The Association between Loneliness with Increased Mental Health Problems and Substance Use During the COVID-19 Pandemic in Richmond, Virginia

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Abstract

***Background*:** The COVID-19 pandemic caused significant psychological distress among U.S. adults leading to increased rates of adverse mental health symptoms and substance use. This study aims to evaluate the consistency of the association between loneliness and increased mental health problems and substance use in Richmond, Virginia during the COVID-19 pandemic.

***Methods*:** Data were collected in two phases: 1) internet-based surveys from August 2020 to March 2021 (N = 327) and 2) paper-pencil surveys from May to October 2021 (N = 225). Logistic regression was used to test the association between loneliness and increased mental health and substance use, while adjusting for sociodemographic factors and pre-existing mental health conditions.

***Results*:** Both survey populations reported a high prevalence of increased loneliness (46.7% - 68.8%), mental health problems (50.2% - 67.3%), and substance use (22.2% - 29.4%) since the COVID-19 pandemic. Increased loneliness since the pandemic was significantly associated with increased mental health problems (Online survey: AOR = 5.00, 95% CI = 2.56 - 9.97; Paper-pencil survey: AOR = 10.48, 95% CI = 4.18 - 28.59) and increased substance use (Online survey: AOR = 3.14, 95% CI = 1.58 - 6.60; Paper-pencil survey: AOR = 5.89, 95% CI = 1.97 - 19.71).

***Conclusions*:** The association between increased loneliness and increased mental health problems and substance use during COVID-19 in Richmond, Virginia was consistent across the two survey populations and similar to the rest of the U.S.

Keywords: COVID-19, pandemic, loneliness, mental health, substance use

Background

Mental Health Burden of COVID-19 Pandemic in the U.S.

The COVID-19 pandemic has resulted in significant psychological distress among U.S. adults. In June 2020, increased levels of adverse mental health symptoms, substance use, and suicidal ideation were reported by U.S. adults. Specifically, 31% reported symptoms of anxiety or depressive disorder, 26% reported symptoms of trauma and stressor-related disorder, 13% started or increased substance use, and 11% reported considering suicide in the last 30 days (Czeisler et al., 2020). In July 2020, roughly 50% of U.S. adults reported the COVID-19 pandemic had a negative impact on their mental health, and this trend persisted through March 2021, with 47% of adults reporting symptoms of anxiety and/or depression (Panchal et al., 2021; Kearney et al., 2021). Additionally, between September 2019 - 2020, there were over 87,000 reported fatal drug overdoses, a 28.8% increase from the previous year, and the highest number of fatal overdoses reported in the U.S. in a single year (Ahmad et al., 2022).

Loneliness: A Potential Contributing Factor of COVID-19 Related Psychological Distress

There are many factors that contribute to the increase in adverse mental and behavioral health consequences. One factor could be the increased loneliness due to the social distancing measures mandated to reduce the spread of COVID-19. Loneliness, defined as perceived social isolation, refers to feelings of distress due to perception that their social needs are not being met by the quantity or quality of social relationships. Loneliness has been associated with poor physical and mental well-being (Cacioppo & Cacioppo, 2014; Hawkley & Cacioppo, 2010).

Loneliness and Mental Health Since the COVID-19 Pandemic

Feelings of loneliness increased since the COVID-19 pandemic began. In May 2020, 50% of Americans felt isolated compared to 23% in 2018 (NORC Issue Brief 1, 2020). This

trend continued through August 2020 with roughly two-thirds of U.S. adults reporting social isolation and increased stress and anxiety since the beginning of the COVID-19 pandemic (NORC Issue Brief 2, 2020). Increased feelings of social isolation due to the COVID-19 pandemic were associated with increased mental health problems. Roughly 40% of Americans reported that the social isolation from the COVID-19 pandemic made them feel more anxious and depressed than usual (American Association of Retired Persons Foundation & United Health Foundation, 2020). More than half of older adults reported increasing loneliness since COVID-19 that was associated with worsening depression and anxiety (Kotwal et al., 2020). Additionally, loneliness from the COVID-19 pandemic was associated with higher levels of poor mental health symptoms in U.S. adults (Horigian et al., 2020; Lee et al., 2020; Hansel et al., 2022). U.S. adult studies of loneliness and mental health during the COVID-19 pandemic are summarized in Table 1.

