Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Changes in activity locations during the COVID-19 pandemic and associations with depression, anxiety, loneliness, and alcohol use

Jessica Frankeberger a, b, Natalie Sumetsy a, b, M. Reuel Friedman c, d, Jessica G. Burke a, b, Robert W.S. Coulter a, b, c, Christina Mair a, b,*

a Department of Behavioral and Community Health Sciences, University of Pittsburgh School of Public Health, 130 De Soto Street, Pittsburgh, PA 15261, USA
b Center for Social Dynamics and Community Health, University of Pittsburgh School of Public Health, 130 De Soto Street, Pittsburgh, PA 15261, USA
c Center for LGBT Health Research, University of Pittsburgh School of Public Health, 130 De Soto Street, Pittsburgh, PA 15261, USA
d Department of Infectious Diseases and Microbiology, University of Pittsburgh School of Public Health, 130 De Soto Street, Pittsburgh, PA 15261, USA

ARTICLE INFO
Keywords:
Activity locations
Routine activities
COVID-19
Mental health
Loneliness
Alcohol use

ABSTRACT
Introduction: Restrictions and guidelines to limit the spread of COVID-19 caused considerable and rapid changes to individuals’ daily routines. This study examines how activity locations changed during the COVID-19 pandemic and associated social distancing restrictions, and whether these changes were associated with depression, anxiety, loneliness, and alcohol use.
Methods: A web-based survey was conducted early in the COVID-19 pandemic (May-June 2020) in Allegheny County (Pittsburgh), Pennsylvania. Participants (n = 265) reported visits to activity locations in the last 30 days and retrospectively for February 2020 (pre-pandemic). A principal components analysis was conducted to assess change in utilization of activity locations. Component scores of changes to activity locations were compared by sociodemographics. Poisson and zero-inflated negative binomial models were used to examine the relationship between component scores and pandemic depression symptoms, anxiety symptoms, loneliness, and drinking days.
Results: Five distinct principal components of activity location changes were identified. The first component, characterizing broad reductions in activity locations during the early phases of the pandemic, was associated with increased depression and loneliness.
Conclusions: Results indicate non-uniform shifts in routine activities during the pandemic and highlight the importance of understanding how changes to the social environment affect individuals’ psychological wellbeing and alcohol use.

1. Introduction

Since the widespread emergence of the novel coronavirus 19 disease (COVID-19) pandemic in the United States in March 2020, national and local governments have implemented policies and public health guidelines to limit the transmission of the virus (Courtemanche et al., 2020). In the early stages of the pandemic, these policies included the closure of non-essential businesses, stay-at-home orders, and cancellation of in-person events. With the exception of essential workers, individuals were ordered to remain at home and limit in-person contact with anyone outside of immediate household members. Due to closures and limited capacities of offices, schools, restaurants, bars, stores, and other locations, there were dramatic and immediate changes to most individuals’ routine activities and substantial increases in unemployment, remote working and schooling, and other virtual activities (Abouk and Heydari, 2021).

Restrictions and guidelines to limit the spread of COVID-19 caused considerable and rapid changes to individuals’ daily routines and social contacts, potentially causing unintended consequences as environmental exposures dramatically shift. According to Routine Activity Theory (Cohen and Felson, 1979), the physical and social environment of daily activities exposes or protects individuals from risks and opportunities in the environment and influence their behavior and health. These exposures are evident in activity spaces and locations where individuals engage in routine activities in and beyond the residential neighborhood, such as work, school, and stores, and impact how
individuals interact and behave in these contexts. This provides a framework for understanding how the environment impacts behaviors and health (Browning et al., 2017; Inagami et al., 2007; Perchoux et al., 2013). For instance, neighborhood exposures to specific types of stores, such as alcohol outlets, may influence activity patterns and lead to increased alcohol use and related problems (Mair et al., 2019). Similarly, exposure, or lack thereof, to activity locations and the social environment in these locations, such as the closure of alcohol outlets and other settings during the COVID-19 pandemic, may contribute to social isolation and changes in mental health and alcohol use patterns.

Changes to an individual’s routine activity locations and social contexts through the COVID-19 pandemic may therefore have inadvertent effects on psychological wellbeing and access to mental health and substance use treatment (Hou et al., 2020; Marroquín et al., 2020). A review of the effects of quarantine efforts to limit disease transmission of previous infectious disease outbreaks found that quarantine and patient isolation were associated with potentially long-lasting negative psychological effects, including stress, depression, anxiety, and PTSD symptoms (Brooks et al., 2020). Similarly, recent research focused on the COVID-19 pandemic has generally found increases in social isolation and depression and anxiety symptoms during social distancing restrictions, with particular increases among specific groups including individuals with pre-existing mental health conditions, sexual and gender minorities, parents of young children, and adolescents (Asmundson et al., 2020; Cameron et al., 2020; Kidd et al., 2021; Loades et al., 2020; Peterson et al., 2020). While many of these groups, such as sexual and gender minorities, have had elevated rates of mental health conditions both before and during the pandemic, it is unknown how their daily activities and environments during the pandemic have been affected and how these changes may contribute to these ongoing disparities.

Similarly, the COVID-19 pandemic has also shifted alcohol use patterns (Ramalho, 2020), with evidence suggesting increases in drinking among women, older adults, and sexual minorities (Callinan et al., 2020; Pollard et al., 2020; Sanchez et al., 2020; Satre et al., 2020). While stressors, social isolation, and mental health may be relevant to changes in alcohol use during the pandemic (Avery et al., 2020; Capasso et al., 2021; Jacob et al., 2021), restrictions to traditional drinking venues and changes in alcohol availability may also partially explain shifts in drinking patterns (Bade et al., 2020; Farhoundian et al., 2020). For instance, social distancing restrictions temporarily closed all non-essential off-premise alcohol outlets and limited capacity for restaurants and bars in many regions of the United States. Some areas also relaxed existing alcohol policies, for example allowing on-premise outlets, such as restaurants, to sell alcohol for off-premise consumption (Colbert et al., 2020; National Institute on Alcohol Abuse and Alcoholism, 2020; Reynolds and Wilkinson, 2020). These changing policies likely shifted alcohol-related activities for many.

