Impact of social isolation and loneliness on mental health and wellbeing

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Impact of social isolation and loneliness on mental health and wellbeing

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Editorial: The impact of social isolation and loneliness on mental health and wellbeing

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Editorial on the Research Topic
The impact of social isolation and loneliness on mental health and wellbeing

Loneliness and social isolation are critical for health and wellbeing. Social isolation is a well-established social determinant of health, and its ill effects have been well-recognized for decades. Over the last 20 years, researchers have increasingly advocated that our health and wellbeing are not only detrimentally affected by being alone but also by feeling lonely (i.e., subjective social isolation) (1). Loneliness was flagged as a critical issue after the onset of the current public health crisis and was recently found to be a prevalent issue across the world (2). Although loneliness is studied as a phenomenon across different nations and cultures, and within different social groups, the exact meaning of loneliness, its antecedents, and its consequences on mental health and wellbeing may vary (3).

The way in which loneliness and social isolation contribute to mental health and wellbeing may be different during the COVID-19 pandemic. This was particularly evident after public health measures such as social restrictions, including national or localized lockdowns, were implemented. Furthermore, quarantine or self-isolation was also recommended for reducing infection (4). It is plausible that many people may have experienced the distress associated with social isolation or loneliness, or both, for the very first time during periods of lockdown, quarantine, and self-isolation. The impacts of quarantine or self-isolation may vary by population. In some populations, self-isolation due to COVID-19 had little influence on daytime sleepiness, insomnia, or depression compared with 1 year earlier (5).

Research interest in this topic has accelerated, with the number of publications about "social isolation" or "loneliness" jumping significantly since 2020 (Figure 1). This reflects the public and research community interest in loneliness and social isolation during the

COVID-19 pandemic. The estimated number of publications about "social isolation" or "loneliness" in 2022 decreased from that of 2021 (Figure 1). This decrease may reflect lower interest due to the lower incidence of new COVID-19 cases since January 2022 (6).

This Research Topic was open for submission between 2021/7/16 and 2022/5/31, during the COVID-19 pandemic. Fourteen papers were published on this special topic. Eleven of them had the term "COVID-19" (Bentley et al.; Liu et al.; Okajima et al.; Mansour et al.; Chernova et al.; McDowell et al.; Peng et al.; Lv et al.; Luo et al.; Pilcher et al.) or "coronavirus" (Goddard et al.) in the title, and another study (Lim et al.) tracked changes over time during the pandemic. Two papers were unrelated to the pandemic (Landry et al.; Chiao et al.). There was a report originally submitted to this Research Topic but it was eventually published in another section of this journal (7).

Five studies analyzed young participants aged 13–29 years old. Liu et al. and Okajima et al. studied high school students. Landry et al., Lv et al., and Chiao et al. studied young adults. Even though loneliness is also an important issue for older people (8), none of the studies in this Research Topic examined loneliness in older adult samples. Three studies targeted specific populations: Goddard et al. recruited people with mobility disabilities; Peng et al. studied consumers and their purchasing intentions; and Mansour et al. recruited men for their study. Most papers only focused on loneliness, but four investigated social isolation(Goddard et al.; Landry et al.; Luo et al.; Pilcher et al.).

Most studies analyzed social isolation and loneliness and their impact on mental health symptoms or related issues. Four studies analyzed depression (Liu et al.; Lim et al.; McDowell et al.; Lv et al.), three analyzed distress (Bentley et al.; Liu et al.; Chernova et al.) and anxiety (Okajima et al.;

Lim et al.; McDowell et al.), and two analyzed sleep or sleep problems (Okajima et al.; Pilcher et al.). In addition, there were international collaborations during the pandemic (9). Two international studies are reported in this Research Topic (Bentley et al.; Lim et al.). The first study examined the association between loneliness and distress in the early stage of the pandemic in eleven countries (Bentley et al.). A subset of countries (three countries) in the study also repeated the analysis 3 months later and revealed that increased loneliness over time was associated with increased psychological distress (Bentley et al.). The second study examined how social restrictions contributed to the severity of loneliness, depression, and social anxiety in participants recruited from the United Kingdom, Australia, and the United States (Lim et al.). The authors found that as social restrictions eased, loneliness and depression reduced, but there was an increase in social anxiety. Overall, the findings of these studies highlighted how sleep problems, social anxiety, and depression are interrelated (10). However, whether these interrelationships are maintained outside of the context of the pandemic remains unclear without the inclusion of pre-COVID-19 data.

The restrictions imposed on people's lives due to COVID-19 have come as a critical reminder of how fundamental social relationships are to our mental health and wellbeing. Countries around the world observed increasing rates of mental ill health during the pandemic and responded with significant government investment and policy changes to combat it (11).

Overall, the pandemic and its associated consequences for health and wellbeing may have highlighted the critical need for being around people and being meaningfully connected to others around us. A deeper knowledge of loneliness and social isolation is required to allow us to better understand their impact on mental health and wellbeing.

FIGURE 1
The number of publications about social isolation and loneliness by year. Data were obtained from Scopus (https://www.scopus.com/; accessed on 2022/11/4) through searches for "social isolation" or "loneliness" (blue line) and "social isolation" or "loneliness" plus "COVID-19" (orange line). The figures for 2022 were estimated from the numbers as of 2022/11/4.
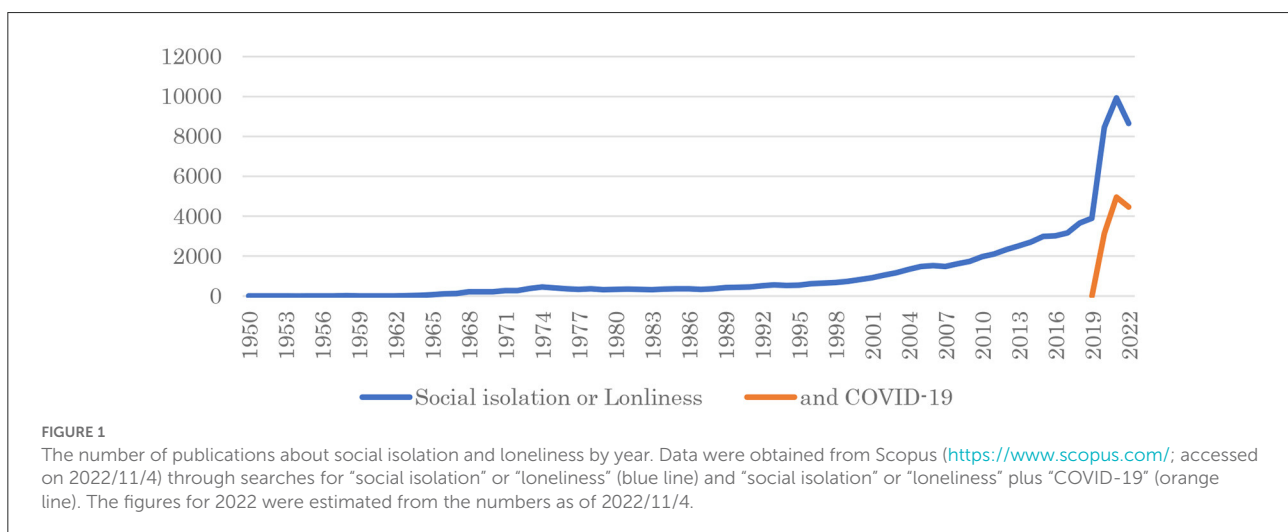
Author contributions

HK wrote the first draft of the manuscript. ML wrote sections of the manuscript. All authors contributed to the conception, manuscript revision, read, and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The Mediating Role of Resilience and Extraversion on Psychological Distress and Loneliness Among the General Population of Tyrol, Austria Between the First and the Second Wave of the COVID-19 Pandemic

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Background: During the first 3 weeks of the COVID-19 pandemic, the federal state of Tyrol, Austria had one of the strictest curfews in Austria and worldwide. The aim of the current study was to investigate the assumingly protective role of resilience and extraversion and its impact on mental health following such an uncertain and unpredictable situation.

Methods: Between the first and the second wave of the pandemic, adult residents of Tyrol were invited to participate in an online survey. Next to the assessment of sociodemographic and COVID-19-related variables the Brief-Symptom-Checklist, the Three-Item Loneliness Scale, the Resilience Scaled, and the Big Five Inventory were used to assess psychological distress, loneliness, resilience, and extraversion. Mediation analysis was used to investigate the role of resilience and extraversion in the context of age-, sex-, and partnership- related differences in psychological distress and loneliness.

Results: One hundred and forty-five participants took part in the survey (68.2% female). Overall, psychological distress and severe loneliness were more often detected in women and singles. They also were less resilient, while men and singles presented with a lower degree of extraversion. Study participants under the age of 30 experienced severe loneliness more frequently than older people, whereas psychological distress, resilience, and extraversion were comparable between age groups. Resilience significantly mediated the relationship between both study participants' sex and partnership situation on one hand and psychological distress and severe loneliness on the other. In addition, extraversion significantly mediated the relationship between participants' partnership situation and psychological distress.

Discussion: Our findings suggest that women, singles, and young people may be particularly affected by the measures and sequelae of the COVID-19 pandemic. Interventions promoting resilience and extraversion among these groups are urgently needed to foster mental health. Ideally, they can be utilized at home in case of renewed mobility restrictions or quarantine in the future.

INTRODUCTION

The COVID-19 pandemic reached Tyrol, Austria as one of the first regions in Europe in March 2020 (1). As declared by the Islandic authorities on March 5th, the ski resort of Ischgl ranked as a risk region at the beginning of the pandemic (2). Initially, the Austrian government reacted with quarantine measures for the Ischgl area, and subsequently for entire Tyrol, followed by a first nation-wide lockdown on March 16th (1). The special aspect of the measures in Tyrol was that no one was allowed to leave the house without a compelling reason, but only for buying groceries, to get to the workplace, or to assist care-dependent others (3). Even going for a walk at a distance of one meter was not allowed in Tyrol (3, 4), but in the rest of Austria (5). This quarantine in Tyrol ended on April 7th, and the first lockdown in Austria on May 1st, 2020 (6). The governmental relaxations in May and June 2020 initially raised the hope for the return to normality and the defeat of the virus. However, it is known that quarantine, as an unexpected intervention in everyday life, can have negative psychological impacts (7). All over the world, the prevalence of psychological distress (8–10) and loneliness (11, 12) has increased in the context of the pandemic. Moreover, boredom is a major issue during lockdown that particularly affects women, singles, unemployed, and low-income people (13). In this context, it is important to foster protective factors that can contribute to maintaining psychological stability. Next to coping mechanisms and social support, the overall construct of resilience is deemed to be relevant in this context.

The concept of resilience describes a dynamic system to cope with adverse life events and stress (14) as well as the ability to quickly balance, recover, and return to a healthy initial state (15). It is still a young concept (15) and to date, there is no uniform definition of resilience (16). Generally, resilience is known to protect from psychological distress (17) and loneliness (18). Moreover, higher levels of resilience are associated with better psychological well-being (17, 19), lower levels of anxiety (17) and depression (17, 20–22), a decreased likelihood of posttraumatic stress disorder (23), and less stress (24). These are important factors in managing the COVID-19 pandemic. Thus, we hypothesized that people with higher resilience are less stressed by the pandemic, the countermeasures, and their sequelae. Next to resilience, certain personality traits could also have an influence on coping strategies (25). Extraversion seems to be particularly important in this context, as extroverts are particularly in need of closeness and contact to other people.

Extraversion is a personal trait describing active people who are sociable, talkative, and assertive (26). These people tend to be outgoing, prone to establish social contacts, seeking for closeness (27), and thus, they prefer large groups and gatherings (25). They are likely to have high self-esteem (28), and to experience peculiar and complex events with lower stress levels and more positive feelings (29). Examining extraversion in relation to psychological distress and loneliness is important, because there were no curfews to this large extent in times of peace prior to COVID-19. Since previous research has shown that people with higher extraversion are inert to stress (30), we hypothesized that people with higher levels of extraversion were less psychologically distressed after the first lockdown.

Most previous studies on psychological distress and loneliness during the COVID-19 pandemic focussed predominantly on the time period during lockdown. However, our online survey was done in the period between the first and the second lockdown in Austria, when governmental restrictions were softened. The aim of the current study was to investigate the assumingly protective role of resilience and extraversion and its impact on mental health following such an uncertain and unpredictable situation.

METHODS

Focussing on the general population of Tyrol, Austria (approximately 760,000 inhabitants), we used a web-based, cross-sectional survey to evaluate the associations between resilience and extraversion and their impact on psychological distress and loneliness amidst the COVID-19 pandemic. The survey was conducted between June 26th and September 13th, 2020.

Data collection was performed in an anonymized manner using the web-based software program Computer-based Health Evaluation System (CHES) (31). Next to the collection of sociodemographic and COVID-19-related data psychological distress, loneliness, resilience, and extraversion were investigated by using online questionnaires (see below).

Members from the general population of Tyrol aged above 18 were invited to participate in the study through advertising in both print and social media. Online consent was obtained at the beginning of the survey and participants were asked to provide an email address in order to be reminded for follow-up surveys. Provision of email addresses was not a prerequisite to participate in the baseline survey. At the end of the survey, participants received a downloadable information sheet on professional support numbers and addresses. Ethical approval was obtained from the ethics committee of the Medical University Innsbruck.

Sociodemographic and COVID-19-Related Data

Data on a variety of demographic aspects were collected including age, gender, education, employment status, professional field, household income, marital and parental status, living situation as well as personal and family history of psychiatric disorders. In addition, some COVID-19-related questions were included, e.g., whether participants had been tested for COVID-19, whether some of their relatives had been tested positive, and whether the measures to prevent the spread of the virus were considered as useful.

Psychological Distress

The Brief-Symptom-Checklist (BSCL) (32) was used to evaluate participants' subjectively perceived impairment through 53 physical and psychological symptoms. Items were rated on a 5-point Likert scale (0 = not at all, 4 = extremely). The BSCL quantifies nine symptom dimensions: somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. A Global Severity Index (GSI) is calculated using the sums of the nine symptom dimensions plus four additional items not included in any of the dimension scores divided by the total number of answered items. Based on community norms, a GSI T-score ≥ 63 was used as a cut-off score to indicate significant distress. The BSCL has shown good to satisfactory internal consistency for all subscales (Cronbach's α ranging from 0.70 to 0.89) and excellent external consistency for the GSI score (α = 0.96) (33).

Loneliness

Loneliness was assessed by using the Three-Item Loneliness Scale (TILS) (34), which is known to demonstrate acceptable internal consistency (Cronbach's α = 0.72). The TILS represents an abbreviated form of the Revised University of California Los Angeles (R-UCLA) Loneliness Scale (35). Participants are asked "How often do you feel that you lack companionship?", "How often do you feel left out?", and "How often do you feel isolated from others?". Possible answers are "often" (scored 1), "some of the time" (scored 2), and "hardly ever or never" (scored 3). The summary score ranges from 3 to 9 points, higher scores suggest greater loneliness. A TILS-score ≥ 7 was considered to indicate severe loneliness.

Resilience

Resilience was evaluated using the Resilience Scale (RS-13) (36), a revised short form of the RS-25 (37) with a good internal consistency of Cronbach's α = 0.90 (36). It consists of 13 items scored on a 7-point scale, ranging from 1 = strongly disagree to 7 = strongly agree. Possible scores range from 13 to 91, higher scores indicate higher resilience. A score up to 66 reflects low resilience, scores between 67 and 72 indicate moderate resilience, and scores of 73 and higher indicate high resilience.

Extraversion

The Big Five Inventory (BFI) (38) is a 44-item self-administered questionnaire, which measures the five personality traits extraversion, openness, conscientiousness, agreeableness, and neuroticism on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The German version used in this study has been validated by Lang et al. (39). We exclusively applied the extraversion subscale (8 questions), which has a good internal consistency (Cronbach's α = 0.90) (39). Possible scores range from 8 to 40, higher scores indicate more pronounced extraversion.

Statistical Methods

All statistical analyses were performed using SPSS, version 26. Sociodemographic and health-related sample characteristics were described by simple summary statistics, means, standard deviations, relative frequencies, etc. The main focus of the analysis was placed on psychological distress and loneliness as the primary outcome variables and on resilience and extraversion as potentially protective factors. Psychological distress and loneliness were dichotomized for the analysis (GSI T-score ≥ 63 vs. < 63, TILS total score ≥ 7 vs. < 7, respectively), whereas resilience (RS-13 total) and extraversion (BFI subscale Extraversion) were used as continuous scales. Group differences in psychological distress and severe loneliness with regard to age, sex, and partnership were analyzed by means of Chi-square tests, using odds ratios to quantify effect sizes. Due to the skewed distribution of resilience and extraversion, group differences in these variables were analyzed by non-parametric methods (Mann–Whitney U-test, Kruskal–Wallis test).

To investigate the relationship between the above variables in more detail we performed several mediation analyses both for the dependent variables psychological distress and severe loneliness (variable Y). The variables sex (male, female), age group (three groups) and partnership (yes/no) served as independent variables (variable X). Resilience and extraversion were regarded as potential mediators, testing for the significance of their effect (variable M). Group variables that were not used in a particular analysis were included as covariates to control for their effect. In each of the mediation analyses, the total effect of X on Y was split up into a direct effect of X on Y and a mediation effect, where the latter represented the part that is accounted for by the mediators via the path X → M → Y. For model fitting and parameter estimation, we applied the PROCESS macro developed by Hayes, using the mediation model no. 4 (40). Significance was confirmed by the Sobel Z-test and bootstrapping with 5,000 bootstrap samples. All continuous variables were z-standardized prior to the mediation analysis.

RESULTS

A sample of 1,045 people from the general population of Tyrol participated in the study. Mean age was 41.4 ± 14.0 years, 68.2% were female 68.6% had a full-time or part-time employment, and the majority (74.4%) were in a permanent partnership. At the time of the survey, 10.4% of respondents were in psychological/psychotherapeutic treatment, and 6.9% in psychiatric treatment. Sociodemographic characteristics of the study sample and health-related variables are presented in **Table 1**.

TABLE 1 | Sociodemographic and health-related variables (N = 1,045).

Variable	Mean ± SD or N (%)
Sex	
Male	331 (31.7%)
Female	713 (68.2%)
Others	1 (0.1%)
Age (Years)	41.4 ± 14.0 (18–96)
Education (Years)	15.5 ± 3.8 (8–30)
Partnership	
Single	267 (25.6%)
Permanent partnership	777 (74.4%)
Children in same household	
None	696 (66.8%)
1	142 (13.2%)
2	158 (15.2%)
≥3	46 (4.4%)
Work situation	
Full time or part-time employment	716 (68.6%)
Self-employed	45 (4.3%)
Education/training	74 (7.1%)
Home office	13 (1.2%)
Short-time work	26 (2.5%)
Unemployed	12 (1.1%)
Retired	97 (9.3%)
Homemaker	19 (1.8%)
Others	42 (4.0%)
Household income	
<25,000 €/year	392 (37.5%)
25,000–49,999 €/year	387 (37.0%)
≥50,000 €/year	235 (22.5%)
Not specified	31 (3.0%)
Place of residence	
Urban (Innsbruck > 100,000 inhabitants)	346 (33.0%)
Village or small town	640 (61.1%)
Places with high exposition to COVID-19	50 (4.8%)
Not specified	9 (0.9%)
Severe physical health problems	90/1,043 (8.6%)
Mental health problems, lifetime	181/1,043 (17.4%)
Current psychiatric treatment	72/1,043 (6.9%)
Current psychological/psychotherapeutic treatment	108/1,043 (10.4%)
Psychological distress [GSI T-Score (BSCL) ≥63]	145/998 (14.4%)
Severe loneliness (TILS score ≥7)	223/1,004 (22.2%)
Resilience (RS-13 total score)	71.7 ± 12.3
Extraversion (BFI total score)	27.8 ± 5.8
SARS-CoV-2 test	
No test performed	742 (71.0%)
Negative test result	274 (26.2%)
Positive test result	23 (2.2%)
Result unknown/not specified	6 (0.6%)
Severity of COVID-19 Symptoms (n = 23)	
No symptoms	5 (21.7%)
Mild symptoms	10 (43.5%)
Symptoms with fever, treatment at home	7 (30.4%)
Severe symptoms, treatment in hospital	1 (4.3%)

BSCL, Brief-Symptom-Checklist; TILS, Three Item Loneliness Scale; RS-13; Resilience Scale; BFI, Big Five Inventory.