Loneliness and Substance Use Since the COVID-19 Pandemic

Social isolation related to COVID-19 has also been associated with substance use during the pandemic. A study in Austria revealed that social isolation was associated with an increased risk of alcohol use disorder relapse during the pandemic (Yazdi et al., 2020). Furthermore, loneliness during the COVID-19 pandemic in New Zealand was linked to increased tobacco use (Gendall et al., 2021). In Canada, loneliness was found to be significantly associated with increased alcohol and cannabis use (Brotto et al., 2021). Finally, in the U.S., individuals under stay-at-home orders were more likely to increase alcohol consumption (Killgore et al., 2021), and increasing loneliness was related to increased substance use during the COVID-19 pandemic (Sharma et al., 2020). Thus, increased prevalence of loneliness during the COVID-19 pandemic

has been associated with poor mental health and substance use outcomes. U.S. adult studies of loneliness and substance use during the COVID-19 pandemic are summarized in Table 1.

Pre-existing Mental Health and Substance Use Burden in Richmond, Virginia

Mental health and substance use have been persistent problems in Richmond, Virginia, and the COVID-19 pandemic may be exacerbating these issues. In 2015, a large-scale community health needs assessment in Virginia identified behavioral health conditions and substance abuse among the top five leading health issues in the state (Virginia Hospital and Healthcare Association, 2015). Additionally, residents of Richmond, Virginia have repeatedly identified mental health and substance use as a top health concern in their community (Richmond City Health District, 2017; Seventh District Health and Wellness Initiative, 2015; Seventh District Health and Wellness Initiative - Datapalooza Results 2015; Bon Secours Richmond Health System, 2019). However, the psychological effects of the COVID-19 pandemic in Richmond, Virginia are still unclear.

Currently, most studies assessing the psychological impact of the COVID-19 pandemic have been conducted at the national level through online surveys and in mostly White populations. However, it is unclear if the same trends are present at the local level and in African American populations (Table 1). Thus, the aims of this study are to (1) assess the prevalence of increased loneliness, mental health problems, and substance use in Richmond residents and (2) evaluate the association between increased loneliness and mental health problems and increased substance use in Richmond residents via online and paper-pencil surveys. We hypothesize that (1) there will be a high prevalence of increased loneliness, mental health problems, and substance use, and that (2) there will be significant associations between increased loneliness and

increased mental health problems and substance use since the COVID-19 pandemic began in both survey populations in Richmond, VA.

Table 1. Summary of U.S. Adult Studies of Loneliness, Mental Health Problems, and Substance Use During the COVID-19 Pandemic

Author and Year	Sample Size	Location	Racial/Ethnic Distribution of Participants	Data Collection Dates	Data Collection Method	Covariates	Loneliness	Mental Health	Substance Use	Association-Loneliness and Increased Mental Health Problems	Association-Loneliness and Increased Substance Use
Kotwal et al (2020)	151	U.S. (San Francisco Bay Area)	70% White	April 8-June 23, 2020	Phone interviews, small number via email or mail	Age, gender, race, marital status, education, financial stress, pre-COVID self-reported anxiety, depression, pre-COVID self-reported medical conditions, functional impairment	Self-reported change in loneliness ("worse, about the same, or better") and 3-item UCLA Loneliness scale	Anxiety (GAD2), Depression (PHQ2), asked how worried they are about the pandemic	N/A	Positive	N/A
Hansel et al (2022)	296	U.S. (55% Louisiana)	86% White	April 7-July 26, 2020	Online survey	Age, race, gender, marital status, income, pre-COVID mental health, physical health, or alcohol problems	Asked if they experienced social isolation during the pandemic	Anxiety (GAD2), Depression (PHQ2)	Alcohol misuse (CAGE)	Positive	No association
Sharma et al (2020)	542	U.S.	Did not specify	April 2020	Online Survey	Age, gender, educational status, pre-COVID mental health problems	3-item UCLA Loneliness scale	N/A	Self-reported change in vaping, marijuana, tobacco, alcohol use	N/A	Positive
Lee et al (2020)	564	U.S. (Seattle, WA)	54.5% White	Jan 6-30, & April 21 – May 18, 2020	Online survey	Age, race, sex, education, sexual orientation, perceived social support (in January 2020), concern about social impact of COVID-19 pandemic (in April/May 2020)	3-item UCLA Loneliness scale	Anxiety and Depression (PHQ4)	N/A	Positive	N/A
Kantor & Kantor (2021)	1005	U.S.	76% White	March 29-31, 2020	Online survey	Age, race, sex, income, education, marital status, location, religiosity, media consumption, time spent outdoors, home size, shelter-in-place order, employment loss, hospitalized in the last 2 years	8-item UCLA Loneliness scale	Anxiety (GAD7), Depression (PHQ9)	N/A	Positive	N/A
Horigian et al (2021)	1008	U.S.	76% White	April 22-May 11, 2020	Online survey	Age, race, gender, education, number of people in the household, self-reported practices of communication via technology, social connectedness (SC-15)	20-item UCLA Loneliness scale	Anxiety (GAD7), Depression (CES-D-10)	Alcohol (AUDIT-10), Drug Abuse (DAST-10)	Positive	Positive

