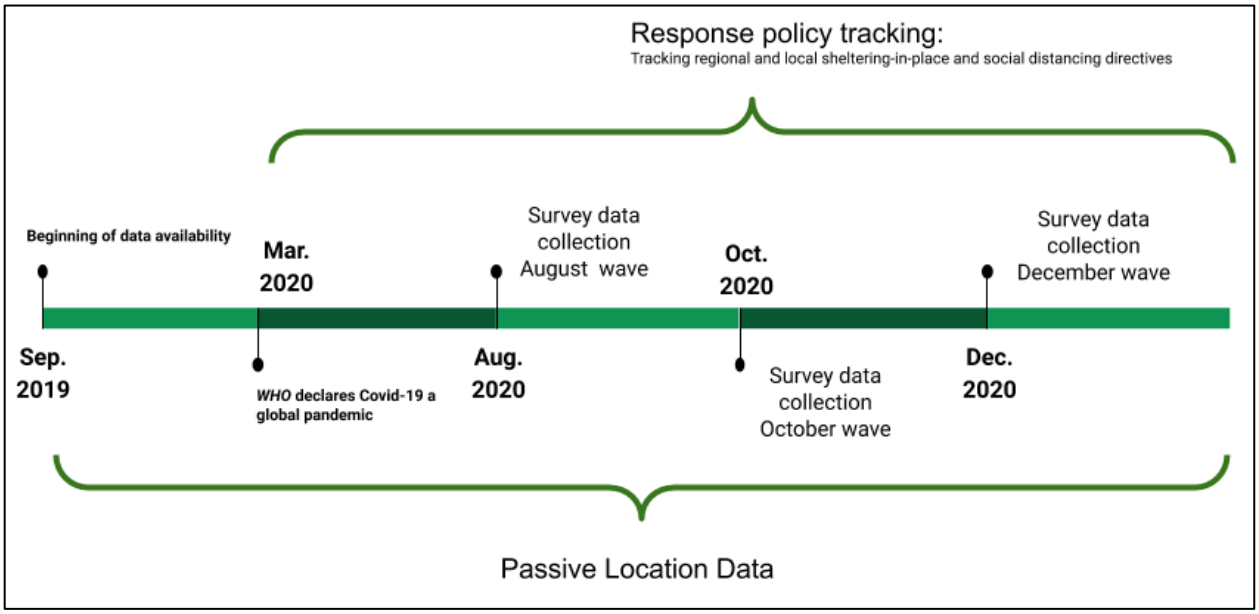


Figure 1: Data collection timeline

Basic demographics and Passive data: Embee Mobile continuously collects passive data from the cell phones of its panel participants, including point of interest (POI) location data and app use. The company maintains a panel of more than 100,000 individuals living across the United States, providing customized targeting of its panel based on client interest. The panel is intended to be representative of the US population that owns smartphones (Embee Mobile, 2021). The POI data include the geographical locations visited by each panelist including the names and types (restaurant, retail, administrative, etc.) of places visited, the duration of each visit, the distance and time traveled to get to each POI, and its geolocation.

Survey: When targeting the panelists, we tried to obtain a sample representative of the US population, both demographically and geographically. The geographic locations of the panelists spanned 191 metropolitan and rural counties across the US. The first ("August") wave of the survey, conducted from August 3 to September 13, 2020, was fielded to approximately 13,000 panelists, with a response rate of approximately 10 percent, with 1,294 completed survey responses. The August questionnaire collected socioeconomic data as well as information on travel, housing conditions, social distancing behavior, mask use, willingness to be vaccinated, political leanings and ideology, housing conditions,

news consumption, physical health, mental health, economic precarity, and a set of questions about attitudes towards stay-at-home orders, non-essential business closures, economic government response, and effectiveness of mitigation strategies.

We distributed the second wave of the survey primarily in October 2020 (beginning in late September and ending November 2) and received approximately 800 repeat responses. We also added approximately 300 new individuals to replenish the panel. The October questionnaire included additional questions relating to change in the residential locations of respondents, attitudes towards the vaccine development process, experience of natural disasters, and the presence of individuals within the respondents' household who are in educational programs. The third wave of the survey was initiated in early December 2020 and finished in January. Those data are yet to be analyzed.

Regulations: We tracked county level stay-at-home and face covering mandates in 191 counties across 35 states (Figure 2, below) from March 2020 to November 2020. The coverage area consists of the counties that are home to the subset of the Embee panel that we surveyed. This area represents about 30 percent of the US population, and includes large metropolitan areas such as Los Angeles, Chicago, Houston, Phoenix, Dallas, New York, Seattle, San Jose, Detroit, and Philadelphia.

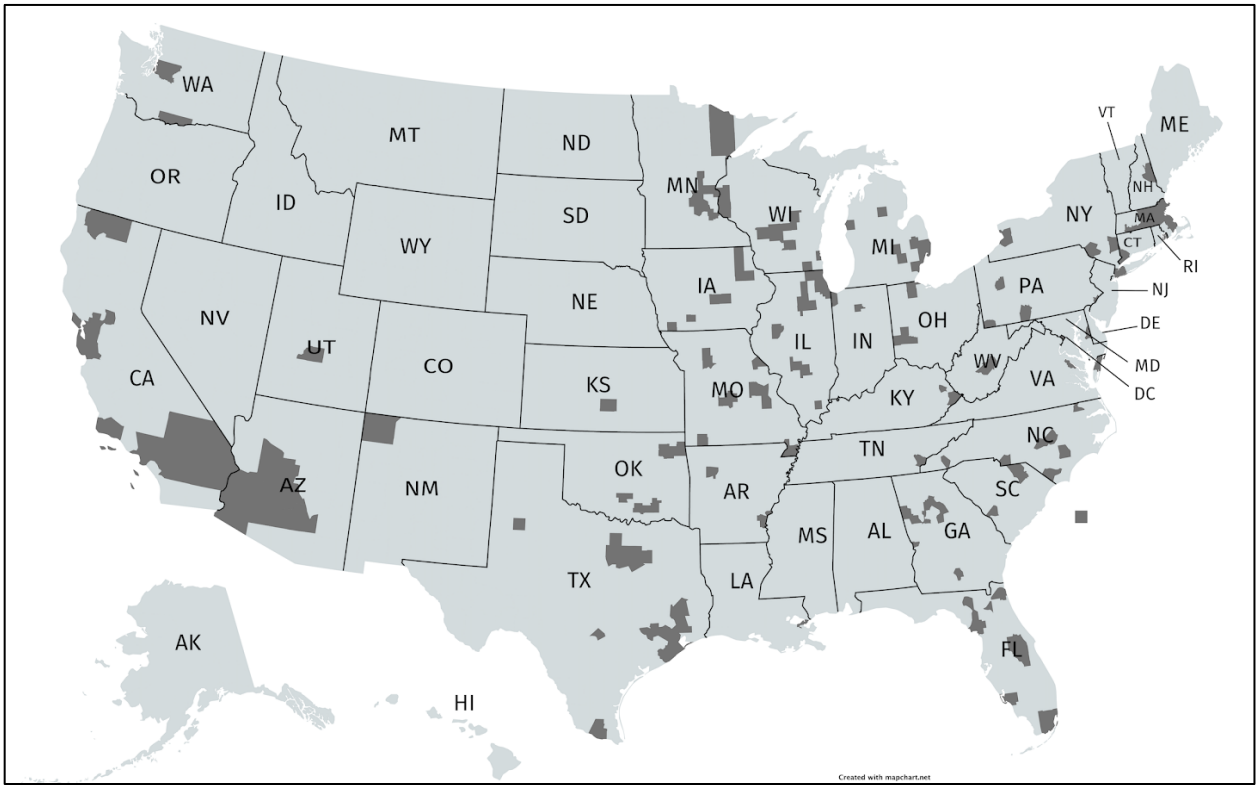
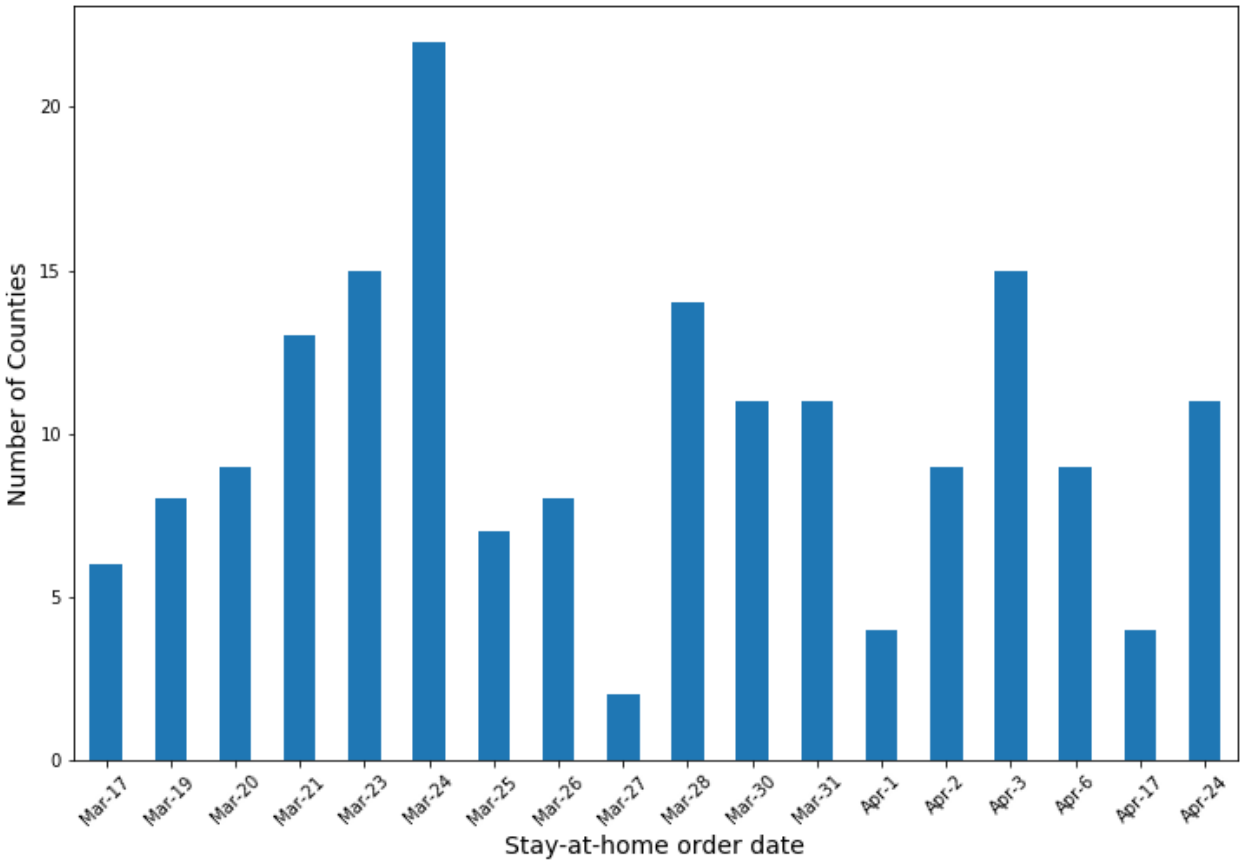