Differences in Psychological Distress, Loneliness, Resilience, and Extraversion Between Subgroups

Differences in psychological distress, loneliness, resilience, and extraversion between subgroups are displayed in **Table 2**. With regard to sex, significantly more women than men reported psychological distress (16.2 vs. 10.4%). Women were also twice as likely to report severe loneliness (TILS score ≥7) (26 vs. 13.5%). In the RS-13, men indicated a significantly higher degree of resilience with a mean of 73.4 ± 11.5 points compared to a mean of 70.9 ± 12.7 points in women. In turn, a mean of 28.1 ± 5.9 points in the BFI indicates that women were significantly more extraverted than men (27.3 ± 5.6 points).

When using partnership situation as a grouping variable, a significantly higher proportion of singles reported psychological distress (22.1%) and severe loneliness (33.3%) compared to study participants living in a permanent partnership (11.9 and 18.4%, respectively). Similarly, singles indicated a significantly lower degree of resilience compared to those living in a permanent partnership (mean of 68.6 ± 13.8 vs. 72.7 ± 11.6 points in the RS-13) and were significantly less extraverted (mean of 27.1 ± 6.2 vs. 28.1 ± 5.6 points in the BFI).

Age was divided into three groups. Psychological distress, resilience, and extraversion were comparable between age groups, whereas, severe loneliness was significantly more frequently observed in the group aged 18–29 years (28.2%) compared to the groups aged 30–59 years (20.9%) and 60–96 years (15.9%).

Association of Resilience and Extraversion With Psychological Distress and Severe Loneliness

We found a positive interrelation between resilience and extraversion. These two constructs were negatively associated with both psychological distress and severe loneliness (**Table 3**).

Results of Mediation Analyses

The findings of the mediation analyses are displayed in **Figures 1**, **2** and in Tables A1, A2 (**Supplementary Material**). We first investigated to what extent the sex differences in psychological distress (higher prevalence in women, **Table 2**) were mediated by resilience and/or extraversion. As shown in **Figure 1A**, resilience emerged as a significant mediator of the sex differences (c-c' = 0.090, p = 0.003), whereas extraversion did not. A considerable proportion of the sex differences (35.3%) was attributable to resilience. The direct effect of sex on psychological distress lost its significance (p = 0.127), which may partly be a power problem, as the effect size was still rather large (c' = 0.162, 64.3% of total effect). Differences in psychological distress between study participants in a permanent partnership and singles were investigated in the same way. Both resilience and extraversion significantly mediated the effect of partnership, accounting for a proportion of 41.4% of the total effect attributable to the two mediators. The direct effect of the partnership situation on psychological distress remained significant. Regarding age, mediation analysis revealed no significant effect of either resilience or extraversion. Details can be found in **Table A1**.

TABLE 2 | Differences in psychological distress, loneliness, resilience, and extraversion between subgroups (sex, partnership situation, and age group).

Grouping variable		Group 1	Group 2 (reference)	Comparison		
Sex		**Female**	**Male**	**Effect size**	**Statistics[a]**	**p-value**
Psychological distress	% (N)	16.2% (113/689) ↑	10.4% (32/308)	OR = 1.69	$\chi^2 = 6.19$	0.013
Severe loneliness	% (N)	26.0% (180/692) ↑	13.5% (42/311)	OR = 2.52	$\chi^2 = 19.47$	<0.001
Resilience	Mean ± SD	70.9 ± 12.7 ↓	73.4 ± 11.5	d = −0.20	Z = −3.02	0.003
Extraversion	Mean ± SD	28.1± 5.9 ↑	27.3 ± 5.6	d = 0.14	Z = 2.12	0.034
Partnership situation		**No partnership**	**Partnership**	**Effect size**	**Statistics**	**p-value**
Psychological distress	% (N)	22.1% (57/258) ↑	11.9% (88/740)	OR = 2.10	$\chi^2 = 16.03$	<0.001
Severe loneliness	% (N)	33.3% (86/258) ↑	18.4% (137/746)	OR = 2.22	$\chi^2 = 24.86$	<0.001
Resilience	Mean ± SD	68.6 ± 13.8 ↓	72.7 ± 11.6	d = −0.34	Z = −4.07	<0.001
Extraversion	Mean ± SD	27.1 ± 6.2 ↓	28.1 ± 5.6	d = −0.17	Z = −2.00	0.048
Age group		**Group 1 (18–29 years)**	**Group 2 [30–59 years (ref.)]**	**Group 3 (60–96 years)**	**Effect size**	**Statistic**	**p-value**
Psychological distress	% (N)	15.6% (38/244)	14.3% (92/645)	13.1% (14/107)	OR₁ = 1.11[b] OR₃ = 0.90[c]	$\chi^2 = 0.43$	0.919[n.s.]
Severe loneliness	% (N)	28.2% (69/245)↑	20.9% (136/650)	15.9% (17/107)	OR₁ = 1.48[b] OR₃ = 0.71[c]	$\chi^2 = 8.14$	0.017
Resilience	Mean ± SD	72.1 ± 11.2	71.8 ± 12.5	70.3 ± 13.7	$\eta^2 = 0.002$	$\chi^2 = 0.532$	0.874[n.s.]
Extraversion	Mean ± SD	28.4 ± 5.8	27.6 ± 5.8	27.5 ± 5.8	$\eta^2 = 0.003$	$\chi^2 = 3.381$	0.184[n.s.]

Note: The age group rows have additional Group 3 and Effect size columns. Correcting alignment for OR values: OR₁ = 1.11^{b}, OR₃ = 0.90^{c}.

SD, Standard deviation; OR, odds ratio; d, Cohen's effect size d; η^2, partial eta squared; n.s., not significant (p > 0.05).

↑significantly higher than in group 2 ↓ significantly lower than in group 2.

[a]Psychological distress (yes/no) and severe loneliness (yes/no) were analyzed by means of logistic regression, resilience and extraversion were analyzed by Mann–Whitney U-Test (two-group comparisons) and Kruskal–Wallis test (three-group comparisons).

[b]OR₁, Odds ratio age group (1) vs. reference age group (2).

[c]OR₃, Odds ratio age group (3) vs. reference age group (2).

TABLE 3 | Association of resilience and extraversion with psychological distress and severe loneliness (Spearman rank correlation coefficients).

		Extraversion (BFI total)	Psychological distress [GSI T-score (BSCL) ≥ 63]	Severe loneliness (TILS ≥ 7)
Resilience RS-13 total	Spearman rho	0.407**	−0.310**	−0.214**
	p-value	<0.001	<0.001	<0.001
	N	1,005	997	1,003
Extraversion BFI total	Spearman rho	–	−0.201**	−0.068*
	p-value	–	<0.001	0.032
	N	–	996	1,002

BFI, Big Five Inventory; BSCL, Brief-Symptom-Checklist; TILS, Three Item Loneliness Scale; RS-13, Resilience Scale. *p < 0.05; **p < 0.01.

Findings of the mediation of the effects of sex and partnership on severe loneliness are displayed in **Figure 2** and **Table A2**. Resilience significantly mediated the relationship between sex and severe loneliness, accounting for 11.5% of the total sex difference, i.e., a comparatively small proportion. Extraversion did not show a significant mediation effect. The direct effect of sex on severe loneliness stayed significant after adjustment for resilience. Similarly, the effect of partnership on severe loneliness was significantly mediated by resilience (18.5% of the total difference), but not by extraversion. The direct effect of the partnership situation on loneliness remained significant. Regarding age, the mediation effect of neither resilience nor extraversion on the relationship between age group and severe loneliness attained significance (details in **Table A2**).

DISCUSSION

Focussing on potential sex differences and study participants' partnership situation, the main objective of this study was to investigate the mediating role of resilience and extraversion on psychological distress and loneliness during the COVID-19 pandemic among the general population of Tyrol, Austria. Overall, psychological distress and severe loneliness were more often detected in women and singles. In addition, they were less resilient, while men and singles presented with a lower degree of extraversion. However, effect sizes were small.

Our finding of a higher risk of suffering from negative psychological consequences in females in the context of the COVID-19 pandemic is in line with previous systematic reviews (41, 42). Earlier studies have shown that the transition to working from home in combination with household chores (43) and the increased involvement in home-schooling (44) due to the closure of daycare centers and schools resulted in additional burdens on women. Whereas, help from the family may have been a common factor prior to the COVID-19 pandemic (45),

FIGURE 1 | Findings of mediation analyses 1, dependent variable psychological distress. **(A)** Effect of resilience as a mediator on the relationship between sex and psychological distress. Numbers shown are standardized regression coefficients. Solid lines indicate statistically significant effects, dashed lines indicate non-significant effects. Extraversion (BFI total score) did not show a significant mediation effect. **(B)** Indirect effect of resilience and extraversion on the relationship between partnership situation and psychological distress. Numbers shown are standardized regression coefficients. Solid lines indicate statistically significant effects. BSCL, Brief-Symptom-Checklist; RS-13, Resilience Scale; BFI, Big Five Inventory.

for instance through grandparents looking after a child in the afternoon, this support may no longer have been available since people aged 60 and older belong to the high-risk group for the COVID-19 infection (46). Thus, many women may have had limited access to supportive networks, which has been related to high psychological distress even before the onset of the pandemic (47). One of our pre-pandemic studies in healthy emerging adults, for example, revealed a much stronger interrelationship between the perception of social support and stress in women than in men (48). Moreover, in Austria, a higher proportion of women than men are employed in the health and social sectors, in education and training, and in the hospitality and commerce sectors (49), i.e., in fields of activity that were severely affected by the COVID-19 pandemic. In addition, a total of 80% of all part-time jobs in Austria are occupied by women (49), and 216,584 women worked in marginal employment positions in 2019 (50).

FIGURE 2 | Findings of mediation analyses 2, dependent variable severe loneliness. (A) Effect of resilience on the relationship between sex and severe loneliness. Numbers shown are standardized regression coefficients. Solid lines indicate statistically significant effects. Extraversion (BFI total score) did not show a significant mediation effect. (B) Effect of resilience on the relationship between partnership situation and severe loneliness. Numbers shown are standardized regression coefficients. Solid lines indicate statistically significant effects. Extraversion (BFI total score) did not show a significant mediation effect. TILS, Three Item Loneliness Scale; RS-13, Resilience Scale.

Accordingly, they were not eligible for government subsidies such as the short-time allowance. This, in turn, can be expected to cause existential worries and to further increase psychological distress (51). Consequently, as a result of the pandemic, more women than men may be in need of increased social and family support in order to reduce COVID-19-related psychological distress and a subsequent risk of mental health symptomatology.

At the time of the survey, women were more prone to being affected by severe loneliness than men. This corroborates the findings of other research groups from all over the world (52–54), however, results gathered prior to the COVID-19 pandemic show that women generally report loneliness more frequently than men (55–57). During the pandemic and the thereof resulting home-office and home-schooling conditions especially young and employed women may have been confronted with the burden of an increase in household tasks (43) and may have had less time to rest as well as less time for self-care and for personal contacts, including contact by way of telephone or the internet. In older age groups, women have generally been suggested to be more likely to perceive loneliness because of lower male life expectancy (58) and the resulting premature loss of the partner, again resulting in widowhood (56), poor health (59), and

financial difficulties (59). Social distancing in the context of the pandemic may further have increased the feeling of loneliness. However, whether men really feel less lonely than women is debatable. Borys and Perlmann (60), for example, have shown that men are less willing to admit loneliness than women. This may be a result of education, social demands, or stigma. Of note, studies from the United States (61, 62) and Brazil (63) have shown that loneliness did not increase during the initial phase of COVID-19, making it necessary to further evaluate the levels of loneliness and its potential consequences on mental health in the future.

As expected and in line with previous investigations, higher degrees of resilience and extraversion were associated with less psychological distress (17) and loneliness (18) among our sample. In addition, women and singles were less resilient compared to men and those living in a permanent partnership, which corroborates the above mentioned findings of our previous investigation (48) and those of other research groups (64, 65). Of note, resilience significantly mediated the relationship between both study participants' sex and partnership situation and psychological distress, accounting for one third of the total effect. To a lesser extent, resilience also mediated the relationship between sex/partnership situation and severe loneliness (11.5 and 18.5% of the total effect, respectively). Obviously, there are a number of other factors that have not been considered in our study and that have previously been shown to be relevant in terms of reduced psychological distress and loneliness, e.g., the availability of sources of social support in (66) and outside the family (48, 67, 68), perceived levels of family cohesion (67), social networks (66), active coping (68), optimism (68), positive reframing (68), purpose in life (68), job (dis)satisfaction (66), and the personal financial situation (69). Clearly, these protective factors can be expected to also apply during a pandemic.

A recent study from Nigeria revealed that the marital status affected overall mental health during the COVID-19 lockdown (70). Generally, the formation of intimate relationships can be considered a crucial developmental achievement in young adults (57), whereas a partner represents a person of trust to all age groups (59). Thus, not living in a permanent partnership has been identified as a risk factor for psychological distress (71), leading more single people to experience symptoms of depression during the COVID-19 period than those who are married or living together (72, 73). Taking into account this close relation of psychological distress to symptoms of depression (71, 74), one can hypothesize that the higher proportion of singles reporting psychological distress and severe loneliness among our sample may be an indirect indicator of a higher prevalence of depressive symptoms in this group at the time of the survey, however, this issue cannot be addressed by our data.

The reasons for feeling lonely and experiencing psychological distress go hand in hand with each other. Loneliness, both in intensity and duration, is correlated with psychological and somatic stress symptoms (75). Further evidence suggests that an increased time of loneliness is associated with a decrease in overall life satisfaction (76). Lower levels of global satisfaction, in turn, predict higher levels of perceived stress (77). One

can assume that in the context of the COVID-19-related confinements, singles living alone spent a major portion of their time on their own. The avoidance of any social contact at work or in private life can cause or reinforce loneliness (57) and psychological distress (7). Unwanted withdrawal from society may have brought the desire of having a partner to the forefront of the discussion, which could have increased the psychological strain and further exacerbated issues related to loneliness.

Extraversion has previously been associated with sociability (78) and has shown the highest correlation with measures of well-being among all the big-five personality traits (79). Margolis and Lyubomirsky, for example, have demonstrated that introverts who behave extrovertly for 1 week show an increase in well-being (80), which, in turn, is negatively associated with psychological distress (81). Accordingly, our finding of a mediating effect of extraversion on the relationship between study participants' partnership situation and psychological distress is not surprising. Notably, a higher degree of extraversion has been related to an increased ability of adaptation to the COVID-19 lockdown in Spain (30) and has also been found to be a predictor of resilience (82). This resembles the positive association between extraversion and resilience found in our sample.

Extraversion has also been related to positive reinterpretation and growth as well as problem-focused coping (25). For example, highly extraverted people have been shown to find creative solutions to communicate with others (e.g., via video chat) (83). We did not investigate this issue in detail, however, our finding of less psychological distress and severe loneliness in extraverted study participants may be seen in this context.

Interestingly, study participants under the age of 30 experienced severe loneliness more frequently than older people, whereas psychological distress, resilience, and extraversion were comparable between age groups. This phenomenon of young people becoming increasingly lonely has been observed before (55) and during the COVID-19 pandemic (11, 52, 84) and is a matter of public concern. In 2020, more than 50% of young people between 20 and 24 years of age lived with their parents as did more than 20% in the age group of 25–29 years (85). Because of campus closures, many students had to move back home and to be with their parents (86). This can become a major task and burden to these individuals for multiple reasons, e.g., not meeting social expectations or parents' wishes, not being able to avoid each other, and involuntarily spending time together. Delays in academic activities, job insecurities and the resulting financial problems, lack of social contacts with peers, and disruptions in everyday life structure could make this age group especially vulnerable. Accordingly, prevention and interventions addressing these public health problems are urgently needed. Our findings suggest that resilience-fostering measures could help to decrease psychological distress and loneliness. Thus, targeted interventions such as resilience training focussing on mindfulness and cognitive behavioral skills (87) as well as physical exercise (88) with a focus on outdoor activity could be recommended. Other measures such as reactivating the social network, e.g., through social media (89), or more frequent phone calls to family members and other related people could increase positive feelings

and decrease the level of worry, possibly leading to higher resilience and subsequently to lower psychological distress and loneliness.

The contradictory aspect of the current situation is that all procedures to alleviate psychological distress and loneliness that have been evaluated so far are based on social interactions and their frequency (57, 90). It is questionable whether this recommendation can be followed during a pandemic. In light of this, there is an urge to develop internet-based programs focussing on a reduction of psychological distress and loneliness, e.g., internet-based behavioral therapy concepts with the aim of increasing well-being. Importantly, our findings underscore the relevance of considering sex- and age-specific aspects in this regard. Moreover, various large-scale interventions at the societal level, such as cultural activities, (sports) club life, and civic participation should be promoted to fight loneliness, psychological burdens, and to strengthen the society.

Findings from this online survey need to be interpreted with caution due to several limitations. Because of the study design, only self-reported questionnaires could be used, which may be subject to desirability bias. We attempted to reach a heterogeneous group of the adult Tyrolean general population by using different information channels. We are aware that not all population groups had equal access to the internet and thus to the online survey. For example, older subjects could be reached less well and our study design did not include children and adolescents. A further part of the non-respondent population may not have participated in the context of softening of restrictions at the time of study conduction and clearly, our convenience sample is not representative for whole Austria. Moreover, the generalizability of our findings is limited because of the variability of stringency of the COVID-19-related confinements across place and time. A further limitation is that our sample was unbalanced in regards of gender and age group membership. Besides, we investigated psychological distress, loneliness, resilience, and extraversion amidst the pandemic, while pre-pandemic data are lacking. However, this is the first study investigating the mediating role of resilience and extraversion on psychological distress and on loneliness among the general population of Tyrol during the COVID-19 pandemic and the large sample size is a clear strength.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of their proprietary nature or ethical concerns. Requests to access the datasets should be directed to Anna Chernova, anna.chernova@i-med.ac.at.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee Medical University Innsbruck. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

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SUPPLEMENTARY MATERIAL

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Conflict of Interest: BH owns part of the IPRs of the CHES software tool.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Pre-pandemic Predictors of Loneliness in Adult Men During COVID-19

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Loneliness is a major public health issue, with its prevalence rising during COVID-19 pandemic lockdowns and mandated "social distancing" practices. A 2020 global study (n = 46,054) found that, in comparison to women, men experienced the greatest levels of loneliness. Although research on predictors of loneliness during COVID-19 is increasing, little is known about the characteristics of men who may be particularly vulnerable. Studies using prospective data are needed to inform preventative measures to support men at risk of loneliness. The current study draws on rare longitudinal data from an Australian cohort of men in young to mid-adulthood (n = 283; aged M = 34.6, SD = 1.38 years) to examine 25 pre-pandemic psychosocial predictors of loneliness during COVID-19 social restrictions (March–September 2020). Adjusted linear regressions identified 22 pre-pandemic predictors of loneliness across a range of trait-based, relational, career/home and mental health variables. Given the extensive set of predictors, we then conducted penalized regression models (LASSO), a machine learning approach, allowing us to identify the best fitting multivariable set of predictors of loneliness during the pandemic. In these models, men's sense of pre-pandemic environmental mastery emerged as the strongest predictor of loneliness. Depression, neuroticism and social support also remained key predictors of pandemic loneliness (R^2 = 26, including covariates). Our findings suggest that men's loneliness can be detected prospectively and under varying levels of social restriction, presenting possible targets for prevention efforts for those most vulnerable.

Keywords: male, COVID-19, loneliness, longitudinal, pandemic

INTRODUCTION

Loneliness is a preventable public health issue and has been linked to mental illness, suicide, poor health behaviors, and premature death (1, 2). It is characterized by a perceived lack of social support and a sense of social disconnection (3, 4) and is often stigmatized or trivialized (5). Emerging evidence indicates loneliness is increasingly prevalent, with a global survey (n = 23,004) finding 1 in 3 adults experience feelings of loneliness (6). Concerns about loneliness have escalated in the context of COVID-19 pandemic lockdowns and mandated "social distancing" practices, with loneliness rising since the first recorded SARS-CoV-2 infections and representing one of the

strongest predictors of depression, anxiety, and post-traumatic stress disorder during the pandemic (7–9). Much of the research to date on loneliness during the pandemic has focused on adolescents (10), or older adults (11–15) or has been limited to investigations of demographic factors (16). Here we extend this work to identify psychosocial factors among men in their young-to mid-adult years who maybe particularly vulnerable (17, 18).