Methods

The Richmond, Virginia COVID-19 Needs Assessment (RVA CoNA) began development in March 2020 to inform community leaders and stakeholders of the most important issues facing Richmond residents and people who work in organizations that offer services to Richmond residents. Partners agreed to develop the RVA CoNA using a highly collaborative process to incorporate input from residents, community leaders, and academic members through every stage of the process.

Any English or Spanish-speaking adult aged 18 or older residing in the Richmond region was eligible for participation. Upon survey completion, participants were invited to participate in a raffle for one of twenty $50 gift cards. Additionally, all participants received a resource card with health, employment, childcare, utilities, food delivery services and a "COVID-19 Quick Information Guide." All participants were also given the option to connect with a community partner if they indicated that they wanted to discuss a need they identified on the survey. For the in-person surveys, participants were given a small gift bag with items (e.g., small water bottle, snack bars, children's books) that did not exceed $5. The Virginia Commonwealth University Institutional Review Board reviewed and approved all research processes and procedures.

A pilot version of the survey was developed and tested prior to large scale administration. Twenty-seven residents, ages 22-77 years, participated in the pilot survey and 17 completed the entire survey (17 out of 27). Women represented 16 of the 17 participants that completed the entire survey. The average age of all participants was 43 years and 88.2% of participants (N = 15) indicated Black/African American race. Respondent feedback was generally positive, and interest was expressed about receiving overall survey results and how they will be used for

additional planning and programing. Survey enhancements after the pilot study included revising suboptimal wording and length of specific survey items.

Data Collection

Data collection was conducted in two phases: 1) internet-based surveys using the REDCap platform from August 3, 2020 to March 23, 2021 and 2) paper-pencil surveys from May 22 to October 15, 2021.

During Phase 1, data collection was entirely online using the REDCap platform (Harris et al., 2009). Study data were collected and managed using REDCap electronic data capture tools hosted at Virginia Commonwealth University. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies, providing (1) an intuitive interface for validated data entry, (2) audit trails for tracking data manipulation and export procedures, (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for importing data from external sources.

Internet-based recruitment and receipt of the survey link were conducted through (1) an informational flyer shared with a person who receives services from a community partner (e.g., food bank distribution), (2) an announcement in a community forum followed by a link shared by a general e-mail from the forum organizer to all forum participants, (3) a digital media post from a partner organization who received an IRB-approved text and flyer image via social media (e.g., Facebook, Instagram), or (4) when an individual received a survey link from a colleague or friend by word of mouth (e.g., text message or forwarded e-mail). Approximately 436 people started the online survey and of these, 75% completed the survey (N = 327). The distribution of survey participants is summarized in Table 2.