While numerous studies have begun to examine mental health and alcohol use patterns during the COVID-19 pandemic, the role of changes in routine activities and social environments in relation to these outcomes remains unclear. In the limited existing research on policy changes, social distancing restrictions and uptake are often analytically considered uniform across populations (Avery et al., 2020; Callinan et al., 2020; Christie et al., 2021; Fisher et al., 2020; Jacob et al., 2021; Pollard et al., 2020). Nevertheless, mobility and pandemic-related restrictions have differed by individual- and county-level socioeconomic status (Cox et al., 2020; Chang et al., 2021; Garnier et al., 2021; Yecheskel et al., 2021). Yet, to the best of our knowledge, no studies have examined how individuals’ routine activities and activity locations have changed during the COVID-19 pandemic and whether these changes are associated with mental health or substance use outcomes. The aim of the current study is to describe how utilization of non-home activity locations changed from immediately before the COVID-19 pandemic in Allegheny County, Pennsylvania (February 2020) to the early period of stay-at-home orders following widespread COVID-19 transmission (May to June 2020). We explore changes in 32 different activity locations, including social activity locations (e.g., restaurants or bars) and other basic activity locations (e.g., an ATM or bank), and how these changes varied by sociodemographic factors. We also assess the associations between activity location changes and depressive symptoms, anxiety symptoms, loneliness, and alcohol use during the pandemic. Describing changes in routine activities and associated outcomes can help us better understand the unintended consequences of the pandemic on daily lives and can be used to inform community interventions and social distancing policies moving forward.

2. Materials and methods

A web-based survey was conducted from May through June 2020, starting shortly after the first case of COVID-19 was reported in Allegheny County (Pittsburgh), Pennsylvania. On March 23, 2020, stay-at-home orders for the county were implemented. During the data collection period (May and June 2020), some restrictions and closures of non-essential businesses were lifted in the county as of May 15th, allowing specific businesses, such as retail stores, to reopen with limited capacity. Restaurants and bars were limited to carry-out and delivery only, while other non-essential locations, such as gyms, remained fully closed (Commonwealth of Pennsylvania, 2020a). Towards the end of the study period in June, Pennsylvania removed their stay-at-home orders and a number of restrictions were lifted, including closures of restaurants and bars. Most businesses however remained at a limited 50% capacity and strict safety procedures and mask mandates remained (Commonwealth of Pennsylvania, 2020b). Recommendations for all non-essential in-person activities to not occur or be conducted virtually remained in place.

Study participants were recruited using Facebook and Instagram paid, targeted advertisements posted by the University of Pittsburgh’s Center for Social Dynamics and Community Health and Center for LGBT Health Research’s accounts. Two sets of advertisements were utilized, one targeting the general adult population of Allegheny County, and the second specifically targeting sexual and gender minority (SGM) residents. Our goal was to recruit 50% SGM as this subgroup already experiences a disproportionate burden of mental health and substance use problems and may have been particularly impacted by the COVID-19 pandemic. Subgroup analysis of outcomes among SGM can be found in previous publications (Coulter et al., 2022; Sumetsky et al., 2021).

Advertisements linked directly to the survey information and screener in Qualtrics. Participants were eligible to complete the survey if they were at least 18 years old and were a resident of Allegheny County. All participants provided informed consent online prior to starting the survey. Surveys were completed in English and took approximately 20–30 min to complete. The study was performed in accordance with the Helsinki Declaration and the Institutional Review Board at University of Pittsburgh approved all study protocols.

2.1. Measures

The survey collected data retrospectively for two time periods: February 2020 and the four weeks prior to the completion of the survey (May–June 2020). February 2020 was chosen as it was prior to the first case of COVID-19 reported in Allegheny County and the implementation of social distancing restrictions and guidelines. Utilization of activity locations and outcome measures were assessed at both time periods. A list of 32 locations where routine activities occur (Table 1) was adapted from Zenk et al. (2019)’s list of non-home activities. This list was developed and validated using GPS-derived data among a racially/ethnically diverse adult sample in Chicago (Zenk et al., 2019). Participants were asked if they had gone to each of the listed activity locations during each time period, and if so, how many times they had visited each place during the 4-week period.
Four outcomes were assessed at both times periods: depressive symptoms, anxiety symptoms, loneliness, and drinking frequency. Depression and anxiety symptoms were measured using the four-item Patient Health Questionnaire-4 (PHQ-4) (Kroenke et al., 2009; Lowe et al., 2010). The PHQ-4 includes two subscales assessing how often depression and anxiety symptoms have bothered the participant in a two-week period. Each subscale score was summed separately and ranged from 0 to 6, with higher scores indicating more depression or anxiety symptoms. Loneliness over each 4-week period was measured using three items adapted from the UCLA Loneliness Scale (Hughes et al., 2004). Items were summed, creating a loneliness score at each time period ranging from 3 to 9 with a higher score indicating more severe loneliness. Lastly, drinking frequency was indicated by the number of days during each 4-week time period in which at least one alcohol-containing beverage was consumed.

Sociodemographic characteristics were assessed for each participant, including age (continuous), race/ethnicity (non-Hispanic white, non-white), gender (man, woman, gender minority—including transgender, non-binary, and genderqueer), sexual orientation (heterosexual/straight, gay/lesbian, bisexual, queer), marital status (married/living together, divorced/separated/widowed, single), education (no college degree, college or graduate degree), annual income (less than $20,000, $20,001 to $60,000, $60,001 to $100,000, more than $100,001), employment status (employed full- or part-time, unemployed, retired/not working), currently in school (yes, no), and currently living with children under age 18 (yes, no).

2.2. Analysis

Descriptive statistics for binary measures of ever visiting and the number of visits to routine activity locations in both time periods were assessed separately for each of the 32 activity location types. Changes in ever visiting each location over the two time periods were evaluated using McNemar tests for paired nominal data. Next, a Principal Component Analysis (PCA) was conducted to examine types of changes in activity locations across the two time periods. PCA is a data reduction technique often used to identify groups of latent variables by examining correlations of observed variables (Burstyn, 2004). In Stata version 15 (StataCorp, College Station, TX), a PCA was conducted with binary variables (representing ever visits) for the 32 activity locations in both February 2020 and for the past 4 weeks during the COVID-19 pandemic. Eigenvalues on a scree plot determined the number of components to retain (Ledesma and Valero-Mora, 2007). Principal component scores were then calculated for each activity location component. Scores above 0.2 or below −0.2 were considered in qualitatively describing each component. While we characterized the components, we recognize that these “types” are a simplification of characteristics that vary continuously across the principal components. The PCA and associated score calculation was conducted with 265 participants who had complete activity location data.

Independent t-tests, one-way ANOVAs, and Pearson correlations, as appropriate, were used for bivariable comparisons of sociodemographic characteristics and outcomes versus principal component scores. Next, regression models were used to assess associations of each of the four outcomes during COVID-19 with the principal components. Poisson models were used to assess the relationships between component scores for activity locations and depression, anxiety, and loneliness scores, while a zero-inflated negative binomial model was used for number of drinking days. Each model adjusted for baseline (February 2020) levels of the outcome and sociodemographic characteristics, including age, race/ethnicity, gender, sexual orientation, marital status, education, employment status, current school status, and living with children under age 18. Variables predicting zero inflation in the drinking days model were the principal component scores and any covariates resulting in effect estimates with p-values less than 0.05 in the fully adjusted model. In the final model, this included baseline drinking days in February 2020.