A 2020 global study capturing data from 237 countries, islands, and territories (n = 46,054) found that, in comparison to women, men experienced the greatest levels of loneliness, particularly young men in "individualistic" societies (e.g., America or Australia) (17). Where individualistic values such as self-reliance and personal autonomy intersect with gendered expectations of men, there may be reduced access and use of social support (19), which may increase risk for loneliness (20). An Australian national survey found men aged 25–44 years who lived alone experienced higher rates of loneliness (39%) than women living alone (12%) (18). This disparity may reflect higher levels of emotional distancing in men, compared to women (21, 22). Relatedly, a 2019 multi-national survey (n = 4,000) found that almost 50% of adult men felt they could not or would not talk to friends about their problems (23). Furthermore, young- to mid-adulthood is the normative age for consolidating relationships and becoming a father (24), yet even during this period of life, almost one in four new fathers report feeling isolated (23).

Rates of loneliness in adult men are particularly alarming when considering meta-analytic evidence that shows over one-third of the variance in suicidal ideation and behavior among men is explained by loneliness, although these findings were not age specific (25). Concerns are compounded by the exceedingly high male suicide rates globally (26). In Australia, where this study was conducted, male suicide is three times greater than the rate for females, and in young adult men up to 34 years of age, suicide accounts for 32.6% of all deaths (27). Loneliness has also been associated with higher rates of mental health problems both before and during the pandemic (4, 28). Cross-sectional pandemic research has found that loneliness during the pandemic is associated with higher rates of mental health problems across both genders (8, 29, 30). In a Polish study of adults aged 18–35 years (n = 380), loneliness was associated with symptoms of mental health problems and increased concern about COVID-19's health threat (30). In pre-pandemic research, loneliness similarly predicted heightened stress appraisals (31) and threat perception (32), suggesting that individuals with high levels of loneliness may assess the pandemic in a more threatening way and therefore be at greater risk of mental health problems or distress (30).

Given the elevated risk of loneliness for all individuals during the pandemic, the high prevalence of loneliness in adult men pre-pandemic (17), and the potential mental health consequences of loneliness (2), further understanding loneliness in men under pandemic conditions is warranted. In particular, an understanding of psychosocial predictors of loneliness in men during the pandemic under varying levels of social restrictions would provide information on who is most vulnerable and the degree to which lockdown and related restrictions are

relevant to this relationship. Factors associated with loneliness, identified in prior research, fall largely within trait-based, relational, career/home and mental health domains (33, 34). At the trait level, loneliness has been associated with the "Big Five" personality traits (35), particularly (low) extraversion and (high) neuroticism (36), as well as constructs such as (low) self-efficacy (37). Relational factors linked to loneliness include lack of social activity and reduced quality of relationships with peers, family, and significant others (38). Across the career and home domain, aspects such as skills and satisfactions have been associated with loneliness (39, 40). In the mental health domain, loneliness has been associated with greater levels of depression, anxiety, and generalized distress (41). However, across all domains, most research has been cross-sectional, analyses often do not report effects of gender, or the predictors or correlates are usually selected from within a single domain (33, 42). Research is yet to prospectively assess a complex set of predictors for adult male loneliness that may help to identify the best set of variables for detecting future vulnerability, particularly during times of social restriction.

The COVID-19 pandemic has been a precipitating or exacerbating event for loneliness and may therefore reveal new insights into factors predicting vulnerability to a sense of social disconnection experienced by many men. The current study draws on rare longitudinal data from an Australian cohort of men in young to mid-adulthood. Our aims were three-fold. First, we sought to separately examine prospective associations between a suite of pre-pandemic variables across the multiple domains and loneliness assessed at two time points across the first year of the COVID-19 pandemic (2020). Second, we aimed to identify if associations differed depending on varying levels of COVID-19 social restrictions. Third, we sought to determine the relative contribution of predictors on the levels of men's loneliness. To achieve the final aim, we used the Least Absolute Shrinkage and Selection Operator (LASSO) penalized regression (43), a machine learning approach, allowing us to identify the best fitting multivariable set of predictors of loneliness during the pandemic.

MATERIALS AND METHODS

Participants

Participants were from the Men and Parenting Pathways (MAPP) Study (N = 608), a longitudinal cohort study that examines the mental health and wellbeing of Australian men across the peak age for transitioning to fatherhood (33 years) (44). Men aged between 28 and 32 years (inclusive) were recruited between 2015 to 2017 from all states and territories of Australia via social media, partnerships with community and private organizations, as well as word of mouth. Three annual waves of data collection, with a participation rate of 83% across waves 2 or 3, were complete prior to the first cases of COVID-19 being detected in the world (45).

In March 2020, the Australian federal, state, and territory governments announced a national response to the COVID-19 pandemic that included the shutdown of non-essential industries and the directive to "stay home" except for four reasons: (1) shopping for essential items, (2) care and caregiving, (3) exercise, and (4) essential study or work—if unable to do so from home

(46). In the same month, a 15-min survey (open between March 21st to May 19th) was added to the MAPP study to capture the impact of the COVID-19 pandemic on the lives of MAPP cohort participants. The stay-at-home restrictions led to a decrease in cases across the country; however, by June there was a rapid spike in COVID-19 cases in the State of Victoria, where 42% of this sample of participants reside. As a result, the Victorian State Government enforced one of the world's strictest lockdowns at the time, where an 8 p.m. curfew and a directive to stay within a 5 km radius from home was enforced, in addition to the prior set of restrictions. During this period (July 20th to September 2nd) MAPP participants who participated in the first COVID-19 specific survey were invited to complete a second COVID-19 survey.

To be included in the current study, participants were required to have provided data on one or both of the MAPP COVID-19 surveys and be living in Australia at the time of the survey. The analytic sample were 283 adult men aged between 32 to 38 years at the time of the second COVID-19 survey ($M = 34.6$, $SD = 1.38$). In comparison to the original MAPP sample, the analytic sample showed no differences on key baseline characteristics including socio-economic advantage and disadvantage (SEIFA), employment, birthplace, ethnicity, parenting status, and sexuality, however, they were more highly educated. The original MAPP sample has been compared against the general Australian population of men at this age, see the MAPP Cohort Profile paper for more information (44).

Measures
Outcome Measure
At both COVID-19 timepoints, loneliness was measured with the 8-item University of California, Los Angeles Loneliness Scale (ULS-8) (47) to examine the level of social contact experienced compared to what is desired. The scale includes statements such as "*I lack companionship*" scored on a 4-point Likert scale where $1 = Never$, $2 = Rarely$, $3 = Sometimes$, and $4 = Always$. The total score ranges from 8 to 32 points. Higher scores reflect greater levels of perceived loneliness. Scores ≥ 25 indicate very high levels of loneliness with chronic experience of at least one symptom (i.e., "always" endorsed in response options). Scores between 17 and 24 inclusive indicate moderate to high levels of periodic loneliness with an average endorsement of "sometimes" as a response option. The ULS-8 has a Cronbach's alpha of 0.83 and has been found to be a valid substitute for the full 20-item version of this scale, the ULCA-20 (47). For the current study, participants' maximum level of loneliness reported across our two COVID-19 waves was used.

Predictor Measures
Twenty-five predictors across individual, relational, and mental health domains were included in analyses to measure risk factors of loneliness. Data for each variable were taken from participants' most recent pre-COVID-19 response across waves 1–3. If data were missing from wave 3, information from wave 2 was given preference, followed by wave 1. Information on the predictor variables and their associated scales are presented in **Table 1**.

Covariates
We sought to examine the predictive nature of psychosocial factors on men's loneliness net of baseline and contextual factors. Therefore, in adjusted regression analyses, we included baseline demographic covariates that had previously been linked to increased levels of loneliness (16, 58, 59). These were income (0 = >$AUD 60,000 per annum, 1 = ≤$AUD 60,000 per annum), birthplace (0 = Australia, 1 = not Australia), and education (0 = >high school education, 1 = ≤ high school completion). We also included relevant contextual factors measured at the time of the pandemic to investigate if the associations were net of varying pandemic experiences. Contextual covariates included living alone (0 = not living alone, 1 = living alone), time spent online socializing with friends (0 = 3 or more times per week, 1 = <3 times per week), and current state of residence (0 = non-Victoria, 1 = Victoria) given the extended lockdown period Victoria experienced in comparison to the rest of Australia as described earlier.

Statistical Analysis
Data were cleaned and derived in Stata 15 (60). Analyses were conducted in R version 4.0 statistical software (61). First, linear regression analyses were used to examine associations between participants' maximum levels of loneliness during the pandemic and each pre-pandemic predictor. Analyses were estimated unadjusted and then repeated adjusting for all covariates. To address our second aim, interactions were tested to examine whether state of residence (Non-Victoria vs. Victoria) during the pandemic moderated the relationship between loneliness and each predictor variable. To address the third aim, LASSO models, a type of penalized regression, were then estimated to develop a predictive model and identify key indicators of loneliness during the pandemic. In comparison to traditional methods, LASSO shrinks coefficient sizes by applying a penalty factor and retains important predictor variables (i.e., coefficients greater than zero) (62, 63). This is advantageous over traditional regression models as it reduces overfitting and in turn improves predictive performance in new data (62). Further, this method produces simpler and more interpretable models with a reduced set of the predictors (63). A more detailed description of the LASSO model is available elsewhere (43, 62). To tune the strength of the penalty factor, 5-fold cross-validation was used, whereby the training data is split into 5 equal datasets, referred to as folds. Models with a range of penalty strengths are iteratively trained using 4-folds and then tested on the remaining fold. This process is repeated five times, such that all folds are used for testing (62). Penalty strength is selected based on the predictive performance across testing folds. Predictive performance of the LASSO was assessed across 100 iterations of training and testing data splits 80/20% (62) via $R2$ in the testing split. For each iteration the LASSO identified: (1) the "best" model, which minimizes predictor error out of the sample, and (2) the "one-standard-error" model, where the out-of-sample prediction error is within one standard error of the "best" model, resulting in a more parsimonious solution (62). To determine the most robust predictors, LASSO models were re-run using the full sample and 100 iterations of 5-fold cross-validation. The mean of the coefficients was

Construct	Scale	No. items	Response options	Possible score range	Reliability (Cronbach's Alpha)
Trait-based					
Openness to experience	Mini IPIP-6	4	1 = Very to 7 = Very accurate	4–28	0.71
Conscientiousness	Mini IPIP-6	4	1 = Very to 7 = Very accurate	4–28	0.63
Extraversion	Mini IPIP-6	4	1 = Very to 7 = Very accurate	4–28	0.81
Agreeableness	Mini IPIP-6	4	1 = Very to 7 = Very accurate	4–28	0.77
Neuroticism	Mini IPIP-6	4	1 = Very to 7 = Very accurate	4–28	0.69
Honesty-humility	Mini IPIP-6	4	1 = Very to 7 = Very accurate	4–28	0.70
Trait anger	STAXI-2	10	1 = Almost to 4 = Almost always	10–40	0.88
Socially prescribed perfectionism	MPS	15	1 = Disagree to 7 = Agree	15–105	0.87
Relational					
Hours spent with friends	Single item	1	Open ended	Per week	-
Social support	MSPSS	12	1 = Very Strongly Disagree to 7 = Very Strongly Agree	12–84	0.92
History of maternal care	PBI	12	1 = Very like to 4 = Very unlike	0–36	0.92
History of maternal control	PBI	13	1 = Very like to 4 = Very unlike	0–39	0.88
History of paternal care	PBI	12	1 = Very like to 4 = Very unlike	0–36	0.93
History of paternal control	PBI	13	1 = Very like to 4 = Very unlike	0–39	0.87
Career and home orientation					
Career orientated identity salience	ISS	5	1 = Strongly disagree to 5 = Strongly agree	4–20	0.79
Job competence	BPNQ	14	1 = Not at all true to 5 = Very true	14–70	0.54
Home competence	BPNQ	14	1 = Not at all true to 5 = Very true	14–70	0.54
Mental health and wellbeing					
Depression	DASS-21	7	0 = Did not apply to me at all to 3 = Applied to me very much, or most of the time	0–42	0.92
Anxiety	DASS-21	7	0 = Did not apply to me at all to 3 = Applied to me very much, or most of the time	0–42	0.86
Stress	DASS-21	7	0 = Did not apply to me at all to 3 = Applied to me very much, or most of the time	0–42	0.89
Environmental mastery	PWB	7	1 = Strongly Disagree to 6 = Strongly Agree	7–42	0.84
Purpose in life	PWB	7	1 = Strongly Disagree to 6 = Strongly Agree	7–42	0.83
Poor overall physical health	Single item	1	1 = Excellent to 5 = Poor	1–5	-
State anger	STAXI-2	15	1 = Not at to 4 = Very much so	15–60	0.95
Irritability	BITe	5	1 = Never to 5 = Always	5–25	0.91

Mini IPIP-6, Mini International Personality Item Pool Six-Items (48); STAXI-2, State-Trait Anger Expression Inventory 2 (49); MPS, Multidimensional Perfectionism Scale (50); Hours spent with friends, How many hours a week on average, outside of work, would you spend in the company of friends? MSPSS, Multidimensional Scale of Perceived Social Support (51); PBI, Parental Bonding Instrument (52); ISS, Identity Salience Scale (53); BPNQ, Basic Psychological Needs Questionnaire (54); DASS-21, Depression Anxiety Stress Scale- 21 Items (55); PWB, Ryff's Scales of Psychological Wellbeing (56); Overall Physical Health, How would you rate your physical health (poor to excellent)?; BITe, The Brief Irritability Test (57).

obtained for predictors that were selected in at least 80% of the cross-validation iterations (62). A single imputed data set was generated using the R *mice* package (64) due to standard penalized regression packages in R not having built in capacity to handle multiple imputed or missing data. All continuous variables were standardized (z-scored) prior to analyses. A series of traditional linear regressions were conducted post LASSO model selection to confirm the relative contribution of covariates and key predictors identified. The covariates were regressed onto the outcome variable of loneliness and the coefficient of determination (R^2) was examined. The key predictors identified in each of the LASSO models were added to the regression and the R^2 was again examined.

RESULTS

Descriptives

Six percent of the analytic sample reported very high levels of loneliness during the pandemic, while a majority (56%) reported moderate to high levels. **Table 2** presents a summary of the outcome, pre-pandemic predictors, and covariates. Pairwise correlations between predictors can be found in **Supplementary Table 1**.

Predictors of Loneliness Across COVID-19
Traditional Regression Models

Table 3 shows prospective associations between pre-pandemic predictors and participant reported loneliness during the

TABLE 2 | Descriptive statistics of the outcome, pre-pandemic predictors, and covariates.

	M	SD	Missing (%)
Outcome			
Loneliness (maximum) during COVID-19	18.08	4.29	0%
Pre-pandemic predictors			
Trait-based			
Openness to experience	20.91	4.49	8%
Conscientiousness	17.68	4.21	8%
Extraversion	15.29	5.00	8%
Agreeableness	19.87	4.70	8%
Neuroticism	14.52	4.67	8%
Honesty-Humility	19.65	4.94	8%
Trait anger	18.16	5.81	8%
Socially prescribed perfectionism	55.18	13.21	10%
Relational			
Hours spent with friends	5.24	6.99	1%
Social support	62.80	13.67	1%
History of maternal care	26.30	7.21	8%
History of maternal control	13.31	7.21	8%
History of paternal care	20.80	8.69	10%
History of paternal control	10.64	7.04	10%
Career and home orientation			
Career orientated identity salience	12.41	3.96	2%
Job competence	22.66	4.05	0%
Home competence	24.80	4.84	1%
Mental health and wellbeing			
Depression	10.61	10.22	0%
Anxiety	6.42	7.40	1%
Stress	12.96	9.25	1%
Environmental mastery	27.60	6.25	0%
Purpose in life	29.07	6.41	2%
Poor overall physical health	3.05	1.04	2%
State anger	29.64	9.75	1%
Irritability	14.15	4.10	1%
Covariates	**n**	**%**	**Missing (%)**
Education (low)	36	13%	0%
Income (low)	30	10%	0%
Birthplace (Australia)	252	88%	0%
State of residence (Victoria)	119	42%	0%
Living alone (yes)	22	8%	0%
Online socializing with friends (<3 times a week)	203	71%	0%

pandemic. Unadjusted analyses and analyses adjusting for all covariates provided evidence for an association between each of the predictors and pandemic loneliness with the exception of agreeableness, honesty-humility, and openness to experience. Specifically, at the trait-based level, neuroticism, trait anger, and perfectionism were positively associated with loneliness during the pandemic (β range = 0.19–0.43), while extraversion, conscientiousness, were negatively associated (β range = −0.15 to −0.26). At the relational level, hours spent with friends, social support, and retrospective accounts of parental care were

negatively associated with pandemic loneliness (β range = −0.16 to −0.40), while retrospective accounts of parental control were positively associated (β range = 0.15–0.16). At the career and home orientated level, job competence and home competence were negatively associated with pandemic loneliness (β range = −0.05 to −0.34), while career orientated identity salience was positively associated (β = 0.12). At the mental health and wellbeing level, positive associations were found with depression, anxiety, stress, state anger, irritability, and poor overall physical health (β range = 0.26–0.48) and negative associations with environmental mastery and purpose in life (β range = −0.08 to −0.33). The pattern of associations was similar in the unadjusted models. Additionally, for all predictor variables, no evidence emerged for an interaction with state of residence (**Supplementary Table 2**).

LASSO Penalized Regression Models

The more parsimonious LASSO model (i.e., the one-standard-error model) selected environmental mastery as the strongest pre-pandemic predictor for loneliness during the pandemic (β = −0.20), followed by depression (β = 0.11), neuroticism (β = 0.07), and social support (β = −0.03). Together, this LASSO model (including covariates) explained 26% of variance in loneliness. In the best fitting model, the same pre-pandemic predictors were selected and had the strongest associations, with the addition of a further four variables, including extraversion (β = −0.04), agreeableness (β = 0.04), overall physical health (β = 0.04), and home competence (β = −0.02), accounting for an additional 4% of the variance in loneliness. To identify the relative contribution of covariates and key predictors selected by the LASSO models, we conducted subsequent traditional regression analyses that showed the six covariates accounted for 9.5% of the variation in loneliness [$F_{(6, 276)} = 4.86$, $p < 0.001$]. When the four key predictors from the "one-standard-error" model were added to the model the amount of variance explained increased more than four-fold to 39.5% [$F_{(10, 272)} = 17.75$, $p < 0.001$]. The additional four predictors from the "best-fit" model accounted for a further 2.2% of variance in loneliness [$F_{(14, 268)} = 13.69$, $p < 0.001$].

DISCUSSION

This study presents findings from a unique Australian longitudinal study of men with the aim of addressing a key gap in knowledge about pre-pandemic predictors of loneliness under socially restrictive, pandemic conditions. In our sample, 6% of men reported high levels of loneliness, endorsing "always" feeling at least one symptom of loneliness such as lacking companionship. A further 56% of men indicated moderate to high levels of loneliness during the pandemic and associated lockdown periods. With respect to aim one, we found evidence of associations between loneliness and 22 of the 25 pre-pandemic predictors we examined before and after adjustment for covariates. In the relational, career/home and mental health and wellbeing domains, all variables predicted loneliness. In the trait domain, only five of the eight traits assessed predicted loneliness. Regarding aim two, all associations were not influenced by living

TABLE 3 | Associations between pre-pandemic predictors and subsequent pandemic loneliness.