Figure 2: County-level regulation tracking, coverage area

As part of this effort, we kept track of the start and end dates of mandates related to face coverings, stay-at-home orders, and curfews at the state and county levels. Figure 3 shows the distribution of the start dates of the county level stay-at-home orders. The variation in the timing of those mandates at the county and state levels will allow us to answer additional research questions in future research; for example, whether government mandates improve compliance with public health measures and recommendations aimed at reducing the spread of COVID-19.



*13 of the 191 counties that we tracked did not have stay-at-home orders in place

Figure 3: County-level stay-at-home order start dates

To the best of our knowledge, this is the only academic research study that combines passive data with a longitudinal survey and regulation tracking. This approach enables a more comprehensive picture of the change in COVID-19 related behaviors and attitudes. The study is ongoing, with the anticipated deployment of the survey in subsequent waves to obtain a more complete picture of such changes.

Panel demographics

Our panel is generally representative of the US population. It oversamples by sex, with 59 percent female respondents. A higher share of our pool has a high school education, at 96 percent, compared to 89 percent of the US population (U.S. Census Bureau 2020a). About 20 percent of our survey respondents are Hispanic/Latinx, as compared to 18.5 percent for the US as a whole (U.S. Census Bureau 2019). Our sample also over-represents non-White respondents, with 54 percent of our sample reporting as White/Caucasian as compared to 72 percent for the US as whole. Eighteen percent of our sample is Black/African American, compared to 13 percent in the US; and seven percent of our sample is Asian or Pacific Islander, compared to 6 percent in the US (Figure 4, below).

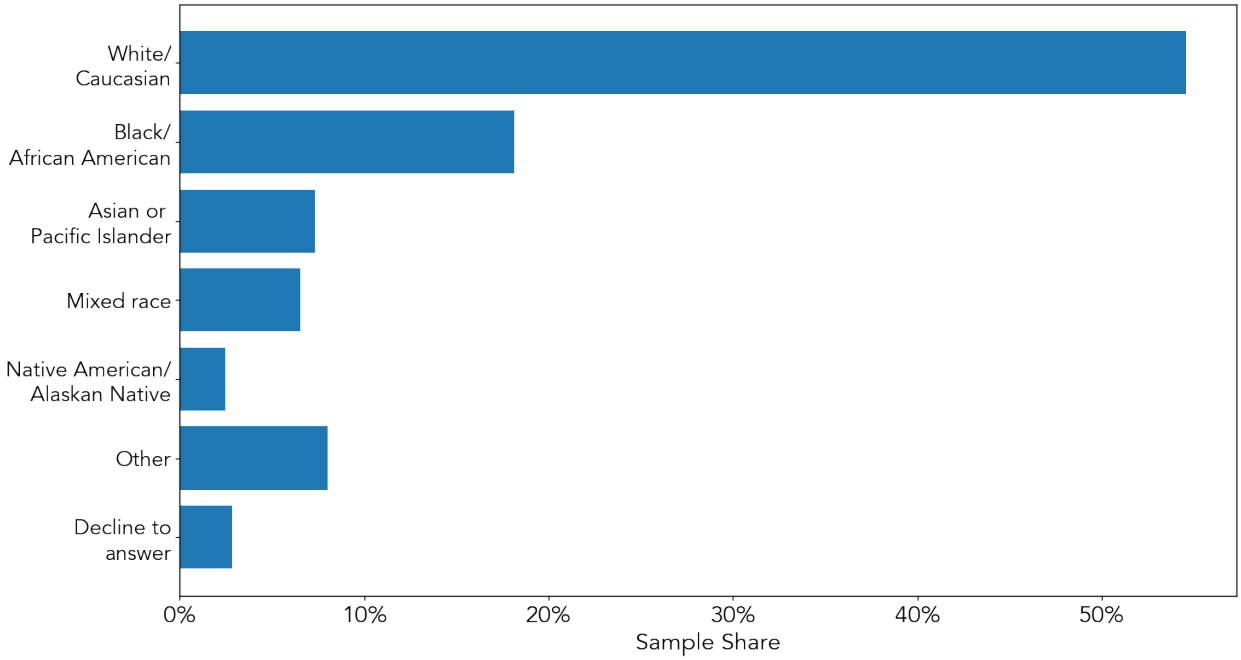


Figure 4 - Racial breakdown of respondents (August wave)

Findings

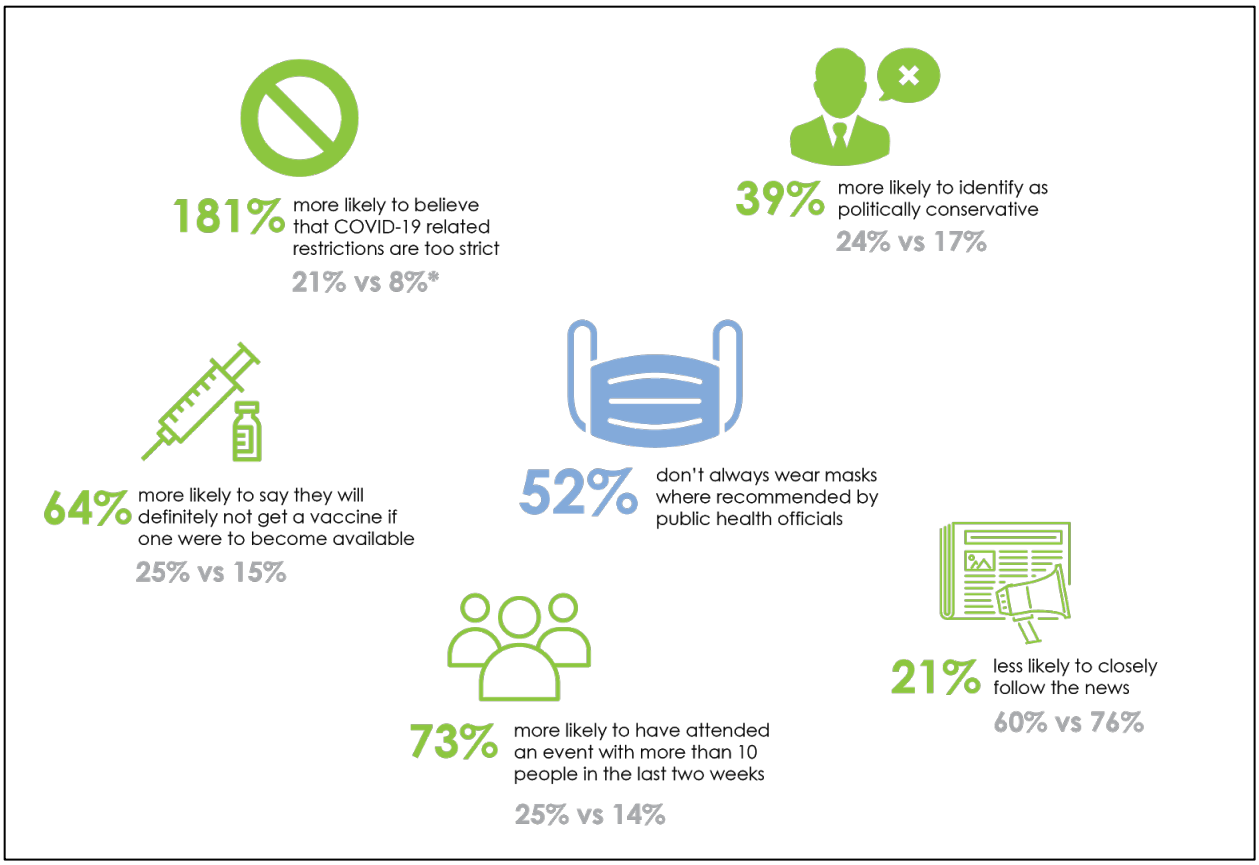
On the next pages we describe findings looking at subgroups of our survey respondents, along with passive data on movement. We focus on two primary topics. The first is pandemic behaviors and attitudes, including individuals who do or do not comply with mask-wearing guidelines, conservatives versus liberals, and people who are willing or unwilling to be vaccinated. The second is the economic impact of the pandemic, including individuals facing economic precarity, those with and without good transportation access, and those who have moved residences during the pandemic.