Due to incomplete data for outcomes, 222 participants were included in the model examining depression, 221 in the anxiety and loneliness models, and 237 in drinking days. Compared to the full sample (n = 265), those with missing data in outcome models (n = 221) were on average older (p < 0.001) and were less likely to identify as a sexual minority (p = 0.009). Missing outcome data were not associated with any other covariates in our models. In a sensitivity analysis, we conducted two PCAs, one using the full sample and one using only those with complete outcome data. As both PCAs resulted in retaining the same number of components, similar explanatory power, and conceptually similar components, we reported results from the full sample for all analyses other than outcome models.

3. Results

Respondents with activity location data included 265 adults, ranging in age from 18 to 89 (mean = 46.1, SD = 19.9). Participants were largely non-Hispanic white (86%). The majority identified as cisgender women (58.1%), 27.9% as cisgender men, and 14.0% as gender minorities. Approximately half of participants identified as heterosexual (50.9%) and half as sexual minorities (49.1%). More than half the sample was a college graduate (59.9%), while 46.8% were employed either full- or part-time, unemployed, or retired/not working, currently in school (yes, no), and currently living with children under age 18 (yes, no).

Table 1

| Variable | Feb 2020 | Past 4 Weeks |
|----------|----------|--------------|
| N (%)    | N (%)    | P-Value*    |
| Work and Education | | |
| Primary job | 135 (50.9) | 76 (28.7) | *** |
| Second job | 17 (6.4) | 8 (3.0) | ** |
| Your school, college, or university | 61 (23.0) | 10 (3.8) | *** |
| Child’s daycare or school | 11 (4.2) | 0 (0) | ** |
| Essential Services | | |
| Health center, clinic, or doctor’s office | 111 (41.9) | 66 (24.9) | *** |
| Pharmacy or drugstore | 170 (64.2) | 144 (54.3) | *** |
| Grocery store | 243 (91.7) | 218 (82.3) | *** |
| Convenience or corner store | 149 (56.2) | 98 (37.0) | *** |
| Big box store like Walmart or Target | 183 (69.1) | 128 (48.3) | *** |
| Discount or dollar store | 133 (50.2) | 75 (28.3) | *** |
| Food pantry or emergency food source | 20 (7.6) | 16 (6.0) | |
| Social service office | 3 (1.1) | 1 (0.4) | |
| Bank or ATM | 169 (63.8) | 108 (40.8) | *** |
| Post office | 114 (43.0) | 73 (27.6) | *** |
| Gas station | 168 (63.4) | 152 (57.4) | * |
| Non-essential Retail | | |
| Non-food store (e.g., clothing) | 127 (47.9) | 18 (6.8) | *** |
| Liquor store or beer distributor | 95 (35.8) | 46 (17.4) | *** |
| Food-related Hospitality | | |
| Restaurant | 189 (71.3) | 65 (24.5) | *** |
| Coffee shop | 121 (45.7) | 25 (9.4) | *** |
| Bar or club | 74 (27.9) | 7 (2.6) | *** |
| Recreation and Exercise | | |
| Friend’s home | 151 (57.0) | 67 (25.3) | *** |
| Family member’s home | 117 (44.2) | 86 (32.5) | *** |
| Library | 84 (31.7) | 1 (0.4) | *** |
| Museum, theater, music lesson, etc. | 79 (29.8) | 3 (1.1) | *** |
| Place of worship | 49 (18.5) | 8 (3.0) | *** |
| Place you volunteer | 32 (12.1) | 7 (2.6) | *** |
| Indoor place to play/participate | 65 (24.5) | 5 (1.9) | *** |
| Location for outdoor exercise | 81 (30.6) | 74 (27.9) | *** |
| Other park, playground, or recreation | 91 (34.3) | 69 (26.0) | ** |
| Other Locations | | |
| Public transit stops near home | 60 (22.6) | 16 (6.0) | *** |
| Other place you often took a child | 11 (4.2) | 1 (0.4) | *** |
| Second residence | 22 (8.3) | 21 (7.9) | *** |

*p < 0.05, **p < 0.01, ***p < 0.001.

- McNemar test compares the proportion of respondents who visited each location before and during the COVID-19 pandemic. A p-value < 0.05 indicates that the number of individuals who visited the location significantly decreased from before to during the pandemic.
part-time at the time of the survey. All sample characteristics can be found in Table 3.

Among the 265 respondents with routine activities data, activity locations changed dramatically from February 2020 to the early stages of the COVID-19 pandemic. Compared to February 2020, almost all activity locations were significantly less likely to be visited in May-June 2020 (Table 1). Restaurants had the greatest reduction in the number of participants who visited before during the pandemic (71.3 vs. 24.5%), followed by non-food stores (47.8 vs. 6.8%), coffee shops (45.7 vs. 9.4%), friends’ homes (57.9 vs. 25.3%) and libraries (31.7 vs. 0.4%). Eleven locations had over a 20% reduction in the number of respondents who ever visited during these periods. During the pandemic, respondents were most likely to visit grocery stores (83.8%), followed by pharmacies (55.3%) and big-box stores (49.3%), compared to grocery stores (91.7%), restaurants (71.3%), and big-box stores (69.1%) in February 2020. Only four activity locations did not see a significant change in the proportion of respondents who visited from before to during the pandemic, including food pantries/food bank (7.6 vs. 6.0%), social service offices (1.1 vs. 0.4%), location for outdoor activities (30.6 vs. 27.9%), and second residences (8.3 vs. 7.9%). Among visitors to each activity location, the number of times participants visited decreased during the pandemic for all but two locations (data not shown): outdoor activities and food pantries (food banks or emergency food sources).

Among those who visited a location for outdoor activity in February (n = 77), the number of visits increased from an average of 7.4 pre-pandemic to 9.9 during the pandemic (n = 70). Among those who visited a food pantry or other emergency food service in February 2020 (n = 18), visits increased from an average of 1.8 pre-pandemic to 2.4 during the pandemic (n = 17).