Variable	Unadjusted				Adjusted*				Penalized regression β (Best fit)*	Penalized regression β (1 SE)*
	β	95%	CIs	p	β	95%	CIs	p		
Trait-based										
Openness to experience	−0.02	−0.13	0.10	0.801	−0.03	−0.14	0.09	0.639		
Conscientiousness	−0.18	−0.30	−0.07	0.002	−0.15	−0.27	−0.035	0.011		
Extraversion	−0.26	−0.37	−0.15	<0.001	−0.26	−0.37	−0.147	<0.001	−0.04	
Agreeableness	−0.05	−0.17	0.07	0.407	−0.02	−0.14	0.091	0.680	0.04	
Neuroticism	0.44	0.33	0.55	<0.001	0.43	0.32	0.54	0.000	0.13	0.07
Honesty-humility	−0.04	−0.15	0.08	0.501	−0.02	−0.14	0.09	0.682		
Trait Anger	0.22	0.11	0.33	<0.001	0.19	0.08	0.31	0.001		
Socially prescribed perfectionism	0.32	0.21	0.43	<0.001	0.32	0.21	0.43	<0.001		
Relational										
Hours spent with friends	−0.15	−0.26	−0.03	0.014	−0.16	−0.27	−0.05	0.005		
Social support	−0.45	−0.55	−0.34	<0.001	−0.40	−0.51	−0.30	<0.001	−0.08	−0.03
History of maternal care	−0.16	−0.27	−0.04	0.008	−0.16	−0.27	−0.04	0.007		
History of maternal control	0.17	0.05	0.28	0.004	0.15	0.04	0.27	0.006		
History of paternal care	−0.20	−0.31	−0.09	0.001	−0.19	−0.30	−0.08	0.001		
History of paternal control	0.20	0.08	0.31	0.001	0.16	0.05	0.27	0.006		
Career and home orientation										
Career orientated identity salience	0.16	0.04	0.27	0.008	0.12	0.00	0.232	0.040		
Job competence	−0.06	−0.08	−0.03	<0.001	−0.05	−0.08	−0.02	<0.001		
Home competence	−0.33	−0.44	−0.22	<0.001	−0.34	−0.45	−0.23	<0.001	−0.02	
Mental health and wellbeing										
Depression	0.50	0.40	0.60	<0.001	0.48	0.37	0.584	<0.001	0.16	0.11
Anxiety	0.28	0.17	0.40	<0.001	0.26	0.15	0.372	<0.001		
Stress	0.33	0.22	0.44	<0.001	0.31	0.20	0.415	<0.001		
Environmental mastery	−0.08	−0.10	−0.07	<0.001	−0.08	−0.10	−0.07	<0.001	−0.21	−0.20
Purpose in life	−0.37	−0.48	−0.26	<0.001	−0.33	−0.45	−0.22	<0.001		
Poor overall physical health	0.30	0.18	0.41	<0.001	0.29	0.19	0.40	<0.001	0.04	
State anger	0.31	0.20	0.42	<0.001	0.27	0.16	0.383	<0.001		
Irritability	0.36	0.25	0.47	<0.001	0.34	0.23	0.448	<0.001		
									$R^2 = 0.30$	$R^2 = 0.26$

Adjusted for education, income, birthplace, state of residence, living alone, and online socializing with friends.

in the state of Victoria where an extended stay at home order was enforced, suggesting associations with loneliness may be relevant across varied experiences of lockdown restrictions. For aim three, the strongest and most consistently selected predictors of loneliness, identified in penalized regression models, were pre-pandemic low environmental mastery, depressive symptoms, neuroticism, and low perceived social support. Additional predictors identified were low extraversion, agreeableness, poor overall physical health, and a low sense of competence in completing home life tasks. The identified predictors accounted for a substantial amount of variance, net of covariates. Our findings bring to light indicators of men's subjective experience of loneliness that existed for men who experienced both short and extended periods of lockdown and were evident regardless of levels of online social interaction and other covariates.

Environmental mastery was the strongest independent pre-pandemic predictor of loneliness, suggesting that higher pre-pandemic mastery in men may confer protection against loneliness during the pandemic. Environmental mastery is characterized by one's ability to manage stressful events and a sense of control over the external world (65, 66). Although some situational factors relevant to mastery such as predictability and choice (67) were lessened in the context of government mandates on pandemic behaviors, associations remained. Our findings align with a recent meta-analysis ($k = 6$, $n = 3,827$) that reported an aggregated negative association ($r = −0.33$) between environmental mastery and loneliness (68). One explanation for this may be that individuals with high levels of mastery are more resilient to stressful life events (68), and employ more active coping strategies, such as approaching others for support, which may mitigate loneliness (69, 70). Further, in line with cognitive models of stress management, those with low mastery may appraise restrictions and the uncontrollable "loss" of connection to others more acutely (65). With past research also demonstrating a direct relationship between mastery and social support (71), men with high mastery may have been more likely

to approach others for support during the pandemic, therefore protecting against loneliness. There is some evidence of higher average levels of environmental mastery in men compared to women (72), suggesting that this may be a particularly important psychological asset for men under conditions of stress.

Consistent with a sizeable body of research, we found pre-pandemic depressive symptoms to be the next strongest predictor men's pandemic loneliness (73–75). Symptoms of depression such as anhedonia, low energy, and hopelessness, can be taxing on interpersonal relationships, particularly when symptoms are chronic or episodes are frequent (76). This can lead to abandonment of social connections and social isolation (73, 74). In longitudinal studies, depressive symptoms have been associated with a reduction in the formation and maintenance of social ties, as well as a termination of previous ones (73, 74). The bi-directionality of the relationship between depressive symptoms and loneliness (75) may also result in persistent symptoms of both. Given high rates of men reporting low levels of social connections (77), understanding the potential perpetuating cycle of depression and loneliness remains key for future research.

We found neuroticism to also predict pandemic loneliness in men. Neuroticism is characterized by negative affect and increased levels of distress (78), which may underlie the inherent emotional content of loneliness that accompanies a sense of disconnection. That is, neuroticism may partially explain feelings of distress when it is perceived that there is no-one who can or will meet one's own social needs (31, 79). Additionally, individuals high on trait neuroticism tend to perceive the world as threatening and find it difficult to manage stressful life events (80). Prior COVID-19 pandemic research reported a positive association between neurotic traits and accepting and employing social distancing guidelines to avoid infection (81, 82). In this respect, individuals with high neuroticism may have heightened levels of concerns around pandemic consequences and related information (79), and therefore engage more stringently in self-isolation practices during COVID-19 that heighten risk of loneliness.

The final of the four key predictors of loneliness in our LASSO models was social support. Our findings align with a vast body of pre-pandemic research that has identified social support provided by friends, family, and significant others, as a protective factor associated with reduced levels of loneliness (41, 83). An earlier COVID-19 pandemic study found that individuals with high levels of perceived social support during the pandemic were 89% less likely than those with low levels of social support to be classed with the highest levels of loneliness (84). We extended on this research demonstrating that men's social support prior to the pandemic predicted their loneliness during the pandemic. Social support engenders a sense of camaraderie, comfort, and healthy interdependence on one another for support within an individual's social network especially during times of increased need. This may assist in maintaining supportive connections into the future, even in the context of physical distancing (41, 85).

The link between social support and loneliness may be particularly relevant to public health initiatives targeting men given that on average, men tend to report lower levels of perceived social support than women (86–88). Masculine ideals that promote stoicism, and stigma attached to seeking support may reduce some men's likelihood of having adequate social support available during times of heightened need (89). Additionally, when experiencing feelings of loneliness, sadness, and distress, some men express difficulty or feelings of embarrassment disclosing this information to a loved one and therefore reduce the likelihood of eliciting support (77). Our research suggests that even in the context of multiple established risk factors, men's low perceived social support stands out as a key indicator of future risk of loneliness.

The four additional predictors of loneliness unique to the best fit penalized regression model were pre-pandemic poor overall physical health, low extraversion, agreeableness, and low home competence (additional $R^2 = 0.04$). Selection of extraversion and agreeableness, in addition to neuroticism, suggests that personality traits are important predictors of loneliness. Lower levels of extraversion (introversion) predicted loneliness, which is consistent with past research (36). Extraversion has been linked to the formation of social ties online, and therefore during periods of restriction, extraverts may have adapted more easily to online strategies for communication with others within their support network during the pandemic thus reducing feelings of loneliness (90). While, agreeableness was a weak predictor of loneliness, these findings should be interpreted with caution given that there was an inverse direction of this association at the bivariate level with wide confidence intervals. In saying this, LASSO prediction models are not guided by p-values (43, 62). Therefore, even though agreeableness was $p < 0.05$ in the traditional model, it still improved the predictive performance of the outcome, in combination with the other predictors. Loneliness during the pandemic was also predicted by poorer health pre-pandemic. Poor health has been shown to have an indirect influence on loneliness through social participation and social resources (91). Home competence was also predictive of loneliness and may be specifically relevant for pandemic related loneliness when a "stay at home" directive was enforced and a sense of efficacy in managing tasks may have promoted positive mood and wellbeing and reduced attention on negative outcomes.

Loneliness is a major public health concern for men in young to mid adulthood (17). We presented rare, community-based, longitudinal data on men in young to mid adulthood; however, evidence indicates that the developmental origins of loneliness are likely to be prior to adulthood (92). Boys, up to the early adolescent years, typically openly express their desire for genuine social connections, particularly with other boys, however, as they reach middle to late adolescence, there can be a "crisis of connection," characterized by a loss of close intimate friendships with other males (93). Longitudinal, qualitative research shows this can perpetuate into early and mid-adulthood (94). With a growing body evidence suggesting

considerable vulnerability for loneliness in men in early to mid-adulthood (18), we provide critical information on who might be at greatest risk of feeling disconnected. This is particularly important given that at this stage of life, men are at the normative age for becoming fathers and their feelings of emotional connection or disconnection may have ramifications for family wellbeing (23).

Strengths and Limitations

There are a number of strengths and limitations in our study that should be noted. As is common in longitudinal studies, MAPP experienced some loss to follow-up, however, retention of participants has been high in comparison to other cohort studies of men (44, 95). The use of self-report measures for all predictors and the outcome measure of loneliness also poses as a possible limitation of this research with concerns around response bias, including social desirability (96). Despite this, the ULS-8 loneliness scale has been shown to be a consistent and valid measure, and the mean levels of loneliness reported by the men in our study were in line with a Norwegian study ($N = 10,061$) when strict social distancing measures had been implemented (97). It is also important to note the low reliability of the two competence scales. Further, most measures were examined prospectively, however, the Parental Bonding Instrument (PBI) is a retrospective assessment of prior relationships in childhood and adolescence. While recall bias may be present, two 20-year longitudinal studies found the measure to be stable and resistant to mood state (98, 99). We used LASSO models because they improve predictive performance when multiple factors are under consideration and increase the likelihood of replication in other samples (62). Further, the breadth of risk and protective predictors included in our analyses allowed for a wide examination across a variety of trait-based, relational, career/home and mental health and wellbeing domains. These should be understood alongside previously identified demographic factors such as education, income, and living arrangements (16). However, there are other possible relevant predictive factors that we did not include such as self-efficacy beliefs, cognitive functioning and feelings of safety in the community, which have been previously linked to feelings of loneliness (100).

Conclusions

Our study presents novel findings within a community-based sample of early to mid-adult men to address a key gap in knowledge about predictors of loneliness, specifically under restrictive pandemic conditions. More than half of the men in our sample indicated at least periodic moderate to high levels of loneliness, and 22 of 25 pre-pandemic risk and protective factors we examined across individual, relational, and mental health and wellbeing domains predicted loneliness. Our analytic technique allowed us to refine this to a set of the four most robust predictors of men's loneliness. These were environmental mastery, depressive symptoms, neuroticism,

and low perceived social support. Using rare, longitudinal data, this study has implications for programs seeking to target men who may be vulnerable to feeling lonely and experiencing its associated risks. These factors may be used in healthcare settings to aid in screening for risk of loneliness. The prospective identification of risk for loneliness represents a vital opportunity for preventing the distressing effects of perceived social disconnection experienced by men. Further, predictors identified in this model warrant investigation in studies that can assess whether they are causally related to loneliness which may inform intervention development.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: As per our data sharing policy, MAPP ethics approvals do not include participant consent for public availability of our data, however, requests for reuse of data for validation, verification or confirmation of past research are supported. The analytic code for the current analyses is available at https://osf.io/5v9wu/?view_only=b45da1a33def47398e841a8966b0e0d0 Requests to access these datasets should be directed to Kayla Mansour, kayla.mansour@deakin.edu.au.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Deakin University, Faculty of Health, Human Research Ethics Advisory Group. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

KM, JM, and CG: study conceptualization and design. JM and CO: longitudinal MAPP study conceptualization and design. KM, JM, LF, and CG: data collection and preparation. KM, CG, and JM: study statistical analyses and interpretation of results. KM: writing of original draft. All authors critically reviewed, edited, and approved the final manuscript.

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Bidirectional Associations Between Depressive and Anxiety Symptoms and Loneliness During the COVID-19 Pandemic: Dynamic Panel Models With Fixed Effects

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Background: Understanding the direction and magnitude of mental health-loneliness associations across time is important to understand how best to prevent and treat mental health and loneliness. This study used weekly data collected over 8 weeks throughout the COVID-19 pandemic to expand previous findings and using dynamic panel models with fixed effects which account for all time-invariant confounding and reverse causation.

Methods: Prospective data on a convenience and snowball sample from all 50 US states and the District of Colombia ($n = 2,361$ with ≥ 2 responses, 63.8% female; 76% retention rate) were collected weekly *via* online survey at nine consecutive timepoints (April 3–June 3, 2020). Anxiety and depressive symptoms and loneliness were assessed at each timepoint and participants reported the COVID-19 containment strategies they were following. Dynamic panel models with fixed effects examined bidirectional associations between anxiety and depressive symptoms and loneliness, and associations of COVID-19 containment strategies with these outcomes.

Results: Depressive symptoms were associated with small increases in both anxiety symptoms ($\beta = 0.065$, 95% CI $= 0.022$–0.109; $p = 0.004$) and loneliness ($\beta = 0.019$, 0.008–0.030; $p = 0.001$) at the subsequent timepoint. Anxiety symptoms were associated with a small subsequent increase in loneliness ($\beta = 0.014$, 0.003–0.025; $p = 0.015$) but not depressive symptoms ($\beta = 0.025$, -0.020–0.070; $p = 0.281$). Loneliness was strongly associated with subsequent increases in both depressive ($\beta = 0.309$, 0.159–0.459; $p < 0.001$) and anxiety ($\beta = 0.301$, 0.165–0.436; $p < 0.001$) symptoms. Compared to social distancing, adhering to stay-at-home orders or quarantining were not associated with anxiety and depressive symptoms or loneliness (both $p \geq 0.095$).

Conclusions: High loneliness may be a key risk factor for the development of future anxiety or depressive symptoms, underscoring the need to combat or

prevent loneliness both throughout and beyond the COVID-19 pandemic. COVID-19 containment strategies were not associated with mental health, indicating that other factors may explain previous reports of mental health deterioration throughout the pandemic.

INTRODUCTION

The COVID-19 pandemic and containment strategies employed to limit its spread (1–3) have profoundly impacted daily life in the US and globally, including substantial negative changes to health behaviors, employment, and mental health (4–8). Experts have expressed particular concern regarding potential increases in loneliness [or perceived social isolation; (9, 10)], defined as subjective distress resulting from a discrepancy between desired and perceived social relationships (11). Mortality attributable to low social support (162,000 deaths in 2000) exceeds that for cancer or stroke in the US (12), and in the UK it is estimated that the cost of loneliness to employers is more than $3 billion annually (13). Loneliness also has a substantial personal burden and is a major risk factor for physiological and health outcomes (14), including coronary heart disease and stroke, increased healthcare use in older people, cognitive decline, depression, and increased risk of all-cause mortality (15–19).

Loneliness and mental health are likely interrelated, underpinned by a combination of psychological and physiological pathways (20). Indeed, much research has examined the relationship between loneliness and depression, but many of these studies have important limitations (i.e., cross-sectional, small samples, and single-item measures of loneliness) and few have assessed bidirectional relationships (17, 21). Some evidence supports a reciprocal relationship (14, 22, 23), but research has not always been consistent (24). Cross-sectional evidence supports associations between loneliness and diagnosed anxiety disorders (25), although few studies have examined the bidirectional relationship between loneliness and anxiety. One such study demonstrated a bidirectional relationship between loneliness and social anxiety (26), while experimental evidence in which feelings of loneliness and social connectedness were hypnotically induced showed that loneliness increased anxiety (and depressive) symptoms (27). This is particularly concerning given the COVID-related deleterious impact on mental health (7), potentially creating a negative feedback loop between deteriorating mental health and loneliness. However, despite initial concerns and cross-sectional evidence of high pandemic-related levels of loneliness (9, 10), early longitudinal evidence suggested only minimal changes in loneliness (28). Nonetheless, loneliness also was not improved across time, and there will likely be longer-term effects of the pandemic; for example, living in economically and socially challenging conditions is associated with higher levels of loneliness (29).

Previous research examining longitudinal bidirectional relationships between depressive symptoms and loneliness across periods of years may not be generalizable to the rapid pandemic-related timeframes (i.e., weeks and months). Moreover, potential confounding from time-invariant factors (e.g., genetic susceptibility to loneliness and/or impaired mental health) and the time-varying effects of psychosocial risk factors known to be associated with both loneliness and depressive symptoms [e.g., low social network size and high perceived stress; (22, 24)] have not been adequately considered. It therefore remains plausible that the association between loneliness and depressive symptoms is, at least in part, attributable to these external factors. Additionally, research exploring potential bidirectional relationships between loneliness and anxiety symptoms is scarce.

Therefore, using dynamic panel models with fixed effects, the study reported here assessed: (1) longitudinal bidirectional relationships between anxiety and depressive symptoms and loneliness, and, (2) whether these associations might be attributable to perceived stress and social network size. These panel models address two central threats to valid causal inference in epidemiological studies, namely time-invariant confounding (e.g., genetics, sex, race, adverse childhood experiences, etc.) and reverse causation (30, 31).

METHODS

Sample

This longitudinal study includes follow-up data from the *COVID-19 and Well-being Study* collected at Iowa State University, following approval as an exempt study by the University Institutional Review Board (IRB# 20-144-00). Data from this study have been utilized in previous publications (6, 32–36). Recruitment methods for the initial survey included: mass emails to Iowa State University students, faculty, staff, and alumni; snowball sampling; and posts to social media pages. Mass emails and posts included a link to an anonymous electronic survey for interested participants to read and consent to enrolment in the study and verify inclusion criteria of being ≥18 years of age and current US residence.

The initial survey took 20–30 min and was completed by 3,133 adults from all 50 US states and the District of Colombia from April 3rd-10th, 2020 who indicated interest in continued participation. Participants had the opportunity to provide consent to be re-contacted to complete 8 weekly abbreviated follow-up surveys. Follow-up surveys were sent every 7 days from initial survey completion for 8 weeks. In the current study, 772 adults who did not complete at least one follow-up survey were excluded, leaving a final sample size of 2,361.

Measures

The 21-item Beck Depression Inventory-II (BDI-II), excluding the suicidality item, assessed depressive symptoms (37). Response options differed for each item but, for example, item 1 response options were "I do not feel sad" (scored as 0), "I feel sad much of the time" (scored as 1), "I am sad all the time" (scored as 2), and "I am so sad or unhappy that I can't stand it" (scored as 3). Scores were divided by 20 and multiplied by 21 to calculate estimated total scores ranging from 0 to 63, with higher scores indicating more depressive symptoms. The BDI-II has previously demonstrated internal consistency around $\alpha = 0.90$ and test-retest reliability between $r = 0.73$–0.96 (38).

The 21-item Beck Anxiety Inventory (BAI) assessed anxiety symptoms (39). Response options for each item were "Not at all" (scored as 0), "Mildly, but it didn't bother me much" (scored as 1), "Moderately—it wasn't pleasant at times" (scored as 2), and "Severely—it bothered me a lot" (scored as 3). Thus, scores range from 0 to 63 with higher scores indicating more anxiety symptoms. The BAI has previously demonstrated internal consistency of $\alpha = 0.91$ and test–retest reliability of $r = 0.65$ (40).

The 3-item Loneliness scale examined loneliness symptoms (41). This measure avoids use of the term "lonely" or "loneliness" and thus avoids much of the stigma associated with, and consequent underestimation of, loneliness. Response options for each item were "Hardly ever or never" (scored as 1), "Some of the time" (scored as 2), and "Often" (scored as 3). Thus, scores range from 3 to 9 with higher scores indicating more loneliness symptoms. It has previously demonstrated an internal consistency of $\alpha = 0.72$ and correlation of $r = 0.82$ with the revised UCLA Loneliness Scale (41).

Social network size was assessed using an abbreviated version of the Lubben Social Network Scale-6 (42) with three items combining friends/relatives in each item. Questions assessed how many relatives/friends the respondent (1) speaks to at least once a day, (2) feels at ease with that they could talk about private matters, and (3) feels close to such that they could call on them for help. Response options were "None" (scored as 0), "One" (scored as 1), "Two" (scored as 2), "Three or four" (scored as 3), "Five through eight" (scored as 4), and "Nine or more" (scored as 5). Thus, scores range from 0 to 15 with higher scores indicating greater social network size. It has previously demonstrated internal consistency of $\alpha = 0.83$ (42).