Section 1: Pandemic Behaviors and Attitudes

Finding 1: Those Not Wearing Masks Move Around More

About 75% of our panel report wearing a mask when indoors in a place other than the home, a percentage similar to the national 80% reported elsewhere (Smith 2020), while over half of our panel respondents report that they do not always use masks in all recommended situations (Figure 5, below). The share of those who do not always wear masks in recommended situations declined slightly from 55 to 52 percent between August and October, but remained quite high in our panel. These individuals are almost twice as likely to believe that COVID-19 restrictions are too strict. Some of their behavior is also different from the rest of the surveyed panel members; they are about 73 percent more likely to have attended a crowded event in the two weeks prior to the survey, and about 64 percent more likely to state they do not plan to be vaccinated (Figure 5, below).

We looked at the difference in the number of trips per week from smartphone location data, comparing those who report wearing masks and those who do not (Figure 6, below). Those who report not consistently wearing masks also travel significantly more, an interesting finding that suggests a magnification of COVID-19 risk and exposure.



*Greyed out percentages correspond to the comparison between people who do not always wear masks where recommended and the rest.

Figure 5: Characteristics of panel respondents who do not comply with mask wearing recommendations relative to those who comply (n=408)

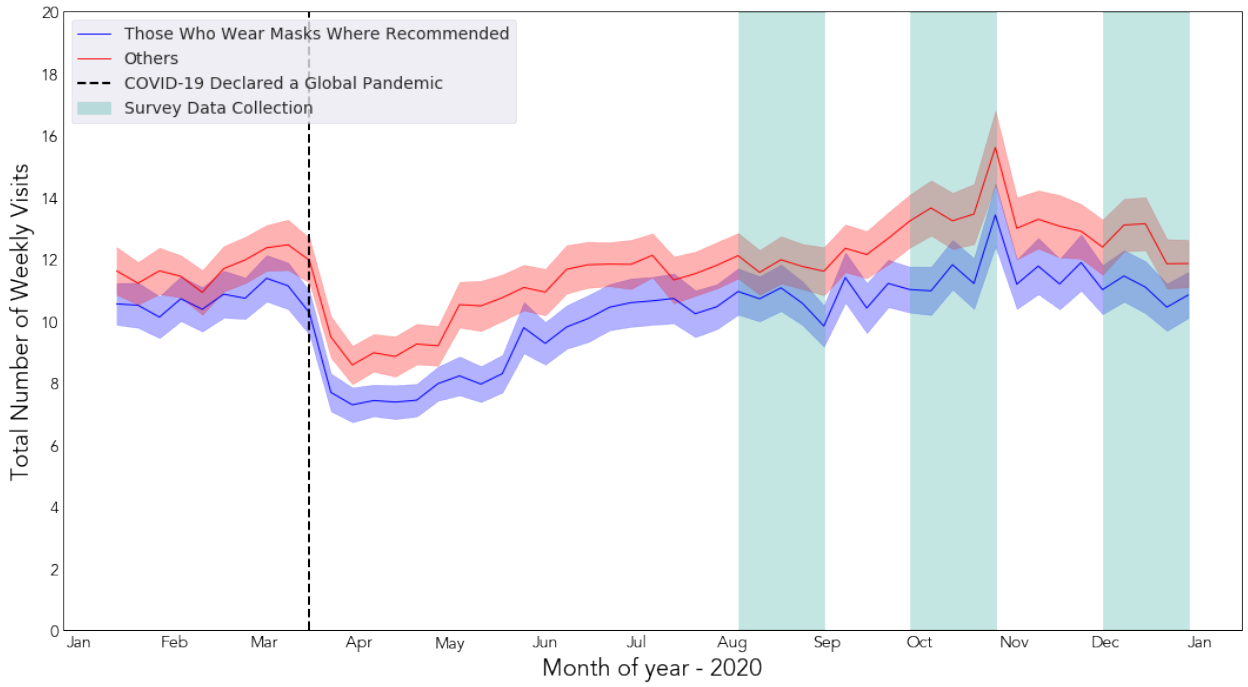


Figure 6: Weekly number of visits vs. mask-wearing compliance - 95% confidence interval (n=1,245)

We also looked over time at respondents who improved or decreased their mask wearing behavior between the August and October waves (Figure 7, below). The "improved mask behavior" group are those who did not report always wearing a mask in the first survey, but did in the second survey. The "reduced mask behavior" group are those who reported always wearing masks in the first phase, but did not in the second survey. Those with reduced mask wearing behavior had greater movement by the end of 2020.