Based on our examination of the scree plot, we included five principal components in our analyses (Table 2). The five components (Eigenvalues of 7.166, 4.002, 2.867, 2.511, and 2.375) accounted for 30.3% of the variance in the 32 routine activity locations at both time points. Table 2 presents the activity locations strongly loaded on each component, while scores for all activity locations can be found in Supplemental Table A. The first principal component (PC1) had loadings over 0.2 for non-food stores, restaurants, bars or clubs, bank/ATMs, and friends’ homes in February 2020, but no activity locations had high loadings during the pandemic. Thus, PC1 roughly represents moving from social activities to no activities. The second component (PC2) is characterized as non-student activities to essentials and family. In February 2020, PC2 had loadings less than −0.2 for school/universities, coffee shops, and public transit stops. During the pandemic, location for outdoor activities had a loading less than −0.2, while big box stores, discount or dollar stores, bank/ATMs, gas stations, and family members’ homes had loadings above 0.2. The third component (PC3) is characterized as continued services and low job attendance. PC3 had high loadings both before and during the pandemic for visits to food pantry and social service offices, as well as negative loadings for primary job in both time periods. Liquor stores also loaded above 0.2 during the pandemic. The fourth component (PC4) had negative loadings for children’s daycare/school and other place you take a child before the pandemic, negative loadings for primary and secondary jobs during the pandemic, and high loadings for pharmacies during the pandemic. PC4 is characterized as non-child activities to pharmacies and low job attendance. The fifth component (PC5) represents moving from little activity to social activities, as only a few activities had strong loadings before the pandemic. A range of activities had high loadings during the pandemic. Before the pandemic, PC5 had high loadings on other places you take a child and negative loadings on the post office and bank/ATMs. During the pandemic, PC5 had high loadings on bars or clubs, indoor places to play or exercise, museum/theater or other cultural locations, friends’ homes, and other places you take a child.

Values for each principal component varied by sociodemographic characteristics of the sample (Table 3). Older age was negatively correlated with PC1 (Social to none) and PC5 (Little activities to social),

| Variable                  | Component 1 | Component 2 | Component 3 | Component 4 | Component 5 |
|---------------------------|-------------|-------------|-------------|-------------|-------------|
|                           | Social to none | Non-student to essentials/family | Continued services/low jobs | Non-child to pharm./low jobs | Little activities to social |
| February 2020             | Primary job  | Your school, college, or university | Child’s daycare or school | Essential Services | Non-essential Retail |
| Work and Education        | −0.2619     | −0.2054     | −0.3067     | −0.2001     | 0.2612      |
| Essential Services        | −0.2379     | −0.2186     | −0.3067     | −0.2001     | 0.2413      |
| Restaurant                | 0.2141      | −0.2087     | −0.3067     | −0.2001     | 0.2413      |
| Bar or club               | 0.2017      | 0.2017      | −0.2105     | −0.2001     | 0.2413      |
| Recreation and Exercise   | 0.2170      | 0.2170      | −0.2105     | −0.2001     | 0.2413      |
| Friend’s home             | 0.2170      | 0.2170      | −0.2105     | −0.2001     | 0.2413      |
| Other Locations           | −0.2051     | −0.2051     | −0.3067     | −0.3067     | 0.2154      |
| Public transit stops near home | −0.2051     | −0.2051     | −0.3067     | −0.3067     | 0.2154      |
| Other place you often took a child | −0.2051     | −0.2051     | −0.3067     | −0.3067     | 0.2154      |

(continued on next page)
but positively correlated with PC2 (Non-student activities to essentials and family). Men had significantly higher values for PC1 than women and gender minorities. Heterosexual individuals had the highest PC2 values, while those who identified as sexual minorities had substantially lower scores. PC3 (Continued services and low job attendance), PC4 (Non-child activities to pharmacies and low job attendance), and PC5 scores did not significantly vary by gender or sexual orientation, and no principal component values significantly varied by race. Those living with children under age 18 had significantly higher scores for PC3 and lower scores for PC4 compared to those not living with children. Socioeconomic indicators, including income, employment status, and education were associated with component scores. Higher incomes were significantly associated with higher scores on PC1, while lower incomes were associated with higher scores on PC4. Similarly, college graduates had significantly higher scores on PC1 than those with less than a college education. All components significantly differed by employment status. Compared to those unemployed and not working (e.g., retired, student, homemaker), those working full- or part-time had the highest scores for PC1 and PC5 and the lowest scores for PC4.

In adjusted models (Table 4), depression scores during the COVID-19 pandemic were positively associated with PC1 ($B = 0.06$, 95% CI = $0.02, 0.10$), but negatively associated with scores for PC2 ($B = -0.05$, 95% CI = $-0.11, -0.001$) and PC3 ($B = -0.10$, 95% CI = $-0.18, -0.03$). Anxiety scores were negatively associated with PC3 scores ($B = -0.08$, 95% CI = $-0.16, -0.002$). Loneliness significantly increased as PC1 scores increased ($B = 0.03$, 95% CI = $0.00, 0.05$), but was not significantly associated with any other principal components. In zero-inflated adjusted models, the number of drinking days among those who drank at least once during the past 4 weeks were negatively associated with PC2 ($B = -0.08$, 95% CI = $-0.15, -0.02$). Having zero drinking days during this period was significantly associated with PC4 ($B = 0.41$, 95% CI = $-0.04, 0.79$). PC5 was not independently associated at the $\alpha = 0.05$ level with any outcome in adjusted models.

### 4. Discussion

This study is one of the first to examine how routine activities changed from before the COVID-19 pandemic to the early stages of social distancing restrictions. Unlike other research that has assessed how mental health and substance use have changed over time during the implementation of pandemic-related restrictions (Asmundson et al., 2020; Avery et al., 2020; Callinan et al., 2020; Jacob et al., 2021), we characterize specific shifts in activity locations and how these may impact mental health and alcohol use patterns. Our results indicate substantial changes in activity locations from February 2020 to the initial months of the pandemic and help to quantify the extreme changes in day-to-day activities and environments of a sample of Allegheny County adults during this unprecedented period.

Specifically, we identified five distinct components of activity location changes across these two time periods, indicating non-uniform shifts in activities across the sample. For instance, individuals scoring highly on PC1 (social to none) likely had the most substantial reductions in their daily activities and locations with no locations indicating strong correlations in the PCA during the pandemic. Comparatively, high scores on PC2 (non-student activities to essential and family) had strong loadings on locations for essential activities during the pandemic (e.g., stores, banks, gas stations). While neither component indicates social activities during the pandemic such as PC5 (little activity to social activities), the distinction of co-occurring in-person essential activities during the pandemic may be associated with different abilities and/or willingness to limit in-person contact and abide by social distancing guidelines. These differential changes also indicate varying social and environmental exposures that may contribute to trends found in our study and previous research of changes in social isolation, loneliness, mental health problems, and substance use during the pandemic.