During Phase 2, data collection was conducted in-person in the Richmond community. Data collection teams consisted of a community resident who facilitated introductions with participants and an academic team member who conducted informed consent and administered the survey. In-person recruitment was conducted through community organization invitation via (1) pop-up tables at community events, (2) inviting residents who visited community resource centers, or (3) community walks with academic and community partners. Approximately 283 people started the paper-and-pencil survey and of these, 79.5% completed the survey (N = 225). The distribution of survey participants is summarized in Table 2.

Measures

Increased loneliness, increased mental health problems, and increased substance use since the beginning of the COVID-19 pandemic were measured as part of an instrument that measured changes as a result of the pandemic (Grasso et al., 2020). This section of items began with, "Since the COVID-19 pandemic began, what has changed for you or your family?"

Increased loneliness since the COVID-19 pandemic. An item asked about loneliness as, "Increased feelings of social isolation and/or loneliness" (Luchetti et al., 2020; Choi et al., 2021). This variable was measured as a binary categorical variable with responses of "Yes" and "No".

Increased mental health problems and substance use since the COVID-19 pandemic. Increased mental health was asked as, "Increase in mental health problems or symptoms (e.g., mood, anxiety, stress)." Increased substance use was measured as, "Increase in use of alcohol or substances" (Czeisler et al., 2020; Robillard et al., 2021). Both items were measured as binary variables with responses of "Yes" or "No".

Covariates

Anxiety and or Depression before the COVID-19 pandemic

This item, which was originally measured as two separate binary categorical variables (Miyakado-Steger & Seidel, 2019), was combined into one binary categorical variable. The anxiety and depression variables were combined due to literature showing high comorbidity rates of depression and anxiety disorders (Kessler et al., 1996; Hirschfeld, 2001) as well as previous studies that have analyzed them together as one variable (Czeisler et al., 2020; Panchal et al., 2021; Vahratian et al., 2021). *Loneliness* and *Stress* before the COVID-19 pandemic were measured as binary categorical variables, with responses of "Yes" or "No" (Hossain et al., 2020).

Age

Age was originally measured as a continuous variable and recoded to reflect a binary categorical variable with responses of 18-49 and 50-100 years old (Shi et al., 2020). Previous studies reported that younger age is related to increased mental health symptoms, substance use, and feelings of loneliness during the COVID-19 pandemic (de Bruin, 2020; Czeisler et al., 2020; Panchal et al., 2021; Kearney et al., 2021; NORC Issue Brief 2, 2020; American Association of Retired Persons Foundation & United Health Foundation, 2020; Hansel et al., 2022; Rumas et al., 2021).

Gender

Participants provided information regarding their gender identity using a five-level categorical item. Almost all participants provided responses in two categories: "Woman" and "Man", and 7-8 participants responded as either gender non-conforming/non-binary or "Other". Responses from these individuals were not included in the analyses. Gender was treated as a binary variable (Shi et al., 2020; de Bruin, 2020; Robillard et al., 2021). Prior research suggests

that women are reporting higher levels of COVID-19 pandemic-induced mental health problems (Kearney et al., 2021; NORC Issue Brief 2, 2020; American Association of Retired Persons Foundation & United Health Foundation, 2020; Hansel et al., 2022).

Marital Status

Participants responded to an item indicating marital status as an eight-level categorical variable. Responses were re-categorized into a binary variable ("Married and/or Living with partner" and "Single and/or divorced"). Previous studies have analyzed marital status as a binary categorical variable (Shi et al., 2020; de Bruin, 2020), and have found that marital status influences mental health outcomes.

Education

Participants responded to a seven-level item reflecting educational attainment: "None," "Less than High School," "High School Graduate or GED," "Some College (no degree)," "Vocational Training (business, trade or technical school)," "College Graduate (Associate's or Bachelor's Degree) or Greater," and "I choose not to answer." Responses were aggregated into two categories: "College Graduate or Greater" and "Some College or Less." Prior studies have analyzed education as a binary categorical variable (Shi et al., 2020; Robillard et al., 2021; de Bruin, 2020) and have demonstrated an association with mental health.

Race/Ethnicity

Participants responded to a seven-level categorical variable, which was recoded as a binary variable with responses of "White" and "Black and/or Other" (Robillard et al., 2021). Prior research has shown that communities of color are associated with increased mental health symptoms and substance use (McKnight-Eily et al., 2021, Czeisler et al., 2020, Panchal et al., 2021).