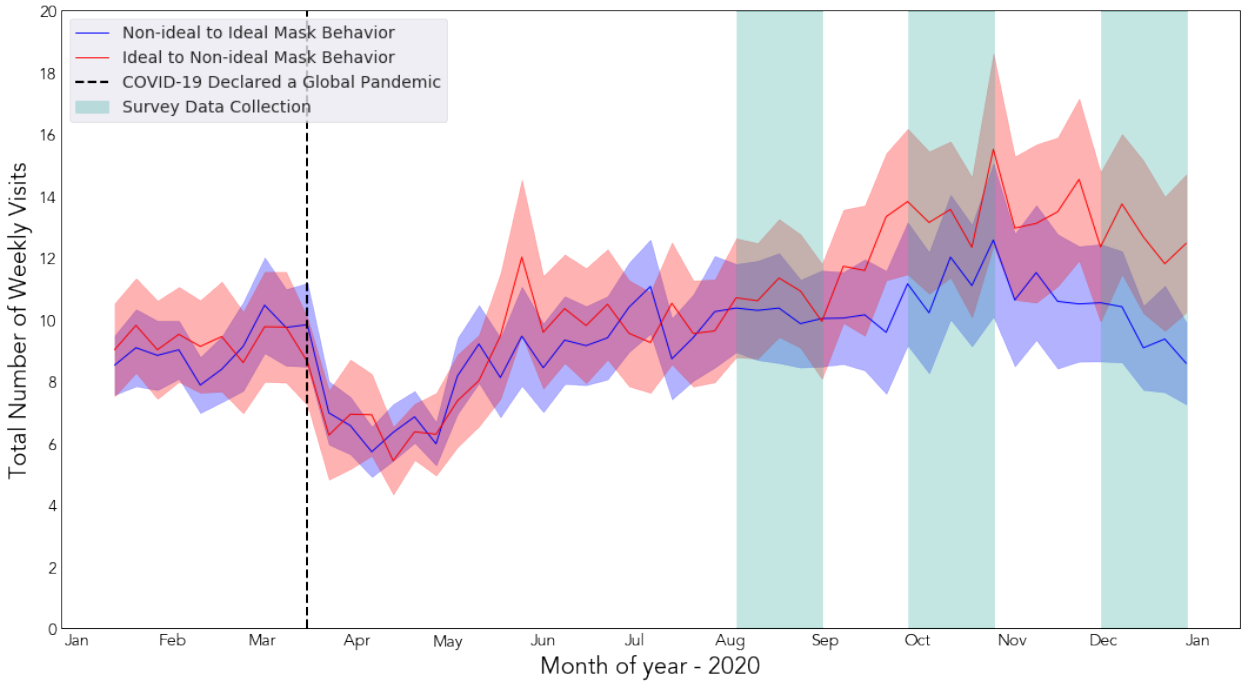


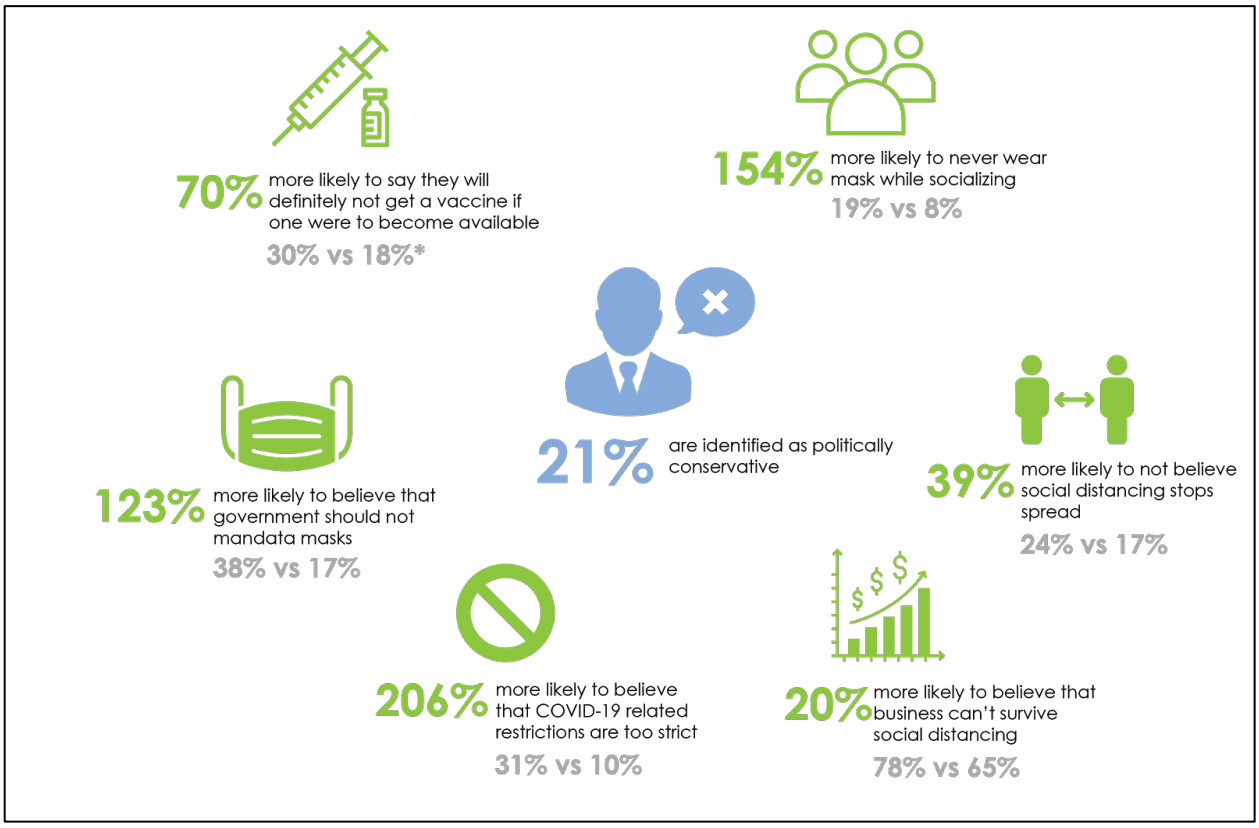
Figure 7: Mobility of those with improved vs. reduced mask-wearing behavior between the August and October waves (n=207)

Finding 2: Though Conservatives are More Risk-Taking, Their Movement is Similar to That of Liberals

On our panel in the August survey about 23 percent identified as liberal, 19 percent as conservative, and 40 percent as moderate. This changed slightly in the October data, with 21 percent identifying as politically conservative. The panel over-represents moderates and under-represents conservatives, compared to the nation as a whole. According to Gallup, approximately 26 percent of Americans identify as liberal, 35 percent as conservative, and 26 percent as moderates (Gallup, 2019).

Our survey shows that self-identified conservatives are much more likely to not wear masks, to believe that COVID-19 restrictions are too strict, and to report having attended a gathering of more than 10 people during the pandemic (Figure 8, below). These findings are consistent with media reports. Self-identified political moderates appear equally in both the mask wearing and non-mask wearing camps.

However, while passive data on movement outside the home show some differences consistent with higher risk taking among conservatives, these are not statistically significant. Movement outside the home by self-identified Republicans is somewhat higher than that of Democrats during parts of the year, but not in a statistically significant sense by the end of 2020, and the same is true of conservatives versus liberals (Figures 9 and 10, below). This runs contrary to the other risk-taking behavior of conservatives and to the standard media portrayal.



*Greyed out percentages correspond to the comparison between people who are identified as politically conservative and others.

Figure 8: Characteristics of panel respondents who are self-identified as conservatives (n=162)

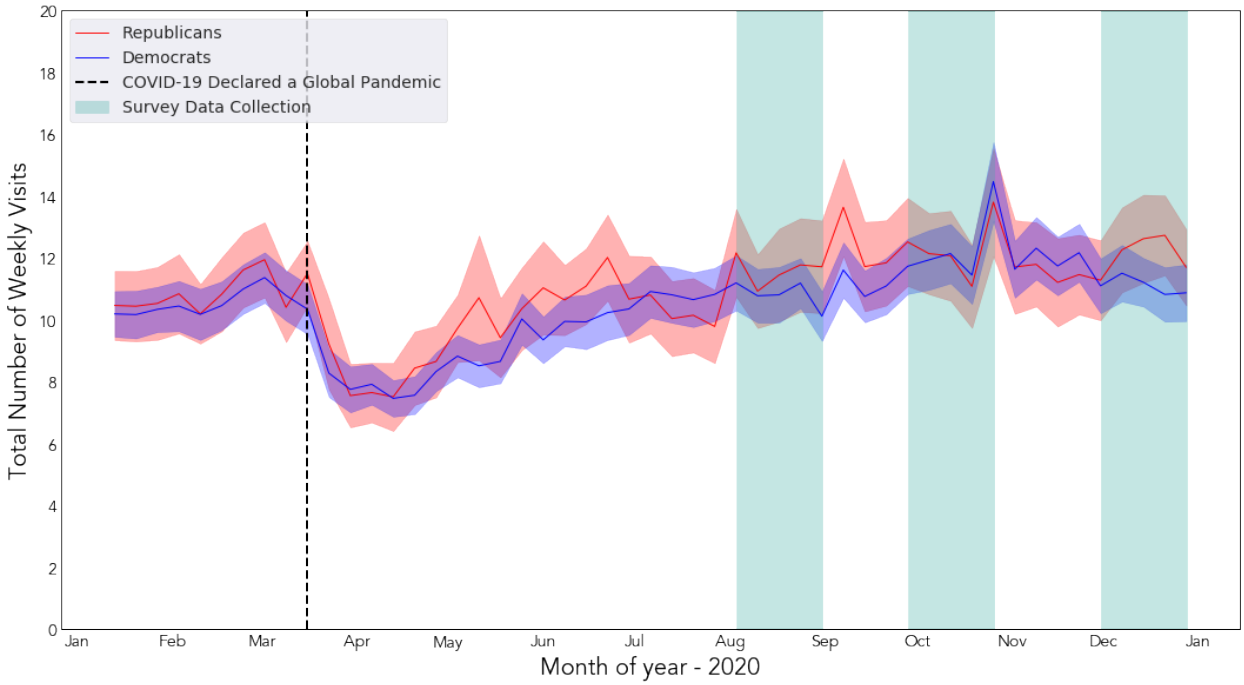


Figure 9: Weekly number of visits for Republican and Democrat panelists - 95% confidence interval (n=646)