The activity location shifts identified in this study were distinctly associated with mental health and alcohol use during the pandemic. After adjusting for baseline levels of each respective outcome and other covariates, depression and loneliness during the pandemic were positively associated with higher scores on components that identified a greater reduction in activity locations from February, such as PC1 (social to none). These changes may be indicators of greater social isolation and are consistent with research identifying isolation as a predictor of psychological distress and loneliness during the pandemic (Banerjee and Rai, 2020; Bu et al., 2020; Elmer et al., 2020; Usher et al., 2020). On the other hand, our results also indicated that specific patterns of activities, such as PC2 (non-student activities to essentials and family) and PC3 (continued services and low job attendance) were associated with reduced depression and anxiety symptoms and drinking days during the pandemic. It is possible these patterns correspond to increased interactions or responsibilities associated with family, such as PC2, or consistent patterns in activity locations, such as PC3. These activity patterns and associated exposures may act as a buffer from the stress of the global pandemic for mental health and alcohol concerns that other activity shifts did not. Future qualitative or mixed-methods studies may be well-suited to provide insights into how and why these physical and social environments protect individuals from risks that contribute to mental health problems or deleterious behaviors.

It is also important to understand how shifts in routine activities during a crisis impact both physical and psychological health and investigate whether distinct groups may be differentially affected. For instance, those who transitioned from visiting a wide range of locations to adhering to stay-at-home orders, such as those described by PC1 (social to none), may have disproportionally experienced psychological...
or alcohol use problems. Based on our results, these individuals may have higher socioeconomic status, as PCI was associated with higher employment and education, and thus may be more able to follow COVID-19 related restrictions and have the resources to limit in-person social interactions. On the other hand, not changing activity patterns during the pandemic may be an indicator of lower capacity to abide by social distancing guidelines and social inequalities (Chang et al., 2021; Clouston et al., 2021; Garnier et al., 2021). For instance, PCI (continued services and low job attendance), which was associated with lower employment levels, characterizes activity patterns that changed little during the pandemic may be an indicator of lower capacity to abide by social distancing guidelines and social inequalities (Chang et al., 2021; Clouston et al., 2021; Garnier et al., 2021).

### Table 3

| Demographics | Total | PC1: Social to none<sup>1</sup> | PC2: Non-student to essentials/family<sup>1</sup> | PC3: Continued services/low jobs<sup>1</sup> | PC4: Non-child to pharm./low jobs<sup>1</sup> | PC5: Little activities to social<sup>1</sup> |
|--------------|-------|-----------------|------------------|--------------------------|----------------------|---------------------|
| Age (n = 265) | 46.10 (19.87) | −0.17** | 0.48*** | 0.02 | 0.00 | −0.27*** |
| Race/Ethnicity (n = 265) | | | | | | |
| White | 228 (86.04) | 0.08 (2.70) | 0.01 (1.91) | −0.02 (1.67) | −0.05 (1.59) | 0.00 (1.59) |
| Non-white/Other | 37 (13.96) | −0.47 (2.53) | −0.05 (2.50) | 0.13 (1.85) | 0.28 (1.51) | 0.02 (1.20) |
| Gender (n = 265) | | | | | | |
| Men | 74 (27.92) | 0.70 (2.90) | 0.08 (1.85) | −0.39 (1.28) | −0.12 (1.93) | −0.08 (1.73) |
| Women | 154 (58.11) | −0.32 (2.57) | 0.29 (1.97) | 0.14 (1.90) | 0.00 (1.46) | 0.03 (1.55) |
| Marital Status (n = 265) | | | | | | |
| Married/Living Together | 111 (41.89) | 0.07 (2.68) | 0.34 (1.62) | −0.16 (1.89) | −0.40 (1.51) | −0.14 (1.49) |
| Divorced/Single/Widowed | 45 (16.98) | −0.58 (2.30) | 0.74 (1.85) | 0.16 (1.45) | 0.31 (1.36) | 0.55 (1.24) |
| Never married | 109 (41.13) | 0.17 (2.81) | −0.72 (2.17) | 0.10 (1.07) | 0.29 (1.67) | 0.37 (1.62) |
| Education (n = 264) | | | | | | |
| Less than College | 106 (40.15) | −0.80 (2.64) | 0.09 (1.94) | −0.09 (1.93) | −0.04 (1.34) | 0.19 (1.43) |
| College Graduate | 158 (59.85) | 0.54 (2.58) | −0.03 (2.02) | 0.05 (1.51) | 0.02 (1.73) | −0.13 (1.61) |
| Annual Income (n = 265) | | | | | | |
| Less than $20,000 | 44 (16.60) | −0.79 (2.99) | 0.17 (2.34) | 0.36 (1.83) | 0.52 (1.33) | −0.07 (1.15) |
| $20,001 to $60,000 | 93 (35.09) | −0.20 (2.56) | 0.27 (2.19) | −0.04 (2.06) | −0.04 (1.40) | −0.10 (1.39) |
| $60,001 to $100,000 | 63 (23.77) | 0.53 (2.51) | −0.29 (1.58) | −0.13 (1.18) | −0.50 (1.69) | 0.07 (1.77) |
| $100,001 or More | 36 (13.58) | 0.85 (2.12) | −0.36 (1.70) | −0.12 (1.43) | −0.13 (1.74) | 0.01 (1.47) |
| Employment (n = 265) | | | | | | |
| Working full or part-time | 124 (46.79) | 0.88 (2.55) | 0.14 (1.88) | −0.71 (1.75) | −0.46 (1.79) | 0.29 (1.83) |
| Unemployed | 33 (12.45) | 0.40 (2.46) | −1.36 (1.89) | 0.29 (1.26) | 0.50 (1.40) | 0.01 (0.99) |
| Not Working (not looking)<sup>1</sup> | 108 (40.75) | −1.13 (2.49) | 0.25 (2.03) | 0.72 (1.39) | 0.37 (1.21) | −0.33 (1.21) |
| Currently in School (n = 264) | | | | | | |
| No | 222 (84.09) | −0.02 (2.77) | 0.22 (1.81) | −0.11 (1.46) | −0.03 (1.56) | −0.15 (1.01) |
| Yes | 42 (15.91) | 0.09 (2.19) | −1.24 (2.45) | 0.57 (2.54) | 0.16 (1.74) | 0.79 (1.46) |
| Living with Kids Under 18 (n = 250) | | | | | | |
| No | 216 (86.40) | 0.03 (2.56) | −0.09 (1.97) | −0.20 (1.40) | 0.03 (1.41) | −0.07 (1.43) |
| Yes | 34 (13.60) | −0.22 (2.82) | 0.44 (2.16) | 0.84 (2.66) | −0.63 (1.95) | 0.36 (1.69) |

| Outcomes during the Pandemic | | | | | | |
| Depression Score (n = 236) | 2.21 (1.78) | 0.05 | −0.27*** | −0.02 | 0.14* | 0.04 |
| Anxiety Score (n = 237) | 2.16 (1.85) | −0.09 | −0.29*** | −0.02 | 0.06 | 0.04 |
| Loneliness Score | 5.54 (1.95) | 0.08 | −0.16** | −0.03 | 0.06 | 0.00 |
| Drinking Days (binary)<sup>1</sup> (n = 254) | | | | | | |
| No drinking days (0 days) | 95 (37.40) | −0.92 (2.38) | 0.19 (1.81) | 0.31 (1.19) | 0.15 (1.43) | −0.26 (1.17) |
| 1+ drinking days | 159 (62.60) | 0.58 (2.70) | −0.12 (2.11) | −0.20 (1.92) | −0.11 (1.68) | 0.20 (1.71) |
| Number of Drinking Days<sup>1</sup> (n = 159) | 7.79 (7.68) | 0.12 | −0.21** | −0.28*** | −0.02 | 0.03 |

<sup>1</sup> p < 0.05, **p < 0.01, ***p < 0.001.