Financial Burden

Financial burden was asked as, “Before the COVID-19 pandemic, how much did you worry that your/your family's total income would not be enough to meet your/your family's expenses and bills?” Participants responded to a three-level ordinal variable (“A lot,” “A little,” “Not at all”), which was recoded as a binary categorical variable, measured as “No” and “Yes” (Center for Economic and Social Research at the University of Southern California, 2021; Kotwal et al., 2020). Evidence shows that individuals experiencing income insecurity reported increased rates of symptoms of anxiety and/or depression (Panchal et al., 2021).

Time Interval

Attitudes and behaviors may have evolved over the course of the pandemic. This variation was measured using an indicator of the number of days that had passed from the start of the survey for each participant. This time interval variable was treated as a continuous variable measured by subtracting the date the survey was taken from the study start date (August 3rd, 2020). A similar method was used in a previous study to account for the time passed since the pandemic was officially declared (Robillard et al., 2021).

Statistical Analysis

Unadjusted logistic regression tested bivariate associations between loneliness and mental health and substance use outcomes. Adjusted logistic regression accounting for the influence of the covariates was also used. Two models tested the associations between increased loneliness with increased mental health problems and increased substance use since COVID-19. All models accounted for the influence of sociodemographic factors, pre-existing mental health conditions, and time since the surveys began. All analyses were conducted in R - 4.0.3 (R Core Team, 2017).

Results

Online Survey Results

Descriptive Analysis

Three hundred and twenty-seven (327) people aged 18 - 90 years old (average age = 46.6, SD = 17.4; 80.1% female) participated in the online survey. Most participants identified as White (69.4%). Most participants were college graduates (76.8%). Roughly 57% were married or with a partner and about half (52%) reported no financial burden. Most participants reported increased loneliness (68.8%) and increased mental health problems (67.3%) since the COVID-19 pandemic. About one-third reported increased substance use (29.4%) since the COVID-19 pandemic (Table 2).

Logistic Regressions

Increased loneliness since the COVID-19 pandemic was significantly associated with increased mental health problems since COVID-19 (OR = 5.84, 95% CI = 3.51 - 9.85). This association remained significant after adjustment for covariates (AOR = 5.00, 95% CI = 2.56 - 9.97). Increased loneliness was also associated with increased substance use since COVID-19 (OR = 3.84, 95% CI = 2.08 - 7.59). This association remained significant after adjusting for covariates (AOR = 3.14, 95% CI = 1.58 - 6.60, Table 3).

Paper-and-Pencil Survey Results

Descriptive Analysis

Two hundred and twenty-five (225) people aged 20 - 80 years old (average age = 47.0, SD = 14.8; 70% female) participated in the paper-and-pencil survey. Most participants were identified as Black or Other Racial/Ethnic group (83.1%). Approximately 30.7% of participants in this sample were college graduates. Roughly 37.8% were married or living with a romantic

partner. Approximately 65% reported experiencing financial burden. Roughly half of participants reported increased loneliness (46.7%) and mental health problems (50.2%) since the COVID-19 pandemic. About one-fourth reported increased substance use (22.2%) since the COVID-19 pandemic (Table 2).

Logistic Regressions

Increased loneliness since the COVID-19 pandemic was significantly associated with increased mental health problems since COVID-19 (OR = 14.45, 95% CI = 7.59 - 28.75). This association remained significant after adjustment for covariates (AOR = 10.48, 95% CI = 4.18 - 28.59). Increased loneliness was also associated with increased substance use since COVID-19 (OR = 10.56, 95% CI = 4.71 – 27.10). This association remained significant after adjusting for covariates (AOR = 5.89, 95% CI = 1.97 - 19.71, Table 3).