The 4-item Perceived Stress Scale-4 assessed stress. Response options for each item were "Never" (scored as 0), "Almost never" (scored as 1), "Sometimes" (scored as 2), "Fairly often" (scored as 3), and "Often" (scored as 4). Thus, scores range from 0 to 16 with higher scores indicating more perceived levels of stress. It has previously demonstrated internal consistency ranging between $\alpha = 0.60$–0.82 (43).

Participants also indicated the COVID-19 containment strategies to which they were adhering (as opposed to those that were recommended in their area). Possible responses were:

1. Self-Isolation: For people who actually have the virus or suspect they may be infected. People who have been infected

with the virus may be asked to self-isolate at home if they have no symptoms or are only mildly ill.
2. Quarantine: For those who may have been exposed to the virus. They are asked to stay at home. Some people may choose to be asked to self-quarantine, meaning they do it voluntarily because they think they may have been exposed or they are being cautious.
3. Shelter-in-place: People that are being asked to stay at home as much as possible, meaning they shouldn't be out unless getting food, gas, or other essentials, or for medical reasons.
4. Stay-at-home order: Residents can still go out for essential needs as long as they are practicing social distancing and "common sense."
5. Social distancing: Means remaining out of congregate settings, avoiding mass gatherings, and maintaining distance (~6 feet or 2 m) from others when possible.

Participants selected all that applied and were grouped based upon the most restrictive strategy that they were following, with quarantine and self-isolation the most restrictive, shelter-in-place or stay-at-home next, and social distancing or none the least restrictive.

Statistical Analyses

Analyses were conducted in STATA 14.2. Summary statistics were means and standard deviations for continuous variables and frequencies for categorical variables. T-tests and Cohen's d effect sizes assessed differences in anxiety and depressive symptoms and loneliness between participants with and without data at follow-up. Using the maximum likelihood–structural equation models method, dynamic panel models with fixed effects were applied to assess associations between anxiety and depressive symptoms and loneliness (44). These models use variation within individuals to estimate the relationships between variables of interest. Thus, major sources of confounding from all time-invariant confounders that may be correlated with anxiety and depressive symptoms and loneliness (e.g., genetics, sex, race, childhood experiences, lifetime diagnosis of anxiety/depression, etc.) are eliminated (31, 45). Panel models, including reciprocal paths between independent and dependent variables and lagged values of both dependent and independent variables, were used to clarify the direction of the association between anxiety and depressive symptoms and loneliness. The fixed effects term was modeled as a latent variable and allowed to correlate with all time-varying independent variables (46). Allowing these correlations supports the claim that these models control for all time-invariant confounders (31). Cross-lagged association was accommodated by declaring anxiety and depressive symptoms and loneliness as "sequentially exogeneous" independent variables, which allows for the possibility that they could be affected by prior values of the dependent variables. Mechanically, the independent variable at time t is allowed to correlate with the error term for the dependent variable at any prior time point (47). COVID-19 containment strategies were not lagged and were included as "strictly exogenous" independent variables, meaning they could not be affected by prior values of the dependent variable. Separate models were

created with regression coefficients constrained to be equal or free to vary across time and model fit was compared using the Bayesian information criterion (BIC), a relative fit statistic which approximates the Bayes factor and is typically superior to other fit indices in finding the true model in larger sample sizes (48). A lower BIC indicates a better fitting model, with differences of 0–2, 2–6, 6–10, and >10 indicative of weak, positive, strong, and very strong evidence, respectively (49, 50). Models were also created controlling for social network size and stress as lagged, sequentially exogenous variables. To reduce bias introduced by missing information, full-information maximum likelihood estimation was used (51, 52). Model fits were assessed using the Chi-Square statistic, comparative fit index (CFI), Tucker-Lewis fit index (TLI), and the root mean square error of approximation (RMSEA). Values of CFI and TLI >0.95 and RMSEA values <0.05 are assumed to be indicative of a well-fitting model.

RESULTS

Participant Characteristics

Participants who dropped out following the baseline survey had slightly higher depression ($d = 0.22$, 95% CI $= 0.14$–0.30; $p < 0.001$), anxiety ($d = 0.11$, 0.03–0.19; $p = 0.011$), and loneliness ($d = 0.15$, 0.07–0.24; $p < 0.001$) symptoms compared to the analytic sample. Full baseline characteristics of participants included in the current study are presented in **Table 1**. Briefly, participants ($n = 2,361$; 75.4% retention rate; 63.9% female) were fairly evenly dispersed across age categories from 18 to 74, with 235 participants aged ≥ 75 years, and were generally well-educated (88.2% college graduates or above) and overweight (BMI $= 26.72 \pm 5.69$ kg/m^2). Respondents in the analytic sample were more likely to be female (63.9 vs. 50.8%), white (93.1 vs. 76.3%), and have a higher education level (college graduates 88.2 vs. 31.5%) compared to US adult population data from the 2019 Census Bureau (53).

Bidirectional Associations Between Anxiety and Depressive Symptoms and Loneliness

Mean depressive and anxiety symptom and loneliness scores and their intercorrelations at each time-point are presented in **Figure 1** and **Supplementary Table 1**, respectively. Dynamic panel models with fixed effects were specified to examine reciprocal relationships between anxiety and depressive symptoms and loneliness over 8 weeks. BIC values (**Supplementary Table 2**) very strongly supported that models with coefficients constrained to be equal across time fit the data better than those with regression coefficients free to vary across time. Model fit statistics (**Table 2**) indicated that these constrained models fit the data adequately. **Figure 2** shows results from the dynamic panel models with fixed effects between anxiety and depressive symptoms and loneliness.

Depressive symptoms were associated with small subsequent increases in both anxiety symptoms ($\beta = 0.065$, 95% CI

TABLE 1 | Baseline participant characteristics ($n = 2,361$ US adults).

Age (years)	
18–24	318 (13.5)
25–34	354 (15.0)
34–44	316 (13.4)
45–54	300 (12.7)
55–64	397 (16.8)
65–74	441 (18.7)
≥75	235 (10.0)
Sex	
Female	1,508 (63.9)
Male	846 (35.8)
Transgender	7 (0.3)
Race	
White	2,199 (93.1)
Education	
Up to high school graduate	33 (1.4)
Some college	246 (10.4)
Up to college graduate	973 (41.2)
Graduate degree	1,109 (47.0)
Body mass index	26.7 ± 5.7
Smoker (yes)	50 (2.1)
Chronic conditions	
0	131 (5.5)
1	794 (33.6)
≥2	1,435 (60.8)
Not reported	1 (<0.1)
Lifetime diagnosis of depression or anxiety (yes)	592 (25.1)
Public health restrictions	
Self-isolating/quarantining	229 (9.7)
Shelter in place	1,134 (48.0)
None/social distancing	998 (42.3)

Numbers are N (%) or mean ± standard deviation.

$= 0.022$–0.109; $p = 0.004$) and loneliness ($\beta = 0.019$, 0.008–0.030; $p = 0.001$). Anxiety symptoms were associated with a small subsequent increase in loneliness ($\beta = 0.014$, 0.003–0.025; $p = 0.015$) but not depressive symptoms ($\beta = 0.025$, -0.020–0.070; $p = 0.281$). Loneliness was strongly associated with subsequent increases in both depressive ($\beta = 0.309$, 0.159–0.459; $p < 0.001$) and anxiety ($\beta = 0.301$, 0.165–0.436; $p < 0.001$) symptoms. Compared to social distancing, quarantining or stay-at-home orders were not associated with anxiety or depressive symptoms or loneliness (all $p \geq 0.095$).

Are the Associations Between Depressive and Anxiety Symptoms and Loneliness Driven by Perceived Stress and Social Network Size?

The next model examined whether the associations between depressive and anxiety symptoms and loneliness might be

FIGURE 1 | Mean **(A)** depression and anxiety (both range: 0–63) and **(B)** loneliness (range: 3–9) symptom scores with 95% confidence interval bands over 8 weeks of follow-up.
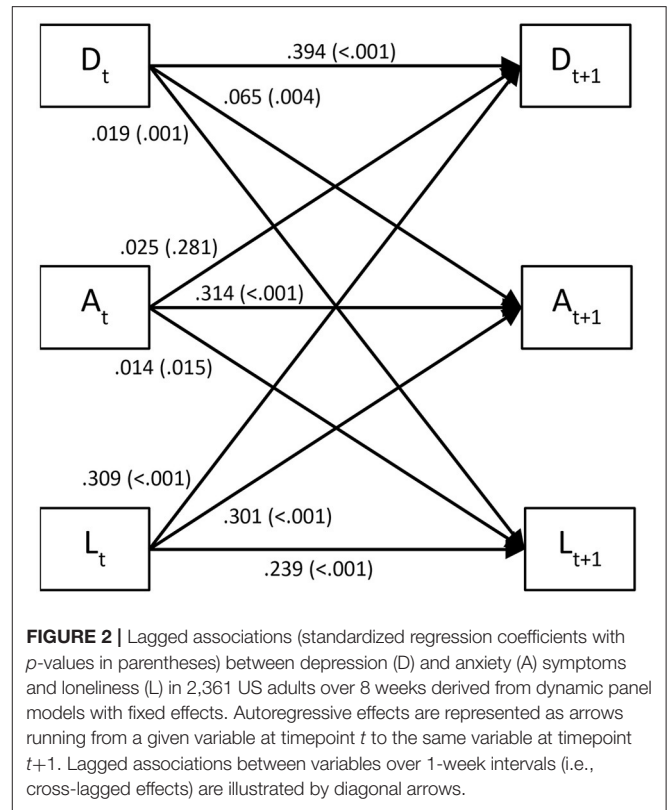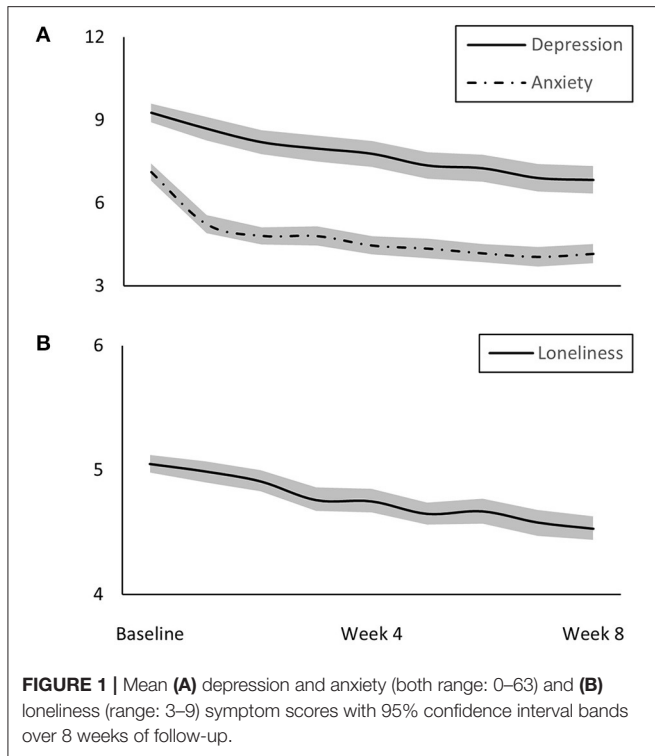
TABLE 2 | Fit statistics for the dynamic panel models with fixed and lagged effects between symptoms of depression, anxiety, and loneliness.

Outcome	Chi square	df	CFI	TLI	RMSEA (90%CI)
Depression	523.87	197	0.983	0.975	0.027 (0.024–0.029)
Anxiety	594.62	197	0.975	0.963	0.029 (0.027–0.032)
Loneliness	411.58	197	0.984	0.976	0.021 (0.019–0.024)

Data were derived from 8 weeks of data in 2,361 US adults.
A CFI and TLI ≥ 0.95 and RMSEA < 0.05 are indicative of a well-fitting model.
90% CI, 90% confidence interval; CFI, comparative fit index; df, degrees of freedom; RMSEA, Root mean squared error of approximation; TLI, Tucker-Lewis index.

attributable to perceived stress and social network size. At baseline, social network size and perceived stress were associated with depressive (social network: $r = -0.177$; $p < 0.001$; stress: $r = 0.666$; $p < 0.001$) and anxiety (social network: $r = -0.066$; $p = 0.001$; stress: $r = 0.536$; $p < 0.001$) symptoms and loneliness (social network: $r = -0.229$; $p < 0.001$; stress: $r = 0.456$; $p < 0.001$). Building on the primary models, social network size and perceived stress were added as sequentially exogenous variables with lagged effects. These models fit the data adequately (**Supplementary Table 3**).

Results from the dynamic panel models with fixed effects between depressive and anxiety symptoms and loneliness controlling for perceived stress and social network size are presented in **Supplementary Figure 1**. Perceived stress was associated with a small subsequent increase in depressive symptoms ($\beta = 0.074$, 0.004–0.144; $p = 0.037$), but not anxiety

FIGURE 2 | Lagged associations (standardized regression coefficients with *p*-values in parentheses) between depression (D) and anxiety (A) symptoms and loneliness (L) in 2,361 US adults over 8 weeks derived from dynamic panel models with fixed effects. Autoregressive effects are represented as arrows running from a given variable at timepoint *t* to the same variable at timepoint *t*+1. Lagged associations between variables over 1-week intervals (i.e., cross-lagged effects) are illustrated by diagonal arrows.

symptoms ($\beta = 0.020$, −0.040–0.081; $p = 0.516$) or loneliness ($\beta = 0.007$, −0.010–0.023; $p = 0.439$). Social network size was associated with a small subsequent decrease in anxiety symptoms ($\beta = -0.153$, −0.287-−0.020; $p = 0.025$), but not depressive symptoms ($\beta = -0.058$, −0.194–0.079; $p = 0.409$) or loneliness ($\beta = -0.011$, −0.045–0.023; $p = 0.537$). Interrelations between depressive and anxiety symptoms and loneliness did not materially differ from primary analyses. Depressive symptoms were associated with small subsequent increases in both anxiety symptoms ($\beta = 0.051$, 95% CI = 0.007–0.095; $p = 0.024$) and loneliness ($\beta = 0.017$, 0.006–0.029; $p = 0.003$). Anxiety symptoms were associated with a small subsequent increase in loneliness ($\beta = 0.014$, 0.003–0.025; $p = 0.013$) but not depressive symptoms ($\beta = 0.027$, −0.018–0.073; $p = 0.239$). Loneliness was strongly associated with subsequent increases in both depressive ($\beta = 0.272$, 0.124–0.421; $p < 0.001$) and anxiety ($\beta = 0.285$, 0.152–0.419; $p < 0.001$) symptoms.

DISCUSSION

This study examined bidirectional relationships between depressive and anxiety symptoms and loneliness in 2,361 US adults over 8 weeks during the COVID-19 pandemic. Findings showed that (1) loneliness was strongly associated with subsequent increases in depressive and anxiety symptoms, but anxiety and depressive symptoms were only weakly associated with subsequent increases in loneliness; (2) depressive

symptoms were associated with subsequent increases in anxiety symptoms, but not vice versa; and, (3) COVID-19 containment strategies were not associated with depressive or anxiety symptoms or loneliness. These findings are independent of time-invariant factors (e.g., genetics, sex, race, adverse childhood experiences, etc.), reverse causation, and time-varying COVID-19 containment strategies, social network size, and perceived stress.

Bidirectional associations between loneliness and depressive/anxiety symptoms were observed, although loneliness was a considerably stronger predictor of depressive and anxiety symptoms relative to the reverse causal direction. Previous evidence for associations between loneliness and depressive symptoms has been mixed and is scarce for loneliness and anxiety symptoms. Findings from the Chicago Health, Aging, and Social Relations Study indicated that loneliness predicted subsequent changes in depressive symptomatology but not vice versa (24). However, most research has demonstrated bidirectional relationships, albeit with variability in the magnitudes of the associations (14, 22, 23). In contrast to the current study, these previous studies have focused on middle-aged to older adult cohorts and had follow-up periods ranging from 2 to 14 years. It seems plausible that age and follow-up period may influence the relationships of interest, although future research is required to test if and how they do moderate the loneliness-mental health relationships. Additionally, compared to these prior studies, an important strength of the current study was the use of standard fixed effect methods which effectively rule out all time-invariant confounding, a central threat to valid causal inference in epidemiological studies, which may contribute to some differences in findings.

Over the course of the 8-week follow-up, anxiety and depressive symptoms and loneliness decreased by ∼10% each, potentially as people adjusted to their "new normal." This is encouraging as it may suggest that the initial mental health impact of the pandemic may not persist. However, there may still be longer-term effects, particularly relative to loneliness which can increase due to economically and socially challenging conditions (29). As increases in loneliness were strongly associated with increases in depressive and anxiety symptoms, addressing this may be a key factor in the maintenance of mental health as the pandemic and its subsequent impact progress.

Meta-analytic evidence has shown that depressive and anxiety symptoms predict one another with moderate and similar strength ($r = 0.31$–0.34), with relationships stronger over shorter time periods and weaker over longer time periods (54). Of the 35 studies included in these analyses, just one had a comparable follow-up period to the current study, but it focused on anxiety patients rather than the general population. This difference in follow-up period may explain why the magnitude of the association for depressive symptoms predicting anxiety symptoms in the current study is smaller than that found in the prior meta-analysis and why anxiety symptoms did not predict depressive symptoms.

Throughout the COVID-19 pandemic, considerable concern has been expressed about the potential mental health impacts of the various containment strategies [e.g., social distancing, stay-at-home orders, etc.; (55)]. Longitudinal data from the UK demonstrated that mental health had deteriorated compared with pre-COVID-19 trends (7). In this study, being young, a woman, and living with children, especially preschool-age children, were strongly associated with increases in mental distress. However, the entire sample was under strict lockdown and adherence was not assessed, so associations between different recommended or actual containment behaviors and mental health were not examined. Previous cross-sectional evidence from the current cohort showed that, compared to individuals who were social distancing, individuals who were self-isolating reported higher depressive and anxiety symptoms (35). However, the present longitudinal findings showed no associations between containment strategies and depressive and anxiety symptoms or loneliness. This suggests that factors external to the containment strategy to which a person is adhering underpin the previously observed deteriorations in mental health.

Limitations

Several potential limitations of this study should be noted. Firstly, although the use of fixed effects models effectively rule out time-invariant confounding, and reverse causation is controlled for by alternatively using panel models allowing for lagged and reciprocal relationships, experimental evidence would confer greater confidence in the causal role of loneliness on depressive and anxiety symptoms and vice versa. Secondly, the use of a convenience sample resulted in a sample that was not representative of the US population, thereby limiting the generalisability of the findings. Additionally, participants who dropped out following the baseline survey had slightly higher depressive and anxiety symptoms and loneliness, meaning the analytic sample had comparatively better mental health. This could lead to an underestimation of the true effect as a potential negative feedback loop between depressive and anxiety symptoms may be stronger among those with worse mental health. Thirdly, self-reported depressive and anxiety symptom measures could lead to more measurement error than clinical interviews, though such measurement error was not expected to be related to our hypotheses. Nonetheless, whether the current findings for depressive and anxiety symptoms extend to clinical diagnoses is unknown. Finally, future research is required to test whether the relationships observed here persist beyond the pandemic.

CONCLUSIONS

These findings contribute to growing evidence that supports the longitudinal bidirectional depressive symptom–loneliness relationship, and provide novel evidence for a bidirectional anxiety symptom–loneliness relationship; however, loneliness was a stronger predictor of depressive and anxiety symptoms relative to the reverse causal direction. High loneliness may

be a key risk factor for the development of future anxiety or depressive symptoms, underscoring the need to combat or prevent loneliness both throughout and beyond the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Iowa State University's Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CM: analysis and interpretation of data and drafting of the manuscript. All authors study concept and design and revision of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt. 2021.738892/full#supplementary-material

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frontiers in Psychology

Social Isolation and Sleep: Manifestation During COVID-19 Quarantines

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Although researchers have investigated the impact of social isolation on well-being, the recent quarantines due to COVID-19 resulted in a social isolation environment that was unique to any examined in the past. Because sleep is one of the endogenous drives that impacts short and long-term health and well-being, it is important to consider how social isolation during the COVID-19 government-mandated quarantines affected sleep and sleep habits. A number of researchers have addressed this question during the last 2 years by examining several concepts related to possible changes in sleep during the quarantines. To best understand these recent results, the current mini review provides a background on the pre-pandemic literature on the effects of social isolation and loneliness with a focus on sleep and then summarizes the recent literature on sleep and sleep habits. In general, sleep was negatively impacted for many people during the pandemics but not all. One group that seemed to benefit from the pandemic in terms of sleep patterns, were younger people who could more easily adapt their sleep times to match their internal chronobiology. Given the potential broad impact of sleep on health and well-being, better understanding how social isolation impacts sleep is an important consideration for individuals, work organizations, and governments.