<sup>1</sup> Comparisons of component means were conducted with Pearson correlations for continuous variables and independent t-test and one way ANOVAs for categorical variables.

<sup>1</sup> PCI represents moving from a range of social activities before to none (no strong loadings) during the pandemic.

<sup>1</sup> PC2 represents non-student activities (e.g., negative loadings on school/universities) before to the pandemic to essentials (e.g., big box stores, banks) and visiting family members' homes during the pandemic.

<sup>1</sup> PC3 represents continued food and social services before and during the pandemic, as well as low job attendance (negative loadings) during both periods.

<sup>1</sup> PC4 represents non-child activities (e.g., negative loadings on daycare/school) before to the pandemic to pharmacies and low job attendance during the pandemic.

<sup>1</sup> PC5 represents moving from little activity (few locations strongly loaded) before the pandemic to a range of activity locations during the pandemic.

<sup>1</sup> Among the sample who were not working/not looking, 42.6% were retired, 6.5% were homemakers, 25.9% were unable to work due to a disability, 17.6% were not working due to being a full-time student, and 7.4% were categorized as other (e.g., having a temporary hold on job due to the pandemic).

<sup>1</sup> Measured per 28 days.

<sup>1</sup> Number of drinking days among those who drank at least once in the last 28 days.
Table 4
Associations between depressive symptoms, anxiety symptoms, loneliness, and frequency of alcohol use during the COVID-19 pandemic and activity spaces principal components, poisson and zero-inflated negative binomial regression models. 

|                        | Depression \(b\) (n = 222) | Anxiety \(b\) (n = 221) | Loneliness \(b\) (n = 221) | Drinking Days \(b\) (n = 237) |
|------------------------|-------------------------------|--------------------------|-----------------------------|-----------------------------|
| B (95% CI)             | B (95% CI)                    | B (95% CI)               | B (95% CI)                  |
| PC1: Social to family  | 0.06 (0.02, 0.10)**           | -0.01 (0.00, 0.03)       | 0.03 (0.00, 0.06)           | 0.03 (0.00, 0.06)           |
| PC2: Non-student activities to essentials | -0.05 (0.00, 0.03) | -0.04 (0.00, 0.03) | -0.03 (0.00, 0.06) | -0.08 (0.00, 0.10) |
| PC3: Continued services & low jobs | -0.10 (0.00, 0.03) | -0.08 (0.00, 0.03) | -0.04 (0.00, 0.06) | -0.10 (0.00, 0.06) |
| PC4: Non-child activities to pharm./low jobs | 0.04 (0.00, 0.07) | -0.03 (0.00, 0.03) | -0.01 (0.00, 0.03) | -0.03 (0.00, 0.03) |
| PC5: Little activities to social | 0.05 (0.00, 0.10) | 0.04 (0.00, 0.07) | 0.01 (0.00, 0.06) | 0.01 (0.00, 0.06) |

Zero inflation: 
- PC1: Social to family: 0.06 (0.00, 0.19) 
- PC2: Non-student activities to essentials: 0.17 (0.14, 0.20) 
- PC3: Continued services & low jobs: 0.35 (0.31, 0.40) 
- PC4: Non-child activities to pharm./low jobs: 0.41 (0.36, 0.46) 
- PC5: Little activities to social: 0.18 (0.14, 0.23)

*p < 0.05, **p < 0.01, ***p < 0.001.

All models adjusted for age, race/ethnicity, gender, sexual orientation, marital status, education, employment status, currently in school, living with children under age 18, and baseline score from February 2020.

Outcome assessed using a Poisson model.

Outcome assessed using a zero-inflated negative binomial model. Zero-inflation predictors included component scores and baseline drinking days from February 2020.

PC1 represents moving from a range of social activities before the pandemic to none (no strong loadings) during the pandemic.

PC2 represents non-student activities (e.g., negative loadings on school/universities) before the pandemic to essentials (e.g., big box stores, banks) and visiting family members’ homes during the pandemic.

PC3 represents continued food and social services before and during the pandemic, as well as low job attendance (negative loadings) during both periods.

PC4 represents non-child activities (e.g., negative loadings on daycare/school) before the pandemic to pharmacies and low job attendance during the pandemic.

PC5 represents moving from little activity (few locations strongly loaded) before the pandemic to a range of activity locations during the pandemic.

Compared to heterosexuals and cisgender individuals, sexual and gender minorities, of which make up approximately half our sample, also had significantly lower scores on PC2 (non-student activities to essentials) and family, which was associated with lower depression and drinking days. Our previous research indicates that this population is at a disproportionate burden of mental health problems during the pandemic (Coulter et al., 2022), and these activity patterns or lack thereof may provide or limit exposures that contribute to or attenuate these disparities. Interventions and policies aimed at addressing the psychological burden of the pandemic thus need to understand both how and why activity patterns have or have not changed.

4.1. Limitations

While this study was a preliminary investigation of changes in activity locations during the COVID-19 pandemic, there are a number of limitations that should be considered. Our sample was relatively small with missing data associated with age and sexual orientation. The sample was not random or representative of the entire county as we recruited from Facebook and Instagram and purposefully oversampled sexual and gender minorities. While this has the advantage of focusing on the impact of the pandemic on an understudied population, our results may not be generalizable to the county’s general population. As we recruited our sample via social media advertisements, we are also unable to assess the overall response rate of our survey. Additionally, our measures rely on self-report which may be susceptible to recall bias, especially for routine activities and outcomes for February 2020 that were measured between 2–3 months retrospectively.

In this study, we also did not separate routine activities that are inherently more social from other activities (e.g., going to a bar or club versus grocery shopping). We recognize that some activities were associated with increased COVID-19 transmission risk and therefore recommended more strongly to avoid. However, we included both types of activity locations in order to assess changes in all activities during the pandemic, including how activity locations for essential activities changed during this period. Additionally, our list of activity locations did not assess actual activity behavior at the location, but simply if the location had been visited. Therefore, we are not able to distinguish between types of activity at a location, such as dining at a restaurant or coffee shop versus carrying out. Moreover, the list of activity locations was used to measure only in-person visits to each location and did not account for virtual activities conducted at home, such as the transition to remote working and schooling that occurred throughout the country after the start of the pandemic. As activities that occur in-person likely lead to different physical and social exposures than virtual activities, future research should examine the influence of remote activities on mental health and substance use outcomes.