Table 2. Summary Statistics

	Internet (N = 327)		Paper and Pencil (N = 225)	
	N	**%**	**N**	**%**
Since COVID-19:				
Increased Loneliness	225	68.8	105	46.7
Increased Mental Health Problems	220	67.3	113	50.2
Increased Substance Use	96	29.4	50	22.2
Before COVID-19:				
Stress	247	75.5	120	53.3
Anxiety and/or Depression	218	66.7	112	49.8
Loneliness	99	30.3	58	25.8
Gender				
Female	255	80.1	149	69.8
Male	65	19.9	68	30.2
Education				
College Graduate or Greater	249	76.8	69	30.7
Some College or Less	76	23.2	149	69.3
Marital Status				
Married/Partner	182	56.6	79	37.8
Divorced/Single	142	43.4	140	62.2
Race				
White	227	69.4	38	16.9
Black/Other	100	30.6	187	83.1
Financial Burden				
No	152	48.0	62	34.7
Yes	170	52.0	147	65.3
Age				
18-49	204	62.4	128	56.9
50+	123	37.6	97	43.1

Table 3. Unadjusted and Adjusted Estimates of Association between Increased Loneliness with Mental Health Problems and Substance Use Across Samples

	INTERNET				PAPER AND PENCIL			
	Increased Mental Health Problems		**Increased Substance Use**		**Increased Mental Health Problems**		**Increased Substance Use**	
	Unadjusted *OR* *(95% CI)*	**Adjusted *OR* *(95% CI)***	**Unadjusted *OR* *(95% CI)***	**Adjusted *OR* *(95% CI)***	**Unadjusted *OR* *(95% CI)***	**Adjusted *OR* *(95% CI)***	**Unadjusted *OR* *(95% CI)***	**Adjusted *OR* *(95% CI)***
Increased Loneliness Since COVID-19								
No	Reference		Reference		Reference		Reference	
Yes	**5.84 (3.51-9.85)**	**5.00 (2.56-9.97)**	**3.84 (2.08-7.59)**	**3.14 (1.58-6.60)**	**14.45 (7.59-28.75)**	**10.48 (4.18-28.59)**	**10.56 (4.71-27.10)**	**5.89 (1.97-19.71)**
Anxiety/Depression Before COVID-19								
No	Reference		Reference		Reference		Reference	
Yes	**4.88 (2.96-8.12)**	**2.80 (1.43-5.51)**	1.42 (0.85-2.44)	0.83 (0.43-1.59)	**7.16 (3.90-13.56)**	**3.94 (1.32-12.37)**	**9.52 (4.07-26.25)**	3.17 (0.87-12.92)
Loneliness Before COVID-19								
No	Reference		Reference		Reference		Reference	
Yes	**2.10 (1.23-3.67)**	0.84 (0.38-1.86)	1.16 (0.69-1.93)	0.93 (0.49-1.76)	**4.55 (2.34-9.32)**	1.02 (0.30-3.31)	**3.83 (1.90-7.81)**	1.43 (0.51-3.98)
Stress Before COVID-19								
No	Reference		Reference		Reference		Reference	

Yes	**7.91 (4.55-14.08)**	**3.99 (1.91-8.57)**	**1.85 (1.03-3.50)**	1.22 (0.58-2.62)	**5.10 (2.75-9.72)**	1.37 (0.48-3.86)	**7.47 (3.02-22.66)**	2.35 (0.62-10.17)
Age								
18-49	Reference		Reference		Reference		Reference	
50+	**0.16 (0.09-0.26)**	**0.25 (0.13-0.47)**	**0.23 (0.12-0.41)**	**0.30 (0.15-0.57)**	**0.46 (0.26-0.79)**	0.51 (0.20-1.23)	0.57 (0.29-1.11)	1.01 (0.39 -2.61)
Gender								
Female	Reference		Reference		Reference		Reference	
Male	0.69 (0.39-1.21)	0.67 (0.31-1.47)	1.21 (0.67-2.16)	1.16 (0.58-2.28)	0.76 (0.42-1.37)	0.60 (0.22-1.61)	1.01 (0.49-2.01)	1.38 (0.44-4.29)

Bolded estimates are significant at p<0.05

Table 3 (continued). Unadjusted and Adjusted Estimates of Association between Increased Loneliness with Mental Health Problems and Substance Use Across Samples