Keywords: social isolation, sleep, social relationships, COVID-19, loneliness, review

INTRODUCTION

Social isolation can arise from many causes. Disruptions to our daily social connections (e.g., job loss) result in people adapting to some level of social isolation. Quarantine procedures used to control virus outbreaks can result in extended social isolation. For example, numerous citywide quarantines were put in place in China and Canada during the 2003 outbreak of severe acute respiratory syndrome (SARS). In the United States, individuals with SARS were placed in individual quarantine. Similarly, many villages in west African countries were quarantined in the 2014 Ebola outbreak (Brooks et al., 2020). Since the new SARS outbreak, COVID-19, in December 2019, many people in numerous countries have been required to quarantine for weeks to months where they were obligated to work at home, home-school children, and drastically decrease social interaction resulting in prolonged periods of enforced social isolation.

The impact of such widespread social isolation is not yet well understood. Some research has, however, focused on the potential impact of meaningful social relationships in humans. The association between positive social relationships and health has been clearly established. Individuals who are well integrated into society typically display lower mortality, lower rates of chronic diseases, and healthier overall behavior (House et al., 1988). Similarly, being socially connected

positively impacts psychological, emotional, and physical well-being (Uchino, 2006). A meta-analytic summary of the literature found that inadequate social relationships is linked with an increase in risk of premature mortality that is similar to well-established health-risk factors such as decreased physical activity and increased obesity (Holt-Lunstad et al., 2015).

Good interpersonal relationships could help enable social influence on individual choices and behaviors by providing a structure that encourages individuals to choose better health-related behaviors (Umberson, 1987). For example, social relationships can help one maintain a more consistent sleep routine that can result in better stress management and long-term health benefits. However, the functionality of this type of social structure could be undermined by a quarantine-like scenario such as those implemented to control the spread of COVID-19.

The purpose of this mini review is to assess recent findings pertaining to sleep and sleep habits under COVID-19 quarantine conditions within the broader context of the social isolation research area. To identify the relevant literature, we used Google Scholar and PsycInfo. We also searched the citations within the literature we identified and the "cited by" index in Google Scholar to locate additional relevant studies. Together, these search methods provided a substantial base of literature to inform our assessment of social isolation and sleep.

SOCIAL ISOLATION AND LONELINESS

Research examining the impact of social isolation is often intermixed with research on perceived loneliness. While the concepts of social isolation and loneliness are sometimes used interchangeably, they can be viewed as two separate scientific constructs. Perceived loneliness is defined by one's inability to fulfill personal social desires (Ernst and Cacioppo, 1999; Cacioppo et al., 2010). Individuals are at greater risk of experiencing perceived loneliness when they have few social networks, conflicts in their current family or intimate relationships, or social connections that are not close enough to be considered a social relationship (Dykstra and Fokkema, 2007; van Tilburg et al., 2015; Gierveld et al., 2018). It is important to note that an individual can be lonely, but not be socially isolated and vice versa (Victor et al., 2000; Cacioppo et al., 2009; Gierveld et al., 2018). While the focus of the current paper is on social isolation, it is important to note that feelings of loneliness are likely part of the broad impact of social isolation resulting from the COVID-19 quarantines.

Although one can be socially isolated and not experience the emotion of loneliness, this is unlikely for most people (Victor et al., 2000; Gierveld et al., 2018). By nature, humans are social entities and when they are isolated from human contact or experience feelings of loneliness, health risks and sleep problems increase (Cacioppo et al., 2000, 2011; Robins et al., 2018; Griffin et al., 2020). In the case of social isolation due to the COVID-19 quarantines, it is likely that many individuals maintained some level of family connections but experienced a decrease in other social contact. In addition, many individuals could have maintained some level of social relationships using social media

(Pancani et al., 2021). It seems likely that most individuals had some level of social contact during the COVID-19 quarantines, nonetheless most would have experienced a dramatic decrease in their normal social interactions.

Research suggests that socially isolated individuals are at a greater risk for increased stress and higher mortality and morbidity (House et al., 1982, 1988; Umberson, 1987; Brummett et al., 2001; Cacioppo et al., 2011). Some research equates experiencing social isolation with the same health risks as smoking 15 cigarettes or drinking six alcoholic beverages a day (House et al., 1982; Brummett et al., 2001; Holt-Lunstad et al., 2015; Robins et al., 2018). Social isolation is also highly comorbid with mental disorders like depression, anxiety, and dementia (Ernst and Cacioppo, 1999; Cacioppo et al., 2000; Robins et al., 2018). However, research also indicates that interaction with as little as one other individual can greatly reduce the health risks associated with social isolation (Cacioppo et al., 2000; Brummett et al., 2001), suggesting that the specific characteristics of the social isolation environment can affect the broader impact on individuals.

The exact social isolation conditions resulting from COVID-19 quarantines varied across different individuals and countries. Some individuals could have been isolated with their families while other individuals could have been living alone but using social media to maintain some social contact. Similarly, some countries repeated quarantines over time while other countries had longer, sustained quarantines in place. As such, the social isolation with the resultant feelings of loneliness experienced during COVID-19 quarantines is unique and presents an environment unlike the types of social isolation seen in previous studies.

SLEEP AND SLEEP HABITS

Pre-COVID-19 pandemic studies have shown that social isolation negatively impacts sleep (Cacioppo et al., 2002; Kurina et al., 2011). Furthermore, a recent review of the pre-pandemic literature on social relationships and sleep concluded that increased quantity and quality of mutually supportive relationships are positively related to sleep (Gordon et al., 2021). It is also well established that sleep and sleep habits can be negatively impacted by psychosocial stress (Åkerstedt, 2006) as occurs during prolonged social isolation as seen in the COVID-19 quarantines (Yuksel et al., 2021).

Sleep is a health behavior that is highly predicated on a consistent routine and thus, could be compromised as a result of the changes in lifestyle during a quarantine. The implication of this relationship could be significant, given the evidence in the scientific community that links poor sleep to poor health outcomes. Sleep disturbances, unrelated to an underlying medical condition, are associated with increased cardiovascular disease, cancer, and obesity as well as to all-cause mortality (Cappuccio et al., 2010). Sleep disturbances also negatively impact psychological functioning, immune response, and mood regulation (Medic et al., 2017). In addition, sleep habits are a better predictor of mental health and well-being than

other health-related behaviors such as physical activity and diet (Wickham et al., 2020).

Sleep loss can also have more acute effects on health. For example, a single night of simulated shift work results in higher blood pressure among young adults at risk for hypertension (McCubbin et al., 2010) and alters respiratory sinus arrhythmia when completing complex tasks (Walker et al., 2009). As such, maintaining good sleep habits and adequate sleep would be an important component of good mental and physical health both in the short-term, such as during a quarantine, but also lifelong.

It is important to note that sleep quality is at least as important to good health as sleep quantity. Sleep quality is often the better predictor of mental health and well-being (Wickham et al., 2020) and is more closely associated with health, affect, and life satisfaction than sleep quantity (Pilcher et al., 1997) particularly in persons sleeping between 6 and 8 h a night. In addition, both social isolation and perceived loneliness negatively impact sleep quality (Matthews et al., 2017; Cho et al., 2019). It has also been shown in older individuals that social isolation predicts poor sleep quality 6 years in the future (Yu et al., 2018). Therefore, understanding the interaction between sleep and social relationships is important in understanding how humans' social nature impact our health and well-being (Cacioppo et al., 2011; Robins et al., 2018).

SOCIAL ISOLATION AND SLEEP DURING COVID-19

Understanding the impact of government-mandated quarantines that extended across many countries and millions of people on sleep is crucial due to the many links between sleep, health, and well-being. Because modern technology has enabled forms of communication that make total isolation less likely, the COVID-19 quarantines may not have resulted in total social isolation for many people, however, the quarantines would have caused unique challenges leading to changes in daily life for most people. Furthermore, recent research indicates that people experienced increased feelings of depression and anxiety during the COVID-19 quarantine (Peterson et al., 2021) which could negatively impact sleep and sleep habits for many individuals.

Meta-Analyses and Large Multi-Country Studies

A number of review articles and multi-country studies have focused specifically on sleep and sleep patterns during the COVID-19 quarantine. One meta-analysis examining sleep habits across 13 countries found that 35.7% of the participants experienced sleep disturbances (Jahrami et al., 2021). Another meta-analysis examined gender differences in sleep problems across 19 countries and found that 24% of female participants and 27% of male participants experienced sleep problems during the quarantines (Alimoradi et al., 2021).

Several multi-country studies included specific information about sleep habits that was not easily captured in the meta-analyses. One multi-country study found that over 50% of the participants delayed their sleep and wake times with more than a third of the participants reporting increased sleep disturbances (Yuksel et al., 2021). In addition, they concluded that poorer sleep was associated with increased depression and anxiety symptoms. Another multi-country study reported that equal numbers of participants indicated no change in sleep as worsening sleep (Mandelkorn et al., 2021). In this study, the people most likely to report increased sleep disturbances were women, people between the ages of 31 and 45, and people who were less physically active. One multi-country study found that sleep was seen as less restful and of lower quality during the quarantine than prior to the quarantine and that decreases in sleep quality were negatively correlated with perceived social isolation, depression, and anxiety (Salah et al., 2021). Finally, a multi-country study that included many high school students found that most changes in sleep patterns occurred within the first 2 weeks of the quarantine (AMHSI Research Team et al., 2020). More specifically, they reported that the differences between sleep duration on weekdays versus weekends disappeared with total sleep time increasing by about one hour during the quarantine particularly for the adolescents.

These large-scale studies provide a good foundation for understanding the impact of social isolation during the COVID-19 quarantine on sleep and sleep habits. These studies reported that people often indicate worse sleep quality or sleep problems during the quarantine. However, there were also some people, particularly older adolescents, who increased their sleep time. In addition, there were differing reports on the prevalence of sleep problems in females and males.

Primary Studies

Other studies, though individually less encompassing than the reviews and multi-country studies, provide important information about the impact of social isolation during the COVID-19 quarantines on sleep. In this section, we focus on primary studies that were published more recently and were not captured in the meta-analyses described above to provide a broad picture of what the current literature is showing.

Many sleep scientists used sleep quality or similar constructs to document changes in sleep during the COVID-19 quarantines. Many studies across numerous countries reported a worsening of sleep quality, increasing sleep problems, or increasing problems with insomnia during quarantine conditions (Blume et al., 2020; Peretti-Watel et al., 2020; Pinto et al., 2020; Voitsidis et al., 2020; AlRasheed et al., 2021; Cellini et al., 2021; Conte et al., 2021; Hisler and Twenge, 2021; Hyun et al., 2021; Marelli et al., 2021; Martínez-de-Quel et al., 2021; Robillard et al., 2021). However, some studies found that sleep quality did not worsen across all participants (Benham, 2020; Gao and Scullin, 2020; Kocevska et al., 2020; Tahara et al., 2021). Of these studies, a common trend was that younger people or college students reported less sleep problems during the quarantine (Benham, 2020; Tahara et al., 2021).

In addition to quality-type measures, many researchers examined changes in sleep patterns during the COVID-19 quarantines. Delays in sleep timing which frequently included a concomitant increase in sleep quantity were commonly found across many countries (Benham, 2020; Blume et al., 2020;

Sinha et al., 2020; Wright et al., 2020; Cellini et al., 2021; Conte et al., 2021; Robillard et al., 2021; Tahara et al., 2021). The delays in sleep timing included later bedtimes, mid-sleep times, and wake-up times often resulting in less social jetlag (where sleep times differ between workdays and non-workdays). One study found that the number of college students reporting seven or more hours of sleep a night increased from 84 to 92% for weekdays during the quarantine (Wright et al., 2020). Not surprisingly, there was variability in the responses from participants about time in bed during the pandemic. One study reported that although average wake time was delayed, some participants reported a decrease in total sleep time (Robillard et al., 2021) while a different study focusing on adults over 60 years old found that about 27% of participants reported more sleep than usual while about 15% reported less sleep than usual during the pandemic (Emerson, 2020). Another study found that average time asleep did not change during the pandemic, however, there was greater prevalence of both shorter and longer sleep than the recommended 7–8 h a night (Hisler and Twenge, 2021).

Another area of sleep-related research during the COVID-19 quarantines concerned the potential impact of variables related to the characteristics of the individual participants. This included differences between females and males, personality types, stress, and mood variables. In general, women were more likely to experience worse sleep quality and worse insomnia than men across many countries (Pinto et al., 2020; Voitsidis et al., 2020; Cellini et al., 2021; Marelli et al., 2021; Robillard et al., 2021). In addition, women were more likely to experience increased feelings of distress and loneliness during the quarantines (Losada-Baltar et al., 2021). In contrast, one study found that although women reported more anxiety than men, their sleep quality did not differ (Bigalke et al., 2020).

Lower quality sleep and insomnia were correlated with depressive symptoms and feelings of loneliness (Voitsidis et al., 2020; Hyun et al., 2021), feelings of anxiety (Xiao et al., 2020), a more negative mood (Ingram et al., 2020; Cellini et al., 2021), and negative affect and worry (Kocevska et al., 2020). Furthermore, some studies divided the participants into groups depending on sleep-related variables or personality-type variables. One study divided their participants into three groups based on sleep quantity (reduced or extended) and delayed sleep times (Robillard et al., 2021). They concluded that those participants experiencing a reduction in sleep quantity or delayed sleep times also experienced more stress, anxiety, and depression during the quarantines. Another study divided their participants into three groups based on adaptive-type personality profiles (Ahmed et al., 2021). They found that persons with highly adaptive personalities exhibited less perceived stress and better sleep quality while persons with a maladaptive personality profile experienced the highest perceived stress and poorer sleep quality.

CONCLUSION AND IMPLICATIONS

The drastic increase in levels of social isolation during the COVID-19 quarantines was accompanied by changes in sleep.

Sleep quality suffered, particularly in women. Interestingly, the timing of sleep changed with some people, especially younger adults, shifting their bed and wake up time to later in the day while often increasing the time asleep. This suggests that many people curtail their sleep to meet the time demands of their workplace or education settings and that the quarantines provided flexibility, thus allowing some individuals to better match their sleep to their chronobiological drives. It is also important to note that not everyone experienced an increase in sleep quantity during the quarantines. Some people, particularly those who reported feelings of depression, anxiety, loneliness, or stress, experienced less sleep as well as worse sleep quality.

As noted earlier, social isolation could include feelings of loneliness for some people. Unfortunately, this manuscript could not address this issue since few studies on sleep during the COVID-19 quarantines examined loneliness. Those studies that did suggested that feelings of loneliness were related to increased incidences of disturbed sleep. However, future research is needed to better document the potential impact of loneliness on sleep under social isolation conditions.

As would be expected, sleep and sleep habits varied across individuals during the COVID-19 quarantines. Some of the differences in sleep disruptions were related to individual characteristics such as differences between females and males or a different adaptation in sleep behaviors for younger adults than other adults. There are other variables that could have moderated the impact of social isolation on sleep such as social support. Studies indicate that during the COVID-19 quarantines perceived social support served as a buffer for the negative impact of the quarantines on sleep, stress, anxiety, and depression (Grey et al., 2020; Li et al., 2020; Xiao et al., 2020). A lack of social support can also cause a decline in self-control ability (Pilcher and Bryant, 2016), which in turn could lead to poorer decisions regarding sleep habits (Pilcher et al., 2015). This sequence of events could contribute to worse sleep under social isolation conditions for individuals who experience less social support. Another potential moderating variable is exercise which has been shown to be related to sleep quality and quantity (Kovacevic et al., 2018; Pilcher et al., 2021). Unfortunately, exercise was not a common measure for the quarantine-based studies on sleep and, thus, could not be assessed here. Other potential moderating variables could be family and work obligations, preexisting medical conditions, or neurological conditions. Unfortunately, these types of constructs were not commonly measured in the quarantine-based studies on sleep. Additional research is needed to document the interactions between potential moderating variables and the impact of social isolation on sleep.

The literature reviewed here suggests that a complex, multi-dimensional relationship exists that connects social integration and sleep. In general, social isolation during the quarantines negatively impacted sleep for many individuals which could then have short- and long-term consequences on health. Given that interventions in one health area could positively impact other health areas (Rajkumar, 2020), it is important to consider the potential impact of developing interventions that address the range of sleep problems that can emerge

during social isolation conditions. This can include interventions from governments, workplaces, and health-care professionals that incorporate educational efforts, treatment of insomnia, chronobiological therapies, and cognitive-behavioral therapies that can help individuals more readily adapt to social isolation.

The current mini review supports the importance of understanding the broader impact of social isolation on sleep as well as the need for additional research. It is important to note that social isolation could occur in a variety of settings other than a pandemic, including isolation because of personal decisions to withdraw from others, disruption in a normal social group such as when losing a job, mental disorders, retirement, aging, and when working primarily from home. Government, workplace, and health-care interventions are needed that are broadly accessible by the public to assist individuals in better

managing their health behaviors including their sleep habits when experiencing social isolation.

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The Association Between Sociability and COVID-19 Pandemic Stress

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The COVID-19 pandemic threatened our physical health, alongside our mental and social wellbeing. Social distancing requirements, which are necessary to mitigate the spread of COVID-19, increased social isolation by limiting social interactions that are an essential part of human wellbeing. In this study, we examined the stress caused by COVID-19 early on in the pandemic through the lens of sociability among a large sample of preservice educators ($N = 2{,}183$). We found that individuals who have higher sociability (including deriving joy from social interactions and using social support to manage emotions) experienced greater COVID-19 stress. This study also contributed to prior literature which has sought to relate pandemic-related stress to demographic group differences. We found no significant relationship between demographic membership (gender, race, and sexual orientation) and COVID-19 stress. This study is among the first, however, to demonstrate that vulnerability to pandemic stress varies as a function of sociability. Implications of these findings and ways people can better cope with pandemic isolation are discussed.

Keywords: COVID-19, stress, social isolation, sociability, social interaction, social support, minorities, health

INTRODUCTION

The COVID-19 pandemic dramatically affected people's lives, with adverse physical and mental health impacts (Kumar and Nayar, 2020; Restubog et al., 2020; O'Connor et al., 2021). At the height of the pandemic, country-level estimates of pandemic stress were as high as 40% (Montano and Acebes, 2020), and in the U.S. more than 40% of people reported adverse mental health experiences (Czeisler et al., 2020). The impact of this stress was significant, and recent studies suggest that COVID-19 stress may be a risk factor for more severe health issues like PTSD (Di Crosta et al., 2020) Recent meta-analysis studies showed that the global prevalence estimate for stress during COVID-19 was 36.5%, and globally, nearly one-quarter of the population experienced posttraumatic stress symptoms as a result of the pandemic (Cooke et al., 2020; Nochaiwong et al., 2021). Emerging research has examined demographic differences in COVID-19 stress (e.g., Kowal et al., 2020; Montano and Acebes, 2020; Yalçın et al., 2021); however, there is little research currently available on how COVID-19 stress affects individuals differently based on their sociability. Because social distancing requirements due to the pandemic have substantially altered social interaction patterns, differences in sociability may be an important bellwether for determining who may be more susceptible to experiencing pandemic stress.

The current study explored whether individual differences in sociability is related to experiencing different levels of COVID-19-related stress early on in the pandemic. Our focus was on the stress related to the pandemic, rather than having or contracting COVID-19. The negative

effects of the COVID-19 pandemic can be long lasting and determining who is most vulnerable to pandemic-related stress would be beneficial for prevention and for supporting groups that need the most help and guidance. We examined the extent to which individuals who derived joy from social interactions or seek social support as a emotion regulation strategy appraised the COVID-19 pandemic as a significant source of stress.

COVID-19 Pandemic and Social Isolation

To reduce the spread of COVID-19, many countries instituted social distancing policies restricting individuals from social interaction to curtail the spread of the virus (Matrajt and Leung, 2020; World Health Organization, 2020a). While these measures are essential to prevent the virus from spreading, limitations on social interaction could cause unintended psychological harm (Cudjoe and Kotwal, 2020; Von Mohr et al., 2021). Imposed isolation can lead to increased negative emotions, including boredom, anger, and loneliness (Montano and Acebes, 2020). The WHO has warned that self-isolation and social distancing increase depression, anxiety, and stress (World Health Organization, 2020b), and emerging research has shown that experiencing long-term quarantine is associated with increased rates of depression and PTSD (Montano and Acebes, 2020). The amount of time spent in social isolation has also been found to be associated with increased stress during COVID-19, and people with higher levels of COVID-19 stress tend to view social isolation as more distressing (Taylor et al., 2020b), creating a harmful downward spiral of isolation and stress.