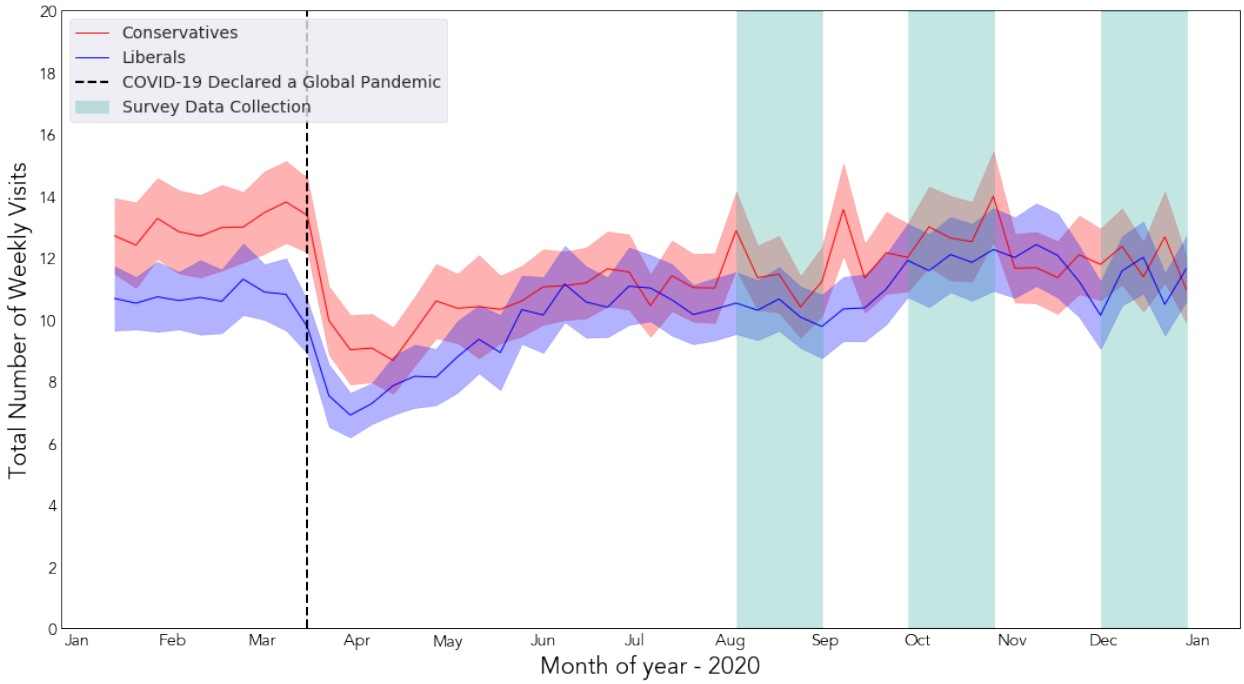
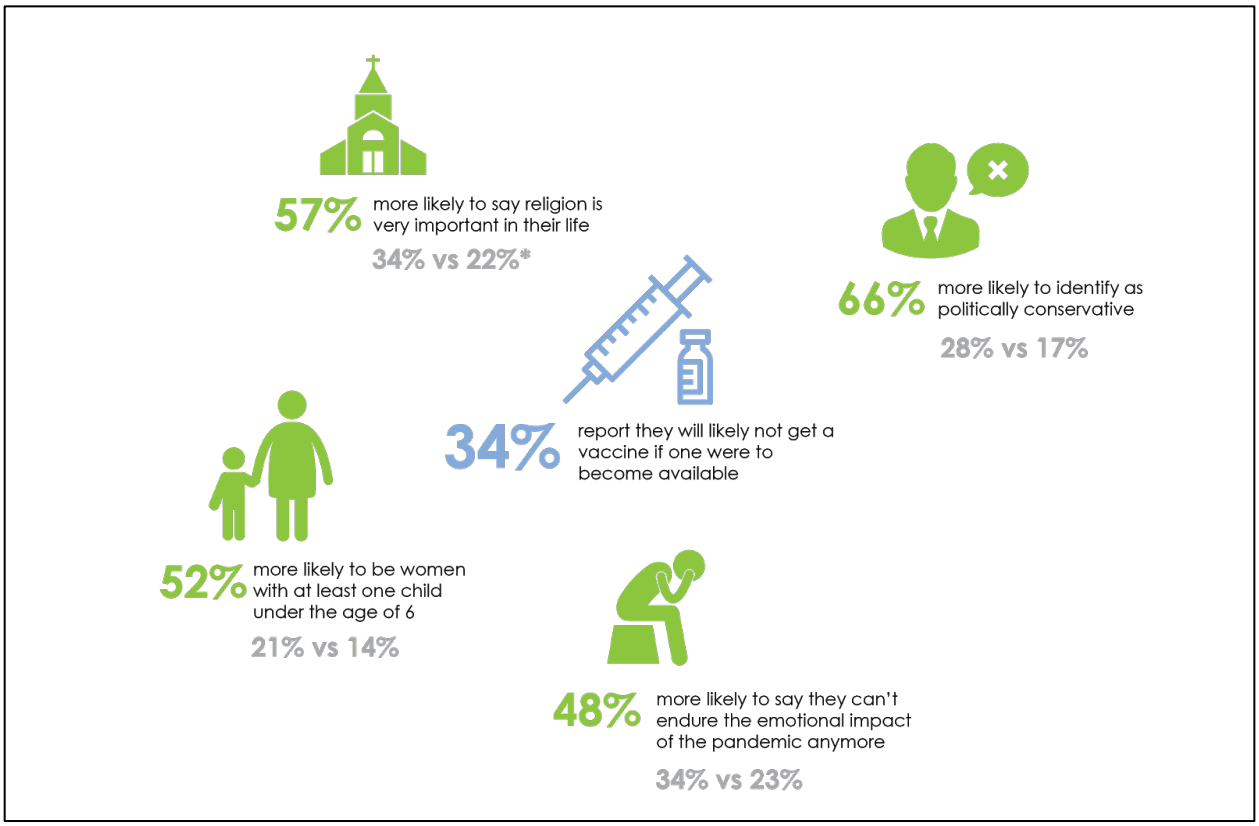


Figure 10: Weekly number of visits for Conservative vs Liberal panelists - 95% confidence interval (n=540)

Finding 3: Unwillingness to be Vaccinated Has Increased, and Travel Trends Suggest COVID-19 Transmission Consequences

More than a quarter of our panel (28 percent) in the initial August 2020 survey said that they were not willing to get a vaccine when it becomes available, and this increased to 34 percent in the October survey. This group is 66 percent more likely to identify as conservative, 57 percent more likely to report they are religious, 52 percent more likely to be female caregivers to a young child, and 48 percent more likely to report that they cannot endure the economic impact of the pandemic (Figure 11, below).



*Greyed out percentages correspond to the comparison between people who reported they would probably not/definitely not get a vaccine and the rest.

Figure 11 - Characteristics of vaccine-hesitant panelists (n=268)

The willingness to be vaccinated decreased among our panel respondents. Between the August and October surveys, the share of respondents who reported that they would *definitely* be getting vaccinated dropped from about 30 percent to about 20 percent. This finding appears consistent with other studies. Among people who report being unsure about the vaccine or unlikely to receive it, 75 percent stated they were concerned about its side effects. Furthermore, approximately 75 percent of respondents in the second wave report being concerned about rapid development of the vaccine without fully establishing safety and efficacy.

The racial breakdown of people who reported being certain of getting vaccinated in August and reported being uncertain in October is similar to the overall sample. Fifty-one percent of these

individuals are White/Caucasian, compared to 54 percent in our sample, and 19 percent are Black/African American compared to 18 percent in our sample. Democrats are slightly overrepresented in this group compared to our sample; as 44 percent of this group identifies as Democrat compared to 40 percent in our sample, and only 10 percent as Republican compared to 17 percent in our sample.

The racial breakdown of people who, in August, reported being likely or certain to get vaccinated, and changed their responses to "unlikely to" or "certain not to" get vaccinated in October is quite different from the overall sample though statistical significance is not large due to sample size. Forty-two percent of these individuals are White/Caucasian, compared to 54 percent in our sample, and 40 percent are Black/African American compared to 18 percent in our sample. Democrats are also overrepresented, as 52 percent of these individuals identify as Democratic and only 10 percent as Republican compared to 40 percent and 17 percent in our sample, respectively.

Figure 12 (below) illustrates the mobility trends for people based on their willingness or unwillingness to get vaccinated. The differences in current rates of travel among those unwilling to get vaccinated are either slightly higher or not statistically significantly different than those who are willing to receive a vaccine. This suggests additional reason for concern about the risks associated with the unvaccinated population, since these individuals appear to be out and about at least as much as the vaccine-willing segment of the population.