	INTERNET				**PAPER AND PENCIL**			
	Increased Mental Health Problems		**Increased Substance Use**		**Increased Mental Health Problems**		**Increased Substance Use**	
	Unadjusted	**Adjusted**	**Unadjusted**	**Adjusted**	**Unadjusted**	**Adjusted**	**Unadjusted**	**Adjusted**
	OR (95% CI)	***OR (95% CI)***	***OR (95% CI)***	***OR (95% CI)***	***OR (95% CI)***	***OR (95% CI)***	***OR (95% CI)***	***OR (95% CI)***
Education								
College Grad or Higher	Reference		Reference		Reference		Reference	

Some College or Less	**0.37 (0.22-0.63)**	0.52 (0.23-1.16)	**0.37 (0.18-0.70)**	0.68 (0.30-1.47)	**0.49 (0.27-0.89)**	0.38 (0.13-1.04)	**0.51 (0.26-0.99)**	0.64 (0.24-1.69)
Marital Status								
Married/Partner	Reference		Reference		Reference		Reference	
Divorced/Single	**0.53 (0.33-0.85)**	0.65 (0.32-1.30)	**0.57 (0.35-0.93)**	0.73 (0.41-1.31)	0.62 (0.35-1.08)	1.11 (0.41-3.09)	**0.50 (0.26-0.96)**	0.39 (0.14-1.10)
Race								
White	Reference		Reference		Reference		Reference	
Black/Other	**0.46 (0.28-0.75)**	0.63 (0.30-1.31)	**0.42 (0.23-0.73)**	0.69 (0.35-1.35)	**0.40 (0.18-0.84)**	1.12 (0.29-4.16)	0.47 (0.22-1.04)	1.64 (0.51-5.64)
Financial Burden								
No	Reference		Reference		Reference		Reference	
Yes	1.44 (0.90-2.31)	1.22 (0.64-2.33)	1.22 (0.76-1.98)	1.41 (0.81-2.47)	1.16 (0.64-2.12)	0.47 (0.16-1.29)	1.40 (0.68-3.02)	0.82 (0.28-2.39)
Time Interval	1.00 (1.00-1.01)	1.00 (1.00-1.01)	1.00 (0.99-1.00)	1.00 (0.99-1.00)	1.00 (0.99-1.01)	1.00 (0.99-1.01)	1.00 (0.99-1.01)	1.00 (0.99-1.01)

Bolded estimates are significant at p<0.05

Discussion

To our knowledge, this was the first study to evaluate the association of loneliness with mental health and substance use at a community level in Richmond, Virginia during the COVID-19 pandemic using both internet-based and paper-and-pencil surveys. It was hypothesized that (1) there would be a high prevalence of increased loneliness, mental health problems, and substance use, and that (2) there would be significant associations between increased loneliness and increased mental health problems and substance use in both survey populations. The results supported our hypotheses. A large portion of Richmond residents were experiencing increased loneliness, mental health problems, and substance use during the COVID-19 pandemic. Additionally, increased loneliness was significantly associated with increased mental health problems and increased substance use in both internet and paper survey populations. Our hypotheses were further supported by the high degree of consistency in our results across the two survey samples, which had very different demographics.

Prevalence of Loneliness, Mental Health Problems, and Substance Use During the COVID-19 Pandemic

There was a high prevalence of increased loneliness, mental health problems, and substance use since the start of the COVID-19 pandemic in Richmond residents. The online and paper-and-pencil surveys found that roughly half of the participants reported increased loneliness and mental health problems, and roughly a quarter of participants reported increased substance use. The slightly lower prevalence of loneliness, substance use, and mental health symptoms among paper-and-pencil survey participants could be due to the later time frame of data collection, which is supported by a previous study showing a higher prevalence of mental health

symptoms closer to the initial COVID-19 lockdown (Brotto et al., 2021). The largely consistent results across the two different samples suggest that Richmond residents of various demographics experienced increased psychological distress due to the pandemic. These results are comparable to national rates of increased loneliness, mental health symptoms, and substance use during the COVID-19 pandemic (NORC Issue Brief 2, 2020; Horigian et al., 2020; Hansel et al., 2022).