Social Isolation and Individual Differences in Sociability

Some individuals may be more (or less) vulnerable to the social isolation caused by quarantine requirements of COVID-19. For example, Taylor et al. (2020b), found that people who lived alone before the pandemic experienced lower COVID-19 stress. This indicates that people may appraise social isolation differently based on their sociability level. Appraisal theory posits that stress is generated by evaluations of events or situations (Roseman and Smith, 2001); that is, it is the interpretation of the event or situation that drives one's experience. Thus, individual experience can vary greatly when facing the same event (e.g., Smith and Ellsworth, 1987; Shaver et al., 1988; Smith and Pope, 1992). Regarding social interaction, some people may view social interaction as a source of joy, while others may appraise social interaction as either neutral or as a stressful resource drain.

Although social interactions are important to the maintenance of mental and physical health (Cacioppo et al., 2011), some people prefer solitude, which researchers distinguish from loneliness. Loneliness involves an appraisal of isolation as a negative emotional experience (Lay et al., 2020). Though solitude is sometimes viewed as a sign of isolation and unsociability, research shows that solitude can be a volitional preference that can enhance wellbeing for those who prefer it (Lay et al., 2020). Individuals who intentionally seek solitude are less likely to feel lonely from social isolation (Lay et al., 2020).

Conversely, isolation due to COVID-19 may be more stressful to those who are high on *sociability* (McCrae and Costa, 1987). Individuals higher in sociability prefer to talk or interact with others more frequently and enjoy such interactions (Cheek and Buss, 1981; McCrae and Costa, 1987). A similar term is *need for affiliation*, which can be described as the trait desire for social contact and belonging (Wiesenfeld et al., 2001; Veroff and Veroff, 2016). Compared to those who prefer solitude, those who are high in sociability and need for affiliation experience and derive relatively more joy from interacting with family and friends (Hill, 1987; Eisenberg et al., 1995). However, this can also make them vulnerable to the effects of social isolation. It is possible that as a result of the COVID-19 pandemic, new norms of social isolation (e.g., quarantine and social distancing) may be appraised by individuals who enjoy social interaction as particularly stressful and harmful. Research shows that the effect of social isolation on mental health can compound for these individuals over time (Pancani et al., 2021).

In this study, we hypothesize that individuals high on sociability who appraise social interaction as a source of joy (for simplicity, we refer to social interaction as a source of joy as *social joy*) experience more COVID-19 stress.

Social Support and Individual Differences in Sociability

The most common strategies used to cope with COVID-19 stress are distraction, active coping, and seeking emotional or social support (Park et al., 2020). Seeking social support is one of the most common ways to cope with stressors (Carver et al., 1989; Yalçın et al., 2021). Seeking social support can include the experience of seeking love and appreciation through one's social network (e.g., from family or friends; Carver et al., 1989; Wills, 1991). Research has shown that social support can be essential for mental and physical health when coping with stressful life events (Mortenson, 2009; Lay et al., 2020). It is thought to be beneficial because it is a deactivating strategy that reduces the experience of stress while enhancing wellbeing (Taylor, 2007). Social support has even been shown to help patients to recover from illness (Taylor et al., 2004).

Though seeking social support can be useful in many situations, some may prefer to seek more social support while others less social support. Sensitive interaction systems theory (SIST) explores the process of seeking social support. According to SIST, people make decisions to seek social support based on many variables, including the threat to self-esteem, likelihood of rejection, and perceived cost of seeking social support (Barbee and Cunningham, 1995). People with low self-esteem or people that fear rejection, for example, are more likely to cope alone instead of using social interaction (Mortenson, 2009). Likewise, prior research has shown gender differences with men less likely to seek social support than women (Carver et al., 1989). Individuals high on sociability also differ in how they regulate and cope with difficult feelings—tending to prefer to seek more social support and tend to use fewer avoidant strategies (Hill, 1987; Vollrath et al., 1995). Taken together, individuals

may benefit more (or less) from social support and differentially seek social support depending on their appraisals (Mortenson, 2009; Feeney and Collins, 2015). A recent study showed that during COVID-19, those who have higher preference on touch for affect regulation (TAR; a way of seeking emotional support from others) but experienced less affectionate touch reported more psychological distress that those who have lower TAR (Burleson et al., 2021). Given that COVID-19 quarantine restrictions limit the ability of individuals to engage in social interaction, in this study we hypothesized that individuals high on sociability who prefer social support as a regulatory strategy (for simplicity, we refer to social support as a regulatory strategy as *social regulation*) would appraise COVID-19 as more stressful.

Demographic Differences on COVID-19 Stress

Demographic characteristics, such as race, age, gender, and sexuality, may interact and affect the experience of stress due to COVID-19 (Montano and Acebes, 2020; Taylor et al., 2020b; Rosi et al., 2021). To date, findings relating demographic variables and COVID are mixed. For example, although Taylor et al. (2020b) found white individuals reported lower stress levels during the pandemic compared to their African American and Asian peers, Ponnock et al. (2021) found that African American educators reported less stress than White educators. Similarly, the evidence for differences in stress levels by gender is mixed, with no significant difference between men and women in COVID-19 stress in some studies (Montano and Acebes, 2020; Szabo et al., 2020; Yan et al., 2021), and women reporting to be more vulnerable than men to COVID-19-related mental health issues including stress in other studies (Ahuja et al., 2020; Mazza et al., 2020; Yalçın et al., 2021). Further, differences across age group experiences of stress have also been observed. Individuals from 41 to 50 years old scored the lowest on COVID-19 stress compared to other younger adult groups or adolescents (Montano and Acebes, 2020; *cf.* Rosi et al., 2021), and students and young adults are more vulnerable to COVID-19 stress (Balsamo and Carlucci, 2020), especially those under 35 (Huang and Zhao, 2020). To address these issues, in the present study we further seek to unpack the potential impact of demographic characteristics on experiences of COVID-19 stress.

In summary, the current study aims to test the following hypothesis:

> *Hypothesis 1* : Individuals high on sociability that appraise social interaction as a source of joy (higher in social joy) will experience more COVID-19 stress.
> *Hypothesis 2* : Individuals high on sociability who prefer social support as a regulatory strategy (higher in social regulation) will experience more COVID-19 stress.

Additionally, we also examined whether there were any differences on COVID-19 stress across demographic groups.

Research Question 1: Are there demographic group differences on COVID-19 stress?

MATERIALS AND METHODS

To explore our hypotheses, we used an open-ended survey study to capture COVID-19 stress, social joy, and social regulation among educators. We chose to examine these phenomena in a large sample of early-career educators because prior studies have noted the severe emotional impact the pandemic has had on educators, with anxiety by far being the most frequently mentioned emotion among educators during the pandemic (Brackett and Cipriano, 2020). We collected these data during the pandemic "surge" of the Summer of 2020 in the U.S. when the most stringent social distancing requirements were in effect.

We operationalized COVID-19 stress as the extent to which participants wrote in COVID-19-related words as stressors (e.g., writing "COVID-19" or "the pandemic" as one of their top sources of stress). Furthermore, we operationalized sociability as the extent to which participants wrote in social-related words as their sources of joy (e.g., writing "my husband," or "my son," or "meeting new people" as one of their top sources of joy) and regulation strategies (e.g., writing "talking to my partner," or "conversation with friends/family," or "spending time with loved ones" as one of their most helpful social emotion regulation strategies). This open-ended approach allowed us to capture the nuances of potential stressors during the COVID-19 pandemic as well as how the pandemic might interfere with social joy and social regulation.

Participants and Procedure

All participants were preservice educators participating in a teacher training program in summer 2020. Data were collected from June 26th to July 3rd. A total of 2,183 individuals completed the survey and were included in the analysis. The sample was on average 24.9 years old ($SD = 6.0$), 75.1% of whom were female with 2.0% identifying as other or not indicating their gender identity. The sample identified as 16.1% African American, 7.4% Asian, 16.4% Hispanic, 8.1% Multiracial, 0.5% Native/Indigenous, and 48.6% White. For sexual orientation, the participants identified themselves as 8.3% bisexual, 2.7% gay, 1.6% lesbian, 3.6% queer, and 69.0% straight; 14.8% choose not to answer or identified as questioning or other.

Measures

The measures used in this study were part of a larger project focusing on the wellbeing of preservice teachers in Teach for America.

Open-Ended Questions

Participants were asked to respond to three open-ended questions, including their: (1) top three sources of stress and anxiety, (2) top three sources of joy, and (3) top three strategies they used to regulate their emotions. The specific questions can be found in **Table 1**. While psychologists differentiate stress and anxiety (stress being an appraisal of demands exceeding resources and anxiety being an appraisal about uncertainty or worry about the future; Bakker and Demerouti, 2007; Grupe and Nitschke, 2013), research has shown that individuals use

TABLE 1 | Open-ended questions.

Open-ended Questions
1. Please reflect on your stress and anxiety over the past few weeks. What are the **top 3** causes of your stress and anxiety? Please list them below.
2. Even in trying times, there can be moments where we experience joy. In the past few weeks, what are the **top 3** things that have brought you **joy**? Please list them below.
3. Please take a moment and reflect on how you are managing your emotions during this difficult time. Over the past few weeks, what 3 strategies/ approaches have you found most helpful for managing **your own emotions**? Please list them below.

these terms interchangeably to describe their experiences. For example, Moeller et al. (2020) found that "stressed" and "anxious" were among the most frequent mentioned emotion words by students, and Ivcevic et al. (2021) reported both stressed and anxious being mentioned frequently by employees simultaneously. Likewise, Floman et al. (2021) found that stress and anxiety frequently co-occur as experiences. In addition, one of the core characteristics of COVID-19 stress is worry or uncertainty about the future (e.g., worry about of getting infected or, facing financial difficulties, or job-related uncertainty) which touches on the core appraisal of anxiety. Indeed, prior research has shown that viral pandemic-related stress is very closely tied to appraisals of uncertainty and feelings of anxiety (see Taha et al., 2014 for empirical studies related to H1N1 stress).

To fully capture the experience of stress due to the COVID-19 pandemic, we chose to ask about both stress and anxiety in our measure. Each question had three response boxes, one for each of the top three categories. Text from our open-ended data were analyzed using Linguistic Inquiry and Word Count (LIWC; Pennebaker et al., 2015). Prior research has used LIWC to examine personality differences related to social interaction, such as extraversion (e.g., Tausczik and Pennebaker, 2010). For example, Pennebaker and King (1999) found that extraversion is correlated with using social words. Furthermore, more recent studies have also demonstrated that language use correlates with both self-perception and other perception of sociable traits (Mehl et al., 2006). Prior studies have demonstrated that individual difference in linguistic style captured by LIWC is consistent and reliable (Pennebaker and King, 1999; Pennebaker et al., 2003). Below, we describe the specific coding procedures and dictionaries used to define social joy, social regulation, and COVID-19 stress.

Sociability: Social Joy and Social Regulation

We analyzed both the sources of joy and the emotion regulation strategy questions using the "social" categories from LIWC 2015s default dictionary. These social categories include words related to family (e.g., aunt and baby), friends (e.g., ally and crew), female- or male-related (e.g., girl and boy), and other social-related words (e.g., help and talk). Any social-related terms (e.g., family, friend, and team) are coded by software to indicate the level of sociability. For example, one participant wrote in, "meeting new people" as a source of joy, and this

would be coded as higher on appraising social interactions as joyful (social joy). Likewise, one participant wrote, "Talking with my partner" in response to one of the emotion regulation questions, this would indicate stronger preference for social regulation. By using open-ended response coding, our study captures many potential sources of social joy and social regulation.

LIWC 2015 scores the social coding category based on the percentage of key social words presented in the open-ended responses (descriptive statistics are shown below in results). Thus, sociability was operationalized as (1) the percentage of social words written in response to the source of joy prompt and (2) the percentage of social words written in response to the emotion regulation prompt. Here higher percentages mean higher sociability.

COVID-19 Stress

We used the same open-ended coding approach to measure COVID-19 stress. The first and second author created a new LIWC 2015 dictionary to capture words related to COVID-19 stress. Each author generated a list of words about COVID-19 independently, met to discuss differences, and reached agreement on a final version of the COVID-19 stress dictionary used for this study. This dictionary included the following words: COVID*, pandemic, virus*, corona*, lockdown, quarantin*, sick, ill, health (* indicate word stems, the coding is not case sensitive). For example, one participant wrote in, "COVID-19" as a source of stress, this would indicate more COVID-19 stress. Thus, we operationalized COVID-19 stress as the percentage of COVID-19-related words written in response to the top stressor prompt, and higher percentage meant higher perceived COVID-19 stress.

Because we only asked for the top three stressors, our open-ended measure tended to capture acute COVID-19 stress rather than mild cases of COVID-19 stress.

When we examined the prevalence of COVID-19 stress, we found many individuals did not write COVID-19 as a top 3 source of stress, and 86% of our responses were coded a zero (i.e., 86% of people did not indicate COVID-19 as their top 3 stressor; for frequency distributions of the study variables, see **Figure 1**). This was expected since participants need to mention key words related to COVID-19 to be coded, and we were only coding for top three stressors. We note that this is a limitation of our data which we address below by using analyses which can account for zero-inflation in our dependent variable. However, 14% participants still indicated COVID-19 as their top stressors without priming.

Analyses Strategy

In order to deal with the zero-inflation of our dependent variable (i.e., many cases being coded as not finding COVID-19 as a top 3 stressor), we used a Tobit model regression, which is designed to handle truncated data with maximum likelihood estimation (McDonald and Moffitt, 1980). We entered our variables into a Tobit regression model in three steps.

In step one, we tested all demographic variables (race, gender, sexual orientation) simultaneously. In step two, we added the main effects of social joy and social regulation. Finally, in step three, we added the interaction of social joy and social regulation

FIGURE 1 | Frequency Distributions of Study Variables. **(1A)** shows the total frequency distribution of COVID-19 stress. **(1B)** shows the frequency distribution of COVID-19 stress with zeros excluded. **(2A)** shows the frequency distribution of Social Joy for individuals who did not report COVID-19 stress. **(2B)** shows the frequency distribution of Social Joy for individuals who did report COVID-19 stress. **(3A)** shows the frequency distribution for Social Regulation for individuals who did not report COVID-19 stress. **(3B)** shows the frequency distribution for Social Regulations for individuals who did report COVID-19 stress.

in order to see whether people who prefer both social joy and social regulation would experience even more COVID-19 stress. We examined the significance of our model coefficients at each step and we also examined the change in model fit (Pseudo R^2 and $\Delta\chi^2$).

RESULTS

Descriptive statistics and correlations between study variables were reported in **Table 2**. Spearman's rank correlation coefficient is used because of the zero-inflation in COVID-19 stress. Initial analyses revealed sociability was positively correlated with COVID-19 stress. Specifically, finding joy in social interactions was positively correlated with appraising COVID-19 as a top stressor ($\rho = 0.09$, $p < 0.001$). Results were similar for the relationship between social regulation and COVID-19 stress. We found that individuals who preferred social regulation tended to appraise COVID-19 as more stressful ($\rho = 0.07$, $p = 0.001$). In addition, we found that COVID-19 stress was not significantly related to demographic

TABLE 2 | Spearman's rank correlations matrix.

	Mean	*sd*	1	2	3	4	5
COVID-19 stress (%)	2.21	6.52					
race	/	/	−0.02				
gender	/	/	0.02	0.00			
sexual orientation	/	/	0.01	−0.01	−0.05*		
social joy (%)	22.53	18.40	0.09**	0.03	0.01	−0.07**	
social regulation (%)	9.92	12.05	0.07**	0.01	0.06**	−0.01	0.10**

*$p < 0.05$; **$p < 0.01$.

group membership,[1] including being a person of color (F (1, 2,181) = 0.20, $p = 0.66$), queer (F (1, 1957) = 0.21, $p = 0.65$), or female (F (1, 2,137) = 1.13, $p = 0.29$).

To account for the zero-inflated nature of our data, we chose to run all study variables in a hierarchical Tobit regression. The hierarchical regression model can be found in **Table 3**. In step one we entered our demographic variables (race, sexual orientation, and gender), none of which were significantly related to COVID-19 stress. In step two, both social joy ($\beta = 2.62$, $p = 0.001$) and social regulation ($\beta = 2.49$, $p = 0.002$) were significantly related to COVID-19 stress, and the addition of these effects improved model fit ($\Delta\chi^2$ (2, $N = 1934$) = 21.53, $p < 0.001$). In step three, we did not find a significant interaction between social joy and social regulation use ($\beta = −0.42$, $p = 0.76$).

DISCUSSION

In this study, we investigated sociability as an antecedent of experiences of stress early in the COVID-19 pandemic and explored if there were differences in experiences of stress based on demographic membership among preservice educators. Despite public and scientific interest in demographic group membership as a risk factor of COVID-19 stress, we did not find support for gender, sexual orientation, or race being associated with COVID-19 stress. We did, however, find that differences in sociability (operationalized as deriving joy from social interaction and using social support regulation strategies) did predict COVID-19 stress. In the section below, we discuss the theoretical and practical implication of our findings.

First, our study suggests that there were individual differences in the experience of the pandemic as those who find social

[1]Because some demographic sub-groups have small samples and may be similar to one another on COVID stress, we decided to collapse these into broad demographic categories (e.g., being white vs. being a person of color, being straight vs. being queer). To determine the appropriateness of the collapsing, we first ran ANOVAs to compare differences among racial groups and sexual orientation groups. When we compared racial sub-groups on COVID-19 stress, we did not find any significant differences (F (5, 2003) = 1.28, $p = 0.27$). When we compared sexual orientation groups, no difference was found except for lesbians compared to some other groups (F (5, 2,177) = 2.55 $p = 0.03$); post-hoc Tukey tests revealed that lesbians had significant higher COVID-19 stress compared to straight ($p = 0.01$), gay ($p = 0.01$), bisexual ($p = 0.02$), and answered/questioning/other ($p = 0.01$). However, we note that this finding is likely due to the small sample size of the lesbian group (n = 35). Given that we did not find substantive differences, we decide to collapse race into White vs. Person of Color, and sexual orientation into Straight vs. Queer.

TABLE 3 | Tobit regression coefficients.

COVID-19 stress	*β*	*SE*	Pseudo *R^2*	*$\Delta\chi^2$* [1]
Step1				
Race	−0.13	0.86		
Gender	1.15	0.88		
Sex Orientation	0.52	0.86		
			0.12	
Step2				
Race	−0.28	0.85		
Gender	1.12	0.87		
Sex Orientation	0.80	0.85		
Social Joy	2.62**	0.81		
Social Regulation	2.49**	0.82		
			0.13	21.53*
Step3				
Race	−0.27	0.85		
Gender	1.11	0.87		
Sex Orientation	0.79	0.86		
Social Joy	2.83**	1.05		
Social Regulation	2.80*	1.31		
Social Joy*Social Regulation	−0.42	1.42		
			0.13	0.09

*$p < 0.05$; **$p < 0.01$.
[1]$\Delta\chi^2$ is calculated on the change of log likelihood.

interaction more important are deprived of it. The COVID-19 pandemic has dramatically altered norms governing social interaction and created a need to practice long-term social distancing and social isolation. Our findings suggest these pandemic practices may be appraised as more stressful by individuals who are high on sociability compared to individuals that prefer solitude. This suggests that people who are higher on sociability are more vulnerable to COVID-19 stress. Prior scholars have noted concerns about the impact of social isolation of COVID-19 on loneliness (Ozcelik et al., 2020; Way et al., 2021). Furthermore, research in general has also indicated a general rise in loneliness over time (Cigna, 2020). COVID-19 isolation could make loneliness more severe, especially for those who are high on sociability. Future study can further examine the relationship between COVID-19 loneliness and sociability.

Second, our research provides preliminary evidence and suggests more attention is needed to unpack the importance of social regulation. Research shows that people are not passively dealing with COVID-19 stress but rather the more stress they report, the more likely they have tried different types of strategies (Taylor et al., 2020a). During the pandemic, people spent more

time on social media, games, TV shows, or other household activities in order to cope with the stress of the quarantine requirements (Ahmed et al., 2021). Seeking social support is a key emotion regulation strategy especially for people with high sociability (Vollrath et al., 1995), yet it is inhibited by the pandemic. Our findings suggest that COVID-19 stress may prove more difficult to deal with for people that rely social coping. Future research should explore what alternative strategies would be most effective in helping sociable people deal with their stress under the conditions of social isolation imposed by the pandemic. Because COVID-19 may constrain social regulation strategies, people who are high on sociability may benefit from other non-social forms of regulation or coping such meditation and mindfulness (Yalçın et al., 2021).