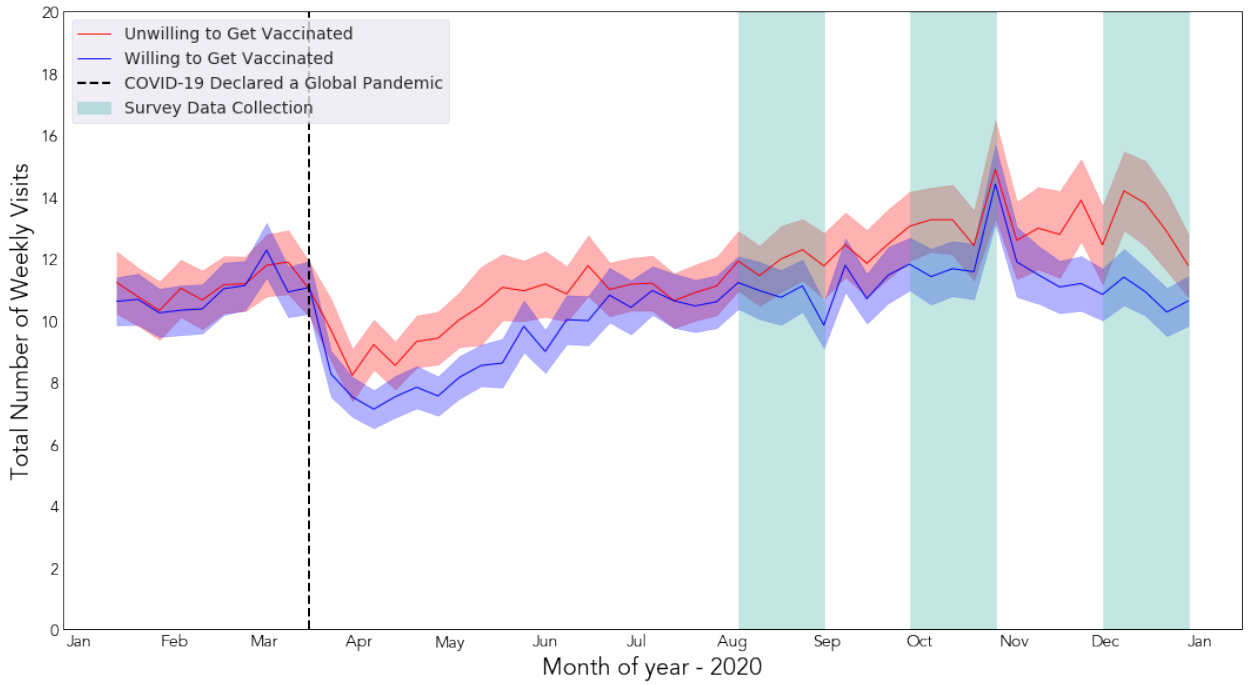
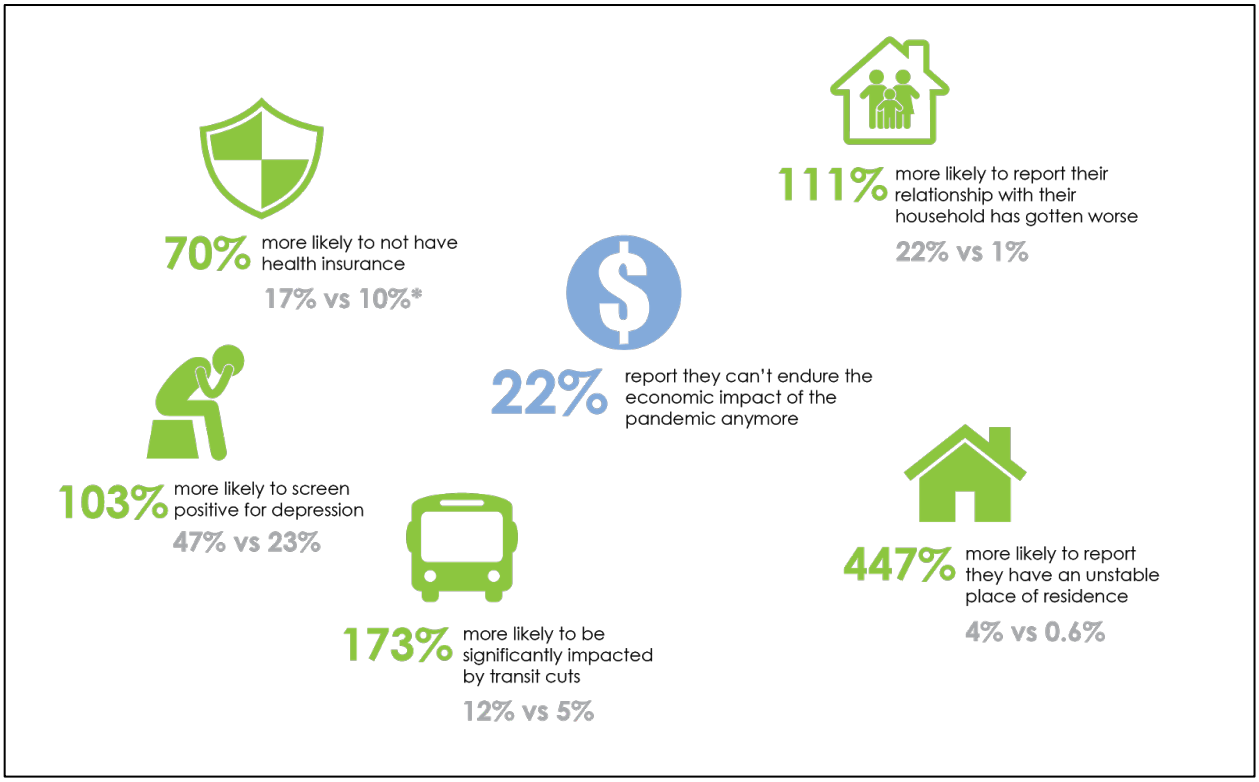


Figure 12 - Weekly number of visits comparing those willing to receive a vaccine to those unwilling - 95% confidence interval (n=869)

Section 2: Economic Impact of the Pandemic

Finding 4. Economically-Impacted Households Are More Depressed and Have Not Been Able to Reduce their Travel

The pandemic has caused significant economic disruption with large impacts on those affected. While the seasonally adjusted unemployment rate was 3 to 4 percent prior to the pandemic (US Bureau of Labor Statistics 2021), we found that 22 percent of our panelists reported in the October survey that they were unable to further endure the economic impacts of the pandemic (a slight uptick from the 21 percent reported in the August survey). We conclude that economic precarity has increased considerably since the pandemic. These respondents facing economic precarity were also much more likely to be impacted by transit cuts, or by a lack of health insurance (Figure 13, below). They are also much more likely to report that relationships within the household have deteriorated, and they are far more likely to have an unstable housing situation. As of the October survey nearly half of the economically distressed also screen positively for depression, compared to 23 percent of the remainder of the panel. This number is consistent with findings from other literature, which have found that the previous 8.5% depression rate has tripled since the beginning of the pandemic to approximately 28% (Ettman et al 2020).



*Greyed out percentages correspond to the comparison between people who reported not being able to endure the economic impacts of the pandemic and the rest.

Figure 13: Differences by economic precarity (n=174)

According to the PEW center, 25 percent of American adults reported that they or someone within their household lost their job as a result of the layoffs following the spread of the virus (PEW, 2020). In the August wave of our survey 52 percent of respondents reported receiving some sort of government financial assistance.

Survey questions provide insight into other aspects of equity and financial precarity. Approximately one-thirds of respondents self-identified as some form of essential worker. Based on movement data in combination with the survey responses, Figure 14 (below) shows that those self-identifying as essential workers had significantly more weekly trips on average, as would be expected.

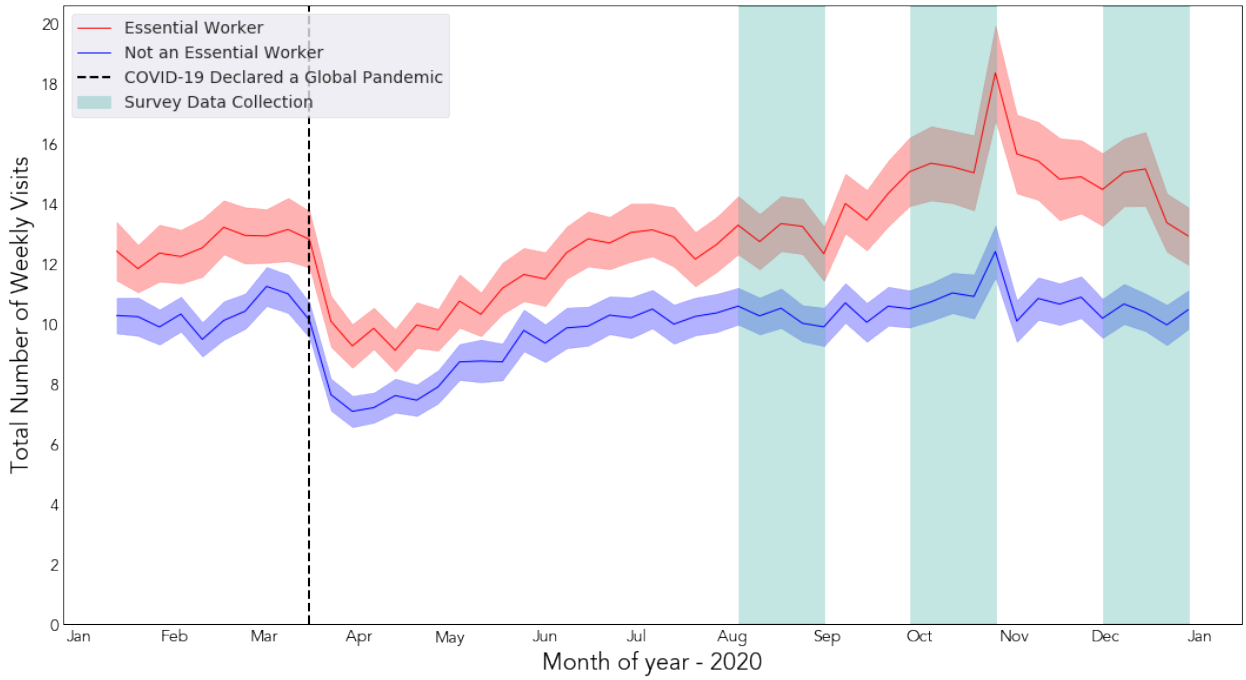


Figure 14: Weekly number of visits by whether or not someone is an essential worker (n=1,245)

We looked at movement data for people who said they could no longer endure the economic impact. We would expect such respondents to travel less because this is typically the case for people with lower income and lower rates of employment. But in fact, we find the opposite. Perhaps because of their need to search for work, or because they are occupied in jobs without the option of working at home, by the end of 2020, people who reported they could not further endure economic impacts of the pandemic were traveling outside the home at a higher rate than those enduring economic losses (Figure 15, below).