Lastly, our study only measured outcomes and activity locations at two time points, before the pandemic and from May–June 2020. As we did not assess change in activity locations or mental health and alcohol outcomes immediately following widespread COVID-19 transmission and lockdowns, we cannot assess temporality or causality in this analysis. Thus, it is possible there is a bidirectional or reverse effect on outcomes and change in activity locations, in that, for instance, those with increased depression symptoms may be more likely to change their activity patterns than those less affected. Additional research is needed to understand the dual effects of activity patterns and mental health and alcohol use in the context of a crisis.

4.2. Conclusions

The COVID-19 pandemic and associated restrictions have resulted in drastic changes to daily life and individuals’ physical and social environments. While limited in-person interaction outside of the household was necessary to reduce the transmission of COVID-19, it is important to understand how these changes in activity patterns impacted individuals’ health and well-being. Policies and guidelines restricting normal activities need to evaluate which restrictions may have the largest impact on psychological well-being while maintaining low transmission. Interventions addressing mental health and alcohol use should consider...
how these outcomes are impacted by routine activities and how these activities continue to change as the pandemic and social distancing policies evolve. Future research is needed to understand the long-term impacts of changes in activity patterns and associated outcomes and how these unintended consequences of pandemic mitigation policies can be effectively addressed.

**Funding**

This study was primarily supported by the Center for LGBT Health Research and the Center for Social Dynamics and Community Health within the University of Pittsburgh’s School of Public Health. Additional support was provided by the National Institutes of Health (NIH), National Institute on Alcohol Abuse and Alcoholism (NIAAA) grants P60AA062822 and K01AA027564 and National Institute on Drug Abuse (NIDA) grant F31DA052142. NIAAA and NIDA had no role in the study design, collection, analysis, or interpretation of the data, writing the manuscript, or decision to submit the paper for publication.

**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.

**Supplementary materials**

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.wss.2022.100092.

**References**

Albouk, R., Heydari, B., 2021. The immediate effect of COVID-19 policies on social-distancing behavior in the United States. Public Health Rep. 136, 245–252. https://doi.org/10.1177/0033354920965757.

Asmundson, G.G., Paluszczak, M.M., Landry, C.A., Racher, G.S., McKay, D., Taylor, S., 2020. Do pre-existing anxiety-related and mood disorders differentially impact COVID-19 stress responses and coping? J. Anxiety Disord. 74, 102271. https://doi.org/10.1016/j.janxdis.2020.102271.

Avery, A.R., Tsang, S., Seto, E.W., Duncan, G.E., 2020. Stress, anxiety and change in informal control capacity. Criminology 55, 754–787. https://doi.org/10.1177/0020764020922269.

Bader, P., Cornish, S., Vandelanotte, C., 2021. The Early Impact of Social Distancing Measures on Drug Use. Subst. Use Misuse 1–8. https://doi.org/10.1080/10826088.2021.1901934.

Clouston, S.P.A., Natale, G., Link, B.G., 2021. Social ecological inequities in the spread of coronavirus-19 in the United States: a examination of the emergence of social inequities. Soc. Sci. Med. 268, 113554. https://doi.org/10.1016/j.socscimed.2020.113554.

Cohen, L., Felson, M., 1979. Social change and crime rate trends: a routine activity approach. Am. Sociol. Rev. 44, 588–608. https://doi.org/10.2307/2094589.

Colbert, S., Wilkinson, C., Thornton, L., Richardson, R., 2020. COVID-19 and alcohol in Australia: industry changes and public health impacts. Drug Alcohol Rev. 39, 435–440. https://doi.org/10.1111/dar.13092.

Commonwealth of Pennsylvania, 2020a. Gov. Wolf announces 13 counties will move to yellow phase of reopening on May 15. Commonwealth of Pennsylvania. In: Gov. Tom Wolf. https://www.governor.pa.gov/newsroom/gov-wolf-announces-13-counties-will-move-to-yellow-phase-of-reopening-on-may-15/.

Commonwealth of Pennsylvania, 2020b. Reopening phase orders updated to include 10 additional counties moving to yellow and 16 to green on June 5. In: Commonwealth of Pennsylvania. Gov. Tom Wolf. https://www.governor.pa.gov/newsroom/reopenng-phase-orders-updated-to-include-10-additional-counties-moving-to-yellow-and-16-to-yellow-on-june-5/.

Coulter, R.W.S., Sumetsky, N., Marsh, L.N., Hoffman, B.L., Burke, J.G., Friedman, M.R., Mitchell, S., Escoabar-Viera, C., Egan, J.E., Mair, C., 2022. How has the COVID-19 pandemic affected mental health disparities for sexual and gender minority adults? Ann. LGBTQ Public Popul. Health. Submitted for publication.

Courtemanche, C., Garuccio, J., Le, A., Pinkston, J., Yelowitz, A., 2020. Strong Social Distancing Measures In The United States Reduced The COVID-19 Growth Rate. Health Aff. 39, 1297–1326. https://doi.org/10.1377/hlthaff.2020.06772.

Elmer, T., Stadfeld, C., 2020. Students under lockdown: comparisons of students' social networks and mental health before and during the COVID-19 crisis in Switzerland. PLoS One 15, e0236337. https://doi.org/10.1371/journal.pone.0236337.

Farhoudian, A., Radfar, S.R., Ardabili, H.M., Rafie, P., Ebrahimiy, M., Zonouzi, A.K., De Jong, C.A., Vahidi, M., Yusenes, M., Kouimtsidis, C., 2020. A global survey on changes in the supply, price and use of illicit drugs and alcohol, and related complications during the COVID-2020 pandemic. doi:10.2196/24591.

Fisher, J.R., Tran, T.D., Hammarg berg, K., Sats ry, J., Nguyen, H., Rowe, H., Popplestone, S., Stocker, R., Stub ber, C., Kirkman, M., 2020. Mental health of people in Australia in the first month of COVID-19 restrictions: a national survey. Med. J. Aust. 213, 458–464. https://doi.org/10.5694/mja2.50831.

Garner, R., Benetka, J.R., Kraemer, J., Bansal, S., 2021. Socioeconomic Disparities in Social Distancing During the COVID-19 Pandemic in the United States: observational Study. J. Med. Internet Res. 23, e24591. 10.2196/jmir.24591.

Hou, W.K., Lai, F.T., Ben-Ezra, M., Goodwin, R., 2020. Bregularizing daily routines for mental health during and after the COVID-19 pandemic. J. Glob. Health 10, 020315. https://doi.org/10.7189/jogh.10-020315.