Association Between Loneliness and Increased Mental Health Problems

There were significant positive associations between increased loneliness and increased mental health problems, which remained significant after controlling for sociodemographic factors, pre-existing mental health conditions, and time since the surveys began. Replication across two different survey samples produced similar outcomes, demonstrating the robust nature of the association between loneliness and increased mental health problems during the pandemic. These results align with national data (Kantor & Kantor, 2020) and previous research demonstrating that loneliness is a risk factor for a variety of mental health issues (Mushtaq et al., 2014).

Association Between Loneliness and Increased Substance Use

Similarly, after adjusting for covariates, increased loneliness was significantly associated with increased substance use. The online survey results were consistent with the replicated analysis in the paper survey population. These results are consistent with national data (Sharma et al., 2020) and prior research demonstrating that loneliness is a risk factor for substance abuse (Hosseinbor et al., 2014; Mushtaq et al., 2014; McDonagh et al., 2020).

Limitations

These results should be considered in the context of the following limitations. First, this study cannot conclude directionality of the associations due to the cross-sectional study design. Nevertheless, this study focused on the relationship between COVID-19 pandemic-related loneliness, mental health symptoms, and substance use. The goal of this preliminary study was not to conclude direction of causation, and future studies focused on this question are encouraged. Second, due to community partners' priorities to reduce participant burden, validated tools to assess loneliness, stress, depression, anxiety, and substance use were not used. The lack of standardized measures makes it challenging to compare these results with other studies. Nonetheless, our results are consistent with those in previously published studies. Third, we were unable to follow changes in behavior over time. Instead, participants reported perceived changes in substance use and mental health problems, which may be subject to recall bias. Longitudinal studies of these outcomes are necessary to determine whether these issues will persist in the years following the pandemic.

Future Directions and Practical Implications

Our study illustrated the role of loneliness related to mental health and substance use. There may be several underlying factors contributing to this relationship. For example, social support is associated with reduced loneliness (Czaja et al., 2021) and a lower risk of developing depressive symptoms (Rosenquist et al., 2010, Santini et al., 2014). The stress-buffering model posits that social support buffers the negative effects of life stressors, improving psychological well-being (Cohen & Wills, 1985). Another factor to consider is relationship stress. For instance, relationship strain is related to increased loneliness (Hawkley et al., 2008) and greater mental distress (Whisman & Uebelacker, 2006). The stress-exacerbation model suggests relationship

stress compounded with other life stressors overloads a person's coping capacity, causing increased negative emotional symptoms (August et al., 2007, Rodriguez et al., 2019). We tested whether relationship stress moderated the association between loneliness and increased substance use as well as increased mental health problems. However, no significant moderation was detected. Future studies should build on our results by exploring the role of social support and relationship stress on the associations between loneliness, mental health, and substance use since they may be important factors influencing these associations.

Data from this study suggest that future support for individuals with mental illness and/or engaged in substance use should consider the role of loneliness. Meaningful interventions to help with the prognosis and recovery of individuals with mental health and substance use disorders include screening for loneliness (Russell, 1996) and connecting lonely individuals with peer support and psychoeducation groups (Haslam et al., 2016; Chiu et al., 2017; Rönngren et al., 2018). Furthermore, these results suggest that addressing loneliness in different communities may benefit from the use of different outreach modalities. For example, some communities may benefit from in-person, hands-on activities related to loneliness. Other communities may benefit from virtual activities. This study demonstrates associations in the Black community that are also consistent with results identified in a White sample in the same region. Nevertheless, the psychological impact of the COVID-19 pandemic on the Black community remains understudied. More research needs to be conducted with this population to develop effective public health policies and strategies to promote mental wellness in the future.

Conclusion

This study provides important insight to the existing body of research examining the psychological impacts of the COVID-19 pandemic. To our knowledge, we are among the first to

use two samples to replicate the associations between loneliness and increased mental health and substance use. Further, this study was also conducted in a predominantly Black community, which is typically underrepresented in research. This study demonstrated that increased loneliness, mental health symptoms, and substance use are significant issues in the Richmond area and should motivate additional action from policymakers to support broad approaches to supporting psychological wellness throughout the COVID-19 pandemic and beyond.

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