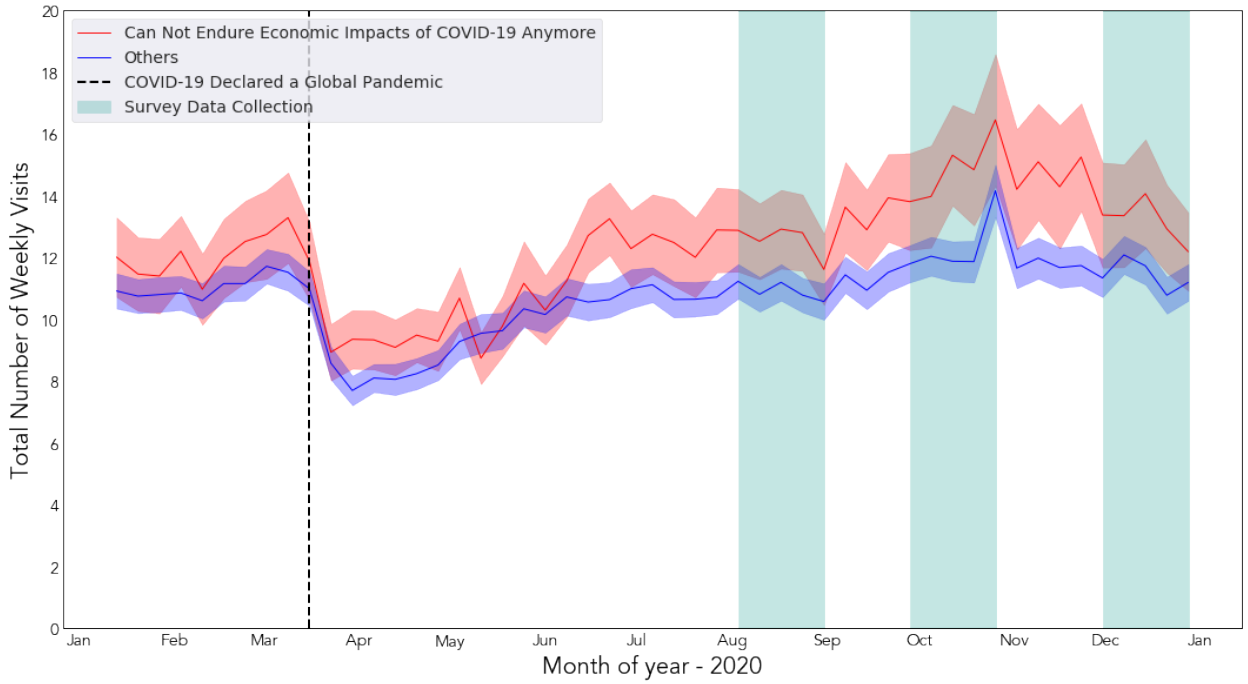
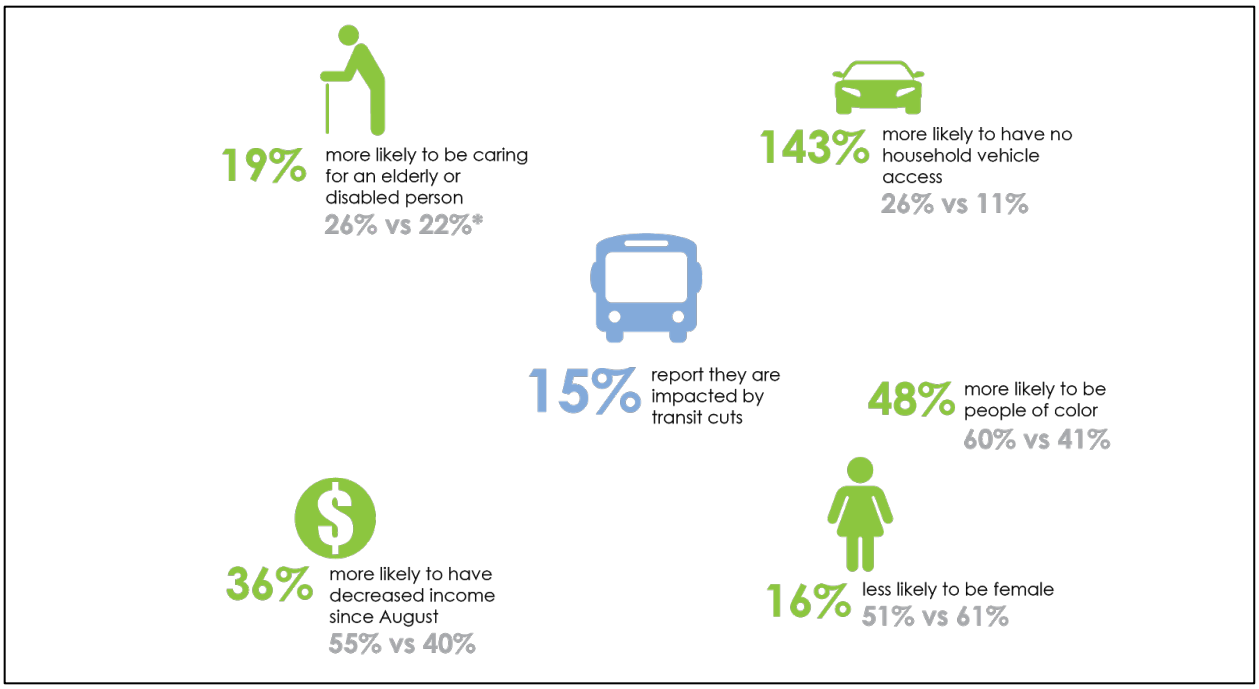


Figure 15: Weekly trips for those who "can't endure" further economic hardship versus others (n=1,245)

Finding 5: Poor Accessibility Has Affected More Vulnerable Households

Approximately twelve percent of panel respondents did not have access to a household vehicle in each of the August and October surveys, and in the October survey, 15 percent reported that they were somewhat or significantly impacted by reductions in public transportation services (a small reduction from the 17 percent reported in the August survey). (Note that our sample over-represents urban areas in which such services are more important: approximately 87 percent of our sample lives in a US Census-defined urbanized area, compared to 71 percent of the US population (US Census Bureau, 2019).) Such cuts have occurred in a number of locations during the pandemic, both due to concerns about transmission among passengers and to drivers, and more importantly, due to fiscal issues requiring a reduction of expenditures.

Those who are affected by transit cuts are more vulnerable in a number of ways (Figure 16, below). Based on our October survey, they are more likely to be caring for elders or other dependents; much more likely to have no access to a vehicle; more likely to be people of color; and more likely to have reduced their income since August, as shown below, as well as previous reductions in income between the pandemic shutdowns and August.



*Greyed out percentages correspond to the comparison between people impacted by transit cuts and others.

Figure 16: Characteristics of people impacted by transit cuts (n=121)

Those with access to a car traveled significantly more than those without access, both before and after the beginning of the pandemic (Figure 17, below). Those with access to a car were able to reduce their travel significantly at the onset of the pandemic and their travel has now almost recovered. By the end of 2020 we see a similar recovery for those without auto access.

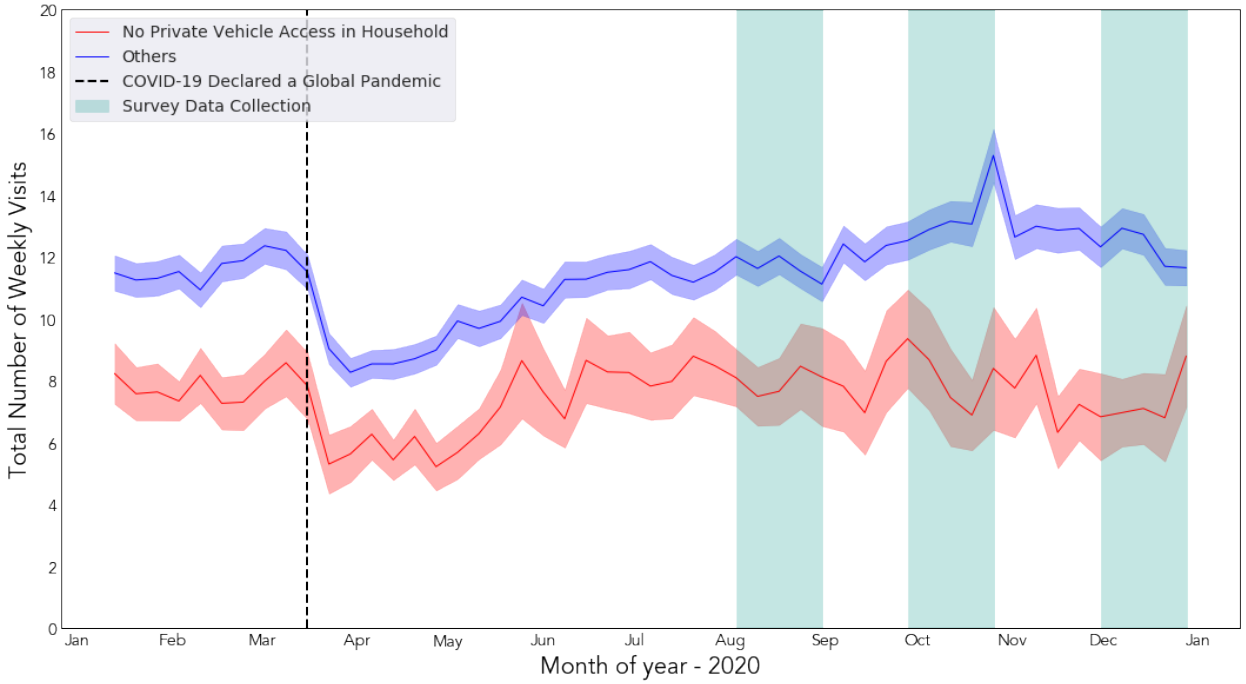


Figure 17: Weekly number of visits to places outside of home for panelists with and without access to a household vehicle - 95% confidence interval (n=1,245)