Hughes, M.E., Waite, L.J., Hawley, K.L., Cacioppo, J.T., 2004. A short scale for measuring loneliness in large surveys: results from two population-based studies. Res. Aging 26, 665–672. https://doi.org/10.1177/0164027504268574.

Imagist, A., Cohen, D.A., Finch, R.K., 2007. Non-residential neighborhood exposure suppresses neighborhood effects on self-rated health. Soc. Sci. Med. 65, 1791–1797. https://doi.org/10.1016/j.socscimed.2007.09.003.

Jacob, L., Smith, L., Armstrong, N.C., Yakkundi, A., Barnett, Y., Butler, L., McDermott, D., 2020. COVID-19 stress responses and coping? J. Anxiety Disord. 74, 102271. https://doi.org/10.1016/j.janxdis.2020.102271.

Jong, C.A., Vahidi, M., Yusenes, M., Kouimtsidis, C., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet North Am. Ed. 395, 912–920. https://doi.org/10.1016/S1477-5558(20)30040-8.

Kidd, J.D., Jackman, K.B., Baracco, R., Dworkin, J.D., Dolezal, C., Navalta, T.V., Belloir, J., Becktig, W.O., 2021. Understanding the impact of the COVID-19 pandemic on the mental health of transgender and gender nonbinary individuals engaged in a longitudinal cohort study. J. Homosex. 1–20. https://doi.org/10.1080/00918369.2020.1868185.

Krouwe, K., Spitzer, R.L., Williams, J.B., Low, B., 2009. An ultra-brief screening scale for anxiety and depression: the PHQ-4. Psychosomatics 50, 613–621. https://doi.org/10.1176/appi.psy.50.6.613.

Krouwe, K., Spitzer, R.L., Williams, J.B., Low, B., 2009. An ultra-brief screening scale for anxiety and depression: the PHQ-4. Psychosomatics 50, 613–621. https://doi.org/10.1176/appi.psy.50.6.613.

Leedsma, R.D., Valero-Mora, P., 2007. Determining the number of factors to retain in an easy-to-use computer program for carrying out parallel analysis. Practical assessment, research and evaluation, 12 Article 2. 10.7257/prp-amp-63.

Loade, M.E., Chatburn, E., Higgin-Sweeney, N., Reynolds, S., Shafra, R., Bridgen, A., Linney, C., McManus, M.N., Borwick, C., Crawley, E., 2020. Rapid systematic review: the impact of social isolation and loneliness on the mental health of children and adolescents in the context of COVID-19. J. Am. Acad. Child Adolesc. Psychiatry 59, 1218–1239. https://doi.org/10.1016/j.jaac.2020.05.009.e1213.

Lowen, M., Michel, I., Rose, A., Matzer, C., Gaensslen, H., Krahmer, S., Schneider, A., Brabler, A., 2010. A 4-item measure of depression and anxiety: validation and standardization of the Patient Health Questionnaire-4 (PHQ-4) in the general population. J. Affect. Disord. 122, 86–95. https://doi.org/10.1016/j.jad.2009.06.019.
Mair, C., Frankeberger, J., Gruenewald, P.J., Morrison, C.N., Freisthler, B., 2019. Space and place in alcohol research. Curr Epidemiol Rep 6, 412–422. https://doi.org/10.1007/s40471-019-00215-3.

Marroquin, B., Vine, V., Morgan, R., 2020. Mental health during the COVID-19 pandemic: effects of stay-at-home policies, social distancing behavior, and social resources. Psychiatry Res. 293, 113419 https://doi.org/10.1016/j.psychres.2020.113419.

National Institute on Alcohol Abuse and Alcoholism, 2020. State Alcohol-Related Laws During the COVID-19 Emergency for On-Premise and Off-Premise Establishments As of April 13, 2020. National Institutes of Health, National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD. https://alcoholpolicy.niaaa.nih.gov/sites/default/files/static/apis_covid-19_memo_4.22.20_508c_(3).pdf.

Perchoux, C., Chaix, B., Cummins, S., Kestens, Y., 2013. Conceptualization and measurement of environmental exposure in epidemiology: accounting for activity space related to daily mobility. Health Place 21, 86–93. https://doi.org/10.1016/j.healthplace.2013.01.005.

Peterson, Z.D., Vaughan, E.L., Carver, D.N., 2020. Sexual identity and psychological reactions to COVID-19. Traumatology, No Pagination Specified-No Pagination Specified. 10.1037/trm0000283.

Pollard, M.S., Tucker, J.S., Green, H.D., 2020. Changes in adult alcohol use and consequences during the COVID-19 pandemic in the US. JAMA Netw. Open 3, e2022942. https://doi.org/10.1001/jamanetworkopen.2020.22942.

Ramalho, R., 2020. Alcohol consumption and alcohol-related problems during the COVID-19 pandemic: a narrative review. Aust. Psychiatry 28, 524–526. https://doi.org/10.1177/1039856220943024.

Reynolds, J., Wilkinson, C., 2020. Accessibility of 'essential' alcohol in the time of COVID-19: casting light on the blind spots of licensing? Drug Alcohol Rev. 39, 305–308. https://doi.org/10.1111/dar.13076.

Sanchez, T.H., Zlotorzynska, M., Rai, M., Baral, S.D., 2020. Characterizing the impact of COVID-19 on men who have sex with men across the United States in April 2020. AIDS Behav. 24, 2024–2032. https://doi.org/10.1007/s10461-020-02894-2.

Satre, D.D., Hirschtritt, M.E., Silverberg, M.J., Sterling, S.A., 2020. Addressing problems with alcohol and other substances among older adults during the COVID-19 pandemic. Am. J. Geriatr. Psychiatry 28, 780–783. https://doi.org/10.1016/j.jagp.2020.04.012.

Sumetsky, N., Frankeberger, J., Coulter, R.W.S., Burke, J.G., Friedman, M.R., Mair, C., 2021. Mental health and alcohol use during and before the early phases of the COVID-19 pandemic. Behav. Med. https://doi.org/10.1080/01615877.2021.1922552.

Usher, K., Bhullar, N., Jackson, D., 2020. Life in the pandemic: social isolation and mental health. J. Clin. Nurs. 29, 2756–2757. https://doi.org/10.1111/jocn.15290.

Yechezkel, M., Weiss, A., Rejwan, I., Shahmoon, E., Ben-Gal, S., Yamin, D., 2021. Human mobility and poverty as key drivers of COVID-19 transmission and control. BMC Public Health 21, 596. https://doi.org/10.1186/s12889-021-10561-x.

Zenk, S.N., Kraft, A.N., Jones, K.K., Matthews, S.A., 2019. Convergent validity of an activity-space survey for use in health research. Health Place 56, 19–23. https://doi.org/10.1016/j.healthplace.2019.01.009.