In comparison, those affected by transit cuts over the course of the year generally had a significant reduction in the number of out of home visits in comparison to people who were not affected by transit cuts, though by the end of the year the difference was not statistically significant (Figure 18, below).

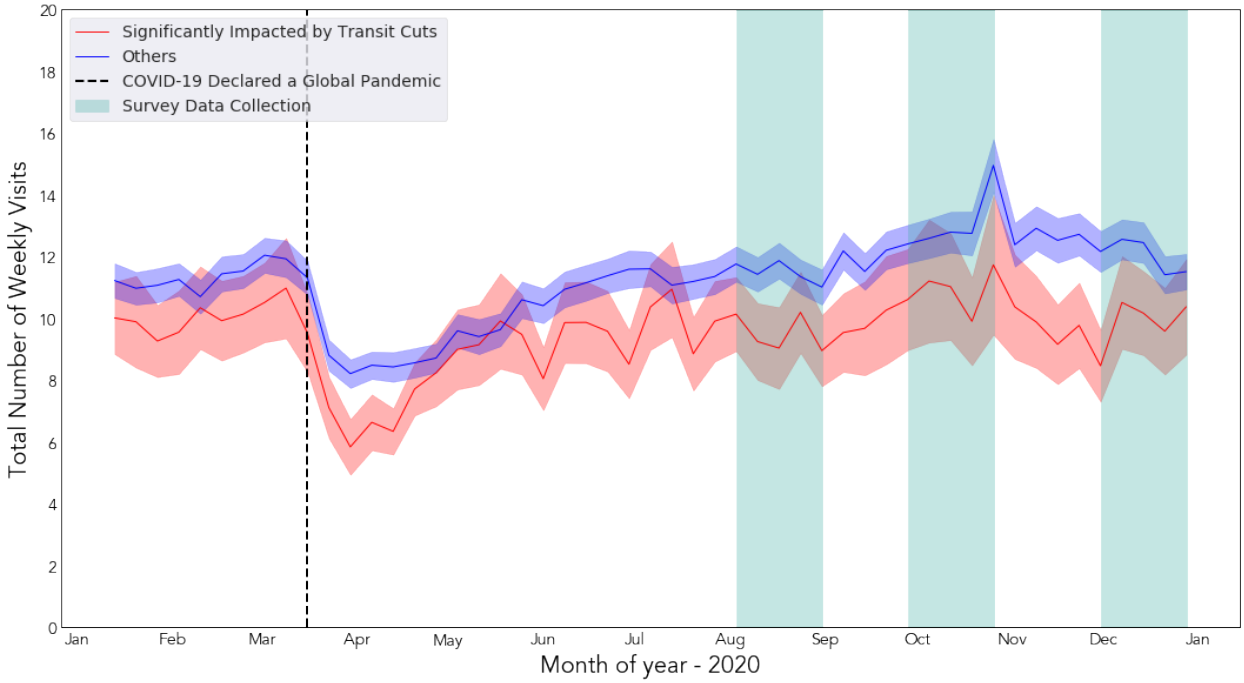
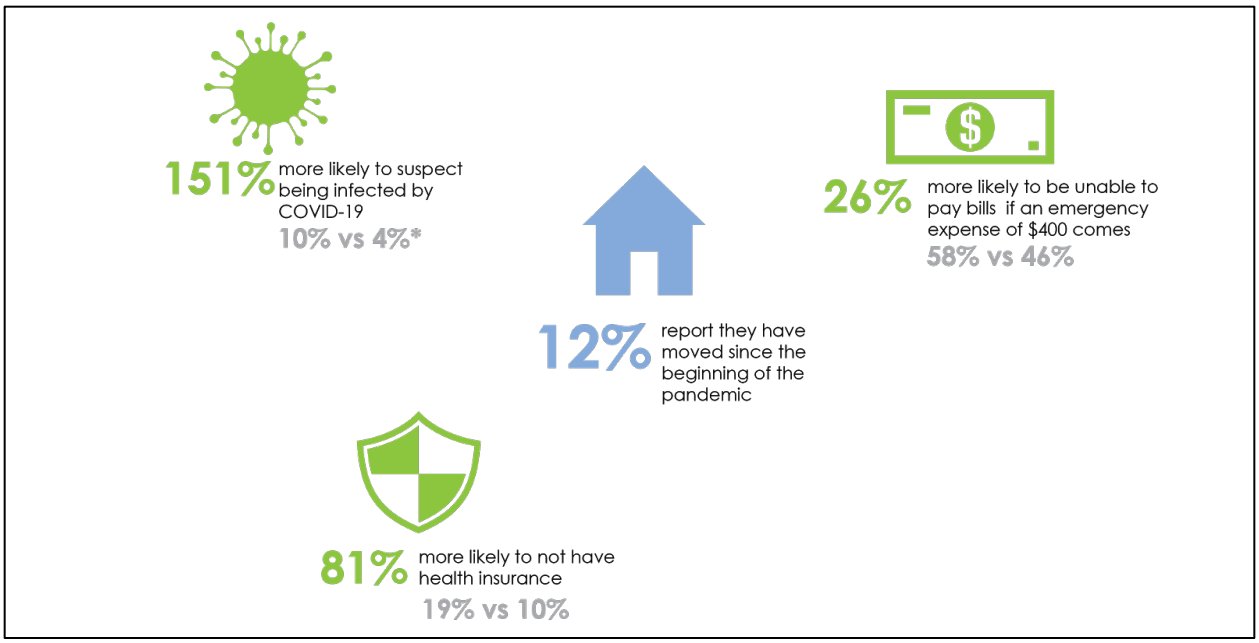


Figure 18: Weekly number of visits to places outside of home for panelists who were affected by transit cuts - 95% confidence interval (n=1,245)

Finding 6: More Households Are Moving Residences, and For Reasons of Economic Precarity

Tracking respondents over time using self-reported survey data and passive cell phone data, we found an increasing propensity to move residences. For example, about 12 percent of survey respondents reported changing their place of residence since the beginning of the pandemic in March (Figure 19). Among these, 62 percent reported that the change had happened since August. The national average for moving is about 10 percent per year (U.S. Census Bureau 2020b), implying that the pandemic has had significant impacts on people's residential locations and living conditions.



*Greyed out percentages correspond to the comparison between people who reported they have moved and those who did not.

Figure 19 - Characteristics of movers compared to non-movers (n=136)

The stated reasons for the move vary including family, employment, and housing-related reasons. Notably, several people mentioned that they moved due to COVID-19 related health risks, the need to care for someone, as well as being impacted by foreclosure/eviction. In fact, 5 percent of those who moved were due to evictions, whereas pre-pandemic only 1 percent of moves were due to eviction (U.S. Census Bureau 2020b). Further, 58 percent of movers reported they would be unable to pay bills if an emergency expense of $400 arose, whereas only 46 percent of non-movers reported these concerns (Figure 19). Movers are also 81 percent more likely to lack health insurance, and 151 percent more likely to report having been infected by COVID-19, compared to non-movers. These trends suggest a somewhat different set of motivations for moving than have been widely reported in the media, which has tended to focus on more affluent households seeking suburban locations with yards. Our survey suggests that the need for moving has largely to do with economic precarity and less to do with new location choices occasioned by the opportunity to work from home during the pandemic.

Conclusions and Next Steps

We demonstrate the usefulness of joining several data streams: passive cell phone data, individual survey information collected from the same individuals over time, and local rules and regulations for pandemic management. Our results highlight the enormous impact the pandemic has had on people, their behavior, and their well-being. They also identify opportunities and challenges for managing the pandemic, including vaccination, as we enter a critical stage of this public health emergency. We expect to continue collecting and processing data to provide further insights on pandemic management and impacts.

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