Finally, future research should explore the relationship between culture and COVID-19 stress. Although social interaction is necessary for people to maintain mental health, not all cultures favor seeking social support when dealing with stressors (Lay et al., 2020). For example, East Asian cultures discourage people from expressing negative emotions to friends and family in order to maintain relationship harmony (Matsumoto, 1996). People in collectivistic cultures are also willing to sacrifice their own personal joy for the greater good of the group (Triandis, 2018). This suggests that people in collectivistic cultures may be more willing to limit their own social interaction during the pandemic and may even derive joy or contentment from engaging in socially beneficial self-isolation. In fact, some studies have shown that people in more collectivistic cultures are more likely to wear masks (Lu et al., 2021). It may be the case that people from Eastern cultures which emphasize collectivism may experience less COVID-19 stress from isolation because collectivistic norms cause them to appraise quarantine and social distancing as maintaining social harmony. To date there is very little direct study of the interaction between culture and pandemic stress, and only one study has examined the effect of country-level individualism (Kowal et al., 2020). Future research should further explore the potential interactions between pandemic stress, culture, and sociability.

A limitation of our study is that our sample was not representative of the overall population of the United States. More than 75% of our sample were women and 100% belonged to a single occupation (educator). Thus, the interpretation of our data is limited by the generalizability of our sample. A second limitation of this study is the cross-sectional design which did not allow us to test the causal effects or the long-term effects of pandemic-related social isolation on sociable individuals. During the data collection period, the pandemic was in its early stages and most severe state which was characterized by uncertainty (including heightened social distancing and quarantine requirements, and the transition to remote work). Future studies should use longitudinal designs to explore the time lagged effects of deriving joy from social interaction and pandemic stress. A third limitation is the open-ended questions we used to code COVID-19. Many people did not write in COVID-19 as one of their top 3 stressors which means that our variable was non-normal. This may contribute to the small effect size in our study. Future research should consider using measures that have been developed to assess COVID-19 stress (e.g., COVID stress scales, see in Taylor et al., 2020a). Due to the data collection timing of our study, however, these measures were not yet available. Future studies could verify our results using other measures of COVID-19 stress. Finally, exposure to COVID-19 or having someone close get infected with COVID-19 may influence people's experience and stress toward COVID-19 (Taylor et al., 2020b). Future research can explore how sociable people might be differentially affected by having these kinds of exposures to COVID-19.

DATA AVAILABILITY STATEMENT

The data supporting the conclusions of this article will be available at: https://osf.io/huj6s/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Yale School of Medicine IRB. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PL: conceptualization, methodology, formal analysis, investigation, and writing – original draft. ML: conceptualization, writing – original draft, and supervision. CC: writing – review and editing and project administration. MB: writing – review and editing and funding acquisition. All authors contributed to the article and approved the submitted version.

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APPENDIX A

COVID-19 Stress in Subgroups.

	Mean	SD	N
Male	1.95	5.79	500
Female	2.31	6.79	1,639
Bisexual	2.18	6.05	188
Gay	1.47	4.67	59
Lesbian	6.02	11.34	35
Queer	2.31	5.56	80
Straight	2.18	6.63	1,552
Not answered/Questioning/Other	2.16	6.00	269
African American	1.94	6.28	352
Asian	2.11	6.14	162
Hispanic	2.61	6.74	158
Multiracial	1.43	4.87	176
Native/Indigenous	4.32	7.22	16
White	2.25	6.80	1,070
Other of Color	2.76	6.45	37

A Global Longitudinal Study Examining Social Restrictions Severity on Loneliness, Social Anxiety, and Depression

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Purpose: Social restrictions and government-mandated lockdowns implemented worldwide to kerb the SARS-CoV-2 virus disrupted our social interactions, behaviours, and routines. While many studies have examined how the pandemic influenced loneliness and poor mental health, such as depression, almost none have focussed on social anxiety. Further, how the change in social restrictions affected change in mental-health and well-being has not yet been explored.

Methods: This is a longitudinal cohort study in community dwellers who were surveyed across three timepoints in the first six months of the pandemic. We measured loneliness, social anxiety, depression, and social restrictions severity that were objectively coded in a sample from Australia, United States, and United Kingdom ($n = 1562$) at each time point. Longitudinal data were analysed using a multivariate latent growth curve model.

Results: Loneliness reduced, depression marginally reduced, and social anxiety symptoms increased as social restrictions eased. Specific demographic factors (e.g., younger age, unemployment, lower wealth, and living alone) all influenced loneliness, depression, and social anxiety at baseline. No demographic factors influenced changes for loneliness; we found that those aged over 25 years reduced faster on depression, while those younger than 25 years and unemployed increased faster on social anxiety over time.

Conclusion: We found evidence that easing social restrictions brought about additional burden to people who experienced higher social anxiety symptoms. As country-mandated lockdown and social restrictions eased, people are more likely report higher social anxiety as they readjust into their social environment. Mental health practitioners are likely to see higher levels of social anxiety in vulnerable communities even as social restrictions ease.

Keywords: SARS-CoV-2, social restrictions, loneliness, depression, social anxiety

INTRODUCTION

Efforts to reduce the spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have led to the implementation of local, national, and international public health restrictions (1). Central to these restrictions is reducing social interactions including social distancing, quarantine, and self-isolation (2). Such public health restrictions simultaneously pose barriers in initiating and maintaining social relationships and interactions (3). This could lead to increased loneliness, an unpleasant feeling that arises when one feels one's actual level of social connection does not meet one's desired level of connection (4). Before the public health crisis, loneliness was recognised as an emerging public health issue (5), with robust evidence indicating negative implications for physical and mental health (6, 7) across the lifespan (8).

In a nationally representative United Kingdom study, loneliness was reported to be stable over the first 7-week lockdown period, except for those who were categorised in the highest or lowest loneliness groups (9). Those in the highest loneliness group at the beginning of the lockdown experienced increased loneliness and those in the lowest loneliness group experienced a decrease in loneliness before rebounding to their starting level by week six of the lockdown period (9). Other studies have shown age-dependent divergence—with decreases in loneliness among younger adults and increases in loneliness among older adults during lockdown periods in the United Kingdom and United States (10, 11).

A meta-analysis that examined the psychological impact of lockdowns on mental health found small but significant impacts on anxiety and depression but not on loneliness, general distress, and positive psychological functioning (12). However, the meta-analysis reported heterogeneity across studies, reflecting the difficulty of studying lockdowns across countries and at different time points across the pandemic (12). Crucially, none of the studies included in the meta-analysis examined the impact of the *severity of social restrictions* on loneliness and mental health.

The study of how social restrictions affected reports of loneliness or mental health are also more likely to use cross-sectional design. In cross-sectional studies, stay-home orders contributed to higher depression and loneliness in the United States (13) and were associated with higher anxiety, depression, and loneliness in Germany (14). Another distinct gap in the current literature on mental health during the SARS-CoV-2 pandemic was the inclusion of social anxiety symptoms. It is plausible to expect social anxiety may ease due to reduced social interactions or increased due to changes in social routines. Furthermore, social anxiety is highly related to loneliness and depression in the general community (15).

The SARS-CoV-2 lockdowns provided conditions of a natural experiment to explore how social restrictions influenced loneliness, depression, and social anxiety, and the relationships between them. We examined changes in loneliness, depression, and social anxiety, identifying specific demographic differences that affected initial experience and rate of change. Given the variation over the first 6 months in the severity of social restrictions imposed, we also explored whether decreasing social restrictions influenced the rate of change in loneliness, depression, and social anxiety.

METHODS

Participants

A total of 2,665 participants across 121 countries completed questionnaires at three time points during the first 6 months of the SARS-CoV-2 pandemic. We recruited participants from organisations interested in monitoring the impact of COVID on loneliness and mental health and the general public. In the current paper, we restrict our analyses to data collected from participants residing in three countries [$N = 1,562$: Australia ($n = 701$), United Kingdom ($n = 483$), and United States ($n = 378$)] because we could reliably extract and code social restriction severity data at the three time points of data collection. **Figure 1** shows the participant recruitment flow chart across time, including dropout rates at each of the three time points; we found no demographic differences ($ps > 0.05$) between those who dropped out (i.e., those who only did T1) versus non-dropouts (i.e., T1–T2, T1–T2–T3 completers[1]). **Table 1** presents demographic information for the entire sample and the subsample whose data were used in the current study.

Measures
Demographic Form
Demographic data relating to the age, gender, relationship status, work status, financial status, household status, and whether the individual was a carer or parent, education level, and postcode/zipcode were collected (see **Table 1**). For analyses, we recoded data as follows: age (0 = 18–25[2] years of age, 1 = 25–65 years of age), gender (1 = female, 2 = male), work status (0 = unemployed, 1 = working full -or part- time), financial status (0 = poor, 1 = fairly well off or well off), household status (0 = living alone, 1 = living with others), carer (0 = yes, 1 = no), and parent of children younger than 16 years (0 = yes, 1 = no). Data for relationship status and education level were significantly skewed and therefore excluded in the analyses. Postcode/zipcode data were used to create data on social restrictions, as noted below.

Loneliness. UCLA Loneliness Scale – Version 3
The UCLA Loneliness Scale – Version 3 (UCLA-LS; 16) is a 20-item measure employing a 1 (Never) to 4 (Always) Likert scale, assess loneliness severity. The UCLA-LS has previously been found to demonstrate good to excellent reliability ($\alpha = 0.89$–0.94) and acceptable test-retest reliability ($r = 0.73$; 16). In the current sample, the UCLA-LS has excellent internal consistency across timepoints ($\alpha s = 0.94$–0.95).

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[1]There were no T1–T3 completers.

[2]Young adults aged 18–25 are well known to be more vulnerable to loneliness, and therefore analysed in a different group to those over 25 years old [see (7) for review on age vulnerability].

FIGURE 1 | Flowchart for participants in Model 1b. Multivariate latent growth curve model (MLGC) accounts for missing data, and those who had a subsequent timepoint are considered completers.
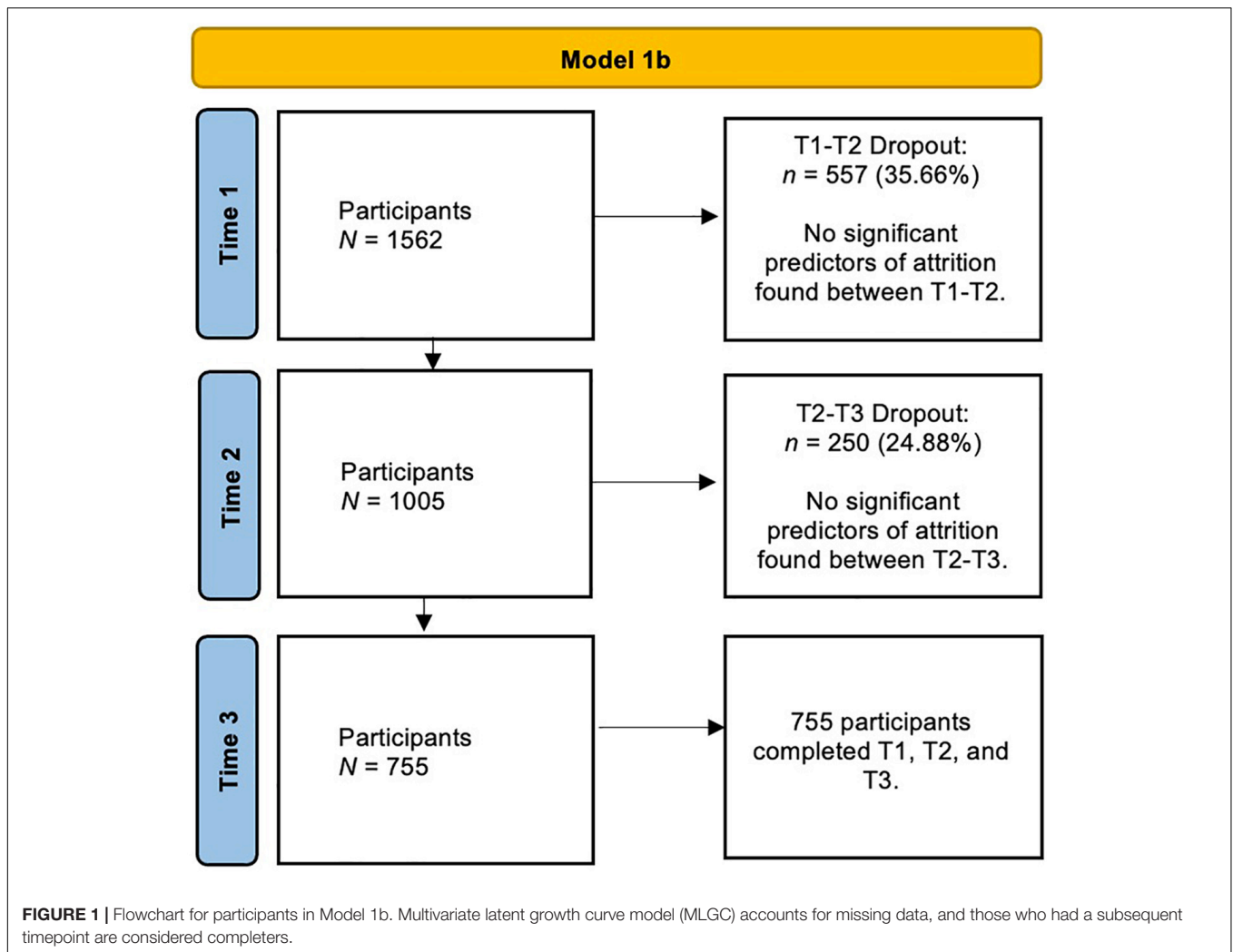
Depression. Patient Health Questionnaire-8

The Patient Health Questionnaire-8 (PHQ-8; 17) is an 8-item measure of depression severity based on DSM-IV criteria. The PHQ-8 has demonstrated sensitivity of 99%, specificity of 92%, and a positive predictive value of 57% when using a cutoff score of 10 or more (17). In the current sample, the PHQ-8 had excellent internal consistency across timepoints (αs = 0.89–0.90).

Social Anxiety. Mini-Social Phobia Inventory

The Mini-Social Phobia Inventory (Mini-SPIN; 18) is a 3-item measure of generalised social anxiety disorder, using a 5-point Likert scale ranging from 1 (not at all) to 5 (extremely). The Mini-SPIN has demonstrated excellent internal consistency (α = 0.90) and good test-retest reliability (r = 0.82) (19). In the current sample, the Mini-SPIN had good internal consistency across timepoints (αs = 0.82–0.85).

Social Restrictions Severity

At each time point of data collection, we coded the number of social restrictions implemented in the United Kingdom,

Australia, and United States, based on a variety of government-sanctioned guidelines that mirrored the subjective social restrictions (e.g., border, school, restaurant closures). See **Supplementary Tables 1–6** for details. Independent coders received training on agreed guidelines for coding social restrictions based on information about restrictions from each location. Two authors (LT and RE) were randomly allocated 10% of the data and intra-class correlations confirmed reliability between each of the three coders' scoring within each country (r values of 0.75, 0.83, and 0.95, for the United Kingdom, United States, and Australia, respectively).

We then generated a social restriction severity variable for each time point of data collection to examine how the severity of social restrictions changed over time, and influenced the variables of interest. We created a restriction score by completing three steps. First, an objective restriction score was created. Objective restrictions were measured on a dichotomous scale with 0 = restriction not in place and 1 = restriction in place based on the current governmental advice for each person based on their geographical location. Scores were summed together and divided by the total number of possible restrictions

TABLE 1 | Demographics across entire sample and subsample.

Item	Full sample	Subsample
	2,665	1,562
Gender *n* (%)		
Male	444 (17%)	217 (13.9%)
Female	2,169 (83%)	1,315 (84.2%)
Intersex	1 (<1%)	1 (<1%)
Transgender	12 (<1%)	8 (<1%)
Other	27 (1%)	16 (1%)
Prefer not to say	10 (<1%)	4 (<1%)
Age		
Mean age	47.62	48.80
Range	18–91	18–91
Relationship status *n* (%)		
In a relationship/married	1,585 (61%)	974 (62.4%)
Single (including separated/divorced/widowed)	982 (37.8%)	567 (36.3%)
Other	31 (1.2%)	19 (1.1%)
Work status *n* (%)		
Full-time	1,232 (47.4%)	684 (43.8%)
Part-time/casual/self-employed	581 (22.4%)	379 (24.3%)
Student	136 (5.2%)	84 (5.4%)
Unemployed	199 (7.7%)	121 (7.7%)
Retired	361 (13.9%)	243 (15.6%)
Other	90 (3.5%)	50 (3.2%)
Household status *n* (%)		
Living with family	1,863 (71.7%)	1,107 (70.9%)
Living alone	561 (21.6%)	355 (22.7%)
Other, i.e., living with non-family members	173 (6.6%)	98 (6.3%)
Financial status *n* (%)		
Very well	958 (36.9%)	639 (41%)
Fairly well	1,297 (50%)	760 (48.7%)
Poorly	340 (13.1%)	160 (10.2%)
Education level *n* (%)		
High school	516 (19.9%)	342 (21.9%)
Bachelor's degree	991 (38.2%)	573 (36.7%)
Postgraduate degree (i.e., Master's, Doctorate)	1,087 (41.9%)	643 (41.3%)
SARS-CoV-R exposure		
Total contact with COVID-19 (reported knowing others who have had COVID-19 [friends, family, or co-worker])	158 (5.9%)	62 (4.0%)
Has had COVID-19 (reported having symptoms of COVID and/or a positive test result).	405 (15.2%)	168 (10.9%)

The subsample data comes only from the United Kingdom, United States, and Australia because we were able to calculate objective social restrictions for participants geographic region based on government data across the first six months of the pandemic. For analyses, we removed data from 29 participants who selected "Other," "Intersex," "Transgender," or "Prefer not to say" for their gender because they represented one or less percent of the total group. Raw values may not add up to total because of missing data on those items. Percentages calculated using raw score and total score for that particular item. Total contact with COVID-19 (0 = know others with COVID-19 (friends, family, and co-workers), 1 = does not know anyone with COVID-19; Has had COVID-19 (0 = has had a positive test result for COVID-19 or has had symptoms, 1 = no symptoms or positive test result for COVID-19). Total contact and has had COVID-19 were used as control variables in the analyses.

(i.e., 12 total restrictions). Second, a restriction severity was created. Restriction severity was measured on a scale anywhere from 0 (no restriction) to 5 (most severe restriction) depending on the variable being coded. See **Supplementary Table 1** for severity coding range for different social restrictions. Scores were summed together and divided by the total possible severity score (i.e., a severity score of 36). Finally, to ensure that we accounted for the number of restrictions impacting the severity scores, we multiplied the objective restrictions by severity (represented as objective restriction score × restriction severity score).

SARS-CoV-2 Exposure

We assessed whether participants had a current or previous diagnosis of COVID-19 because this could confound results. Response options included, "Yes I suspect I have (or have previously had) COVID-19 but no formal test was taken," "Yes I have (or had) COVID-19 which was diagnosed through a positive test result," or "No, I do not have (or have not had) COVID-19." Participants were also asked if they knew anyone who had tested positive for the virus within the last 14 days and, if yes, whether they had been in close contact with that person. Participants provided this information at each time point of data collection. Using those data, we created two new variables that we included in our analyses as control variables: (1) total contact with COVID-19 [0 = know others with COVID-19 (friends, family, co-workers), 1 = does not know anyone with COVID-19] and (2) has had COVID-19 (0—has had a positive test result for COVID-19 or has had symptoms, 1 = no symptoms or positive test result for COVID-19).

Procedure

Ethics approval was granted by the Swinburne University of Technology Human Research Ethics Committee. Participants were recruited via collaborative organisation networks, media, and digital advertising and gave consent online. We administered three online surveys across three time points (T1, T2, and T3) where each time point was 6–8 weeks apart, beginning March 2020. Participation was voluntary. See **Figure 1**.

Data Analysis Plan

Longitudinal data on loneliness, depression, social anxiety, and social restrictions were analysed using a multivariate latent growth curve model (MLGC) in Mplus (20). Our MLGC model is a single model of growth in loneliness, depression, social anxiety, and social restrictions where we fit the four simultaneous growth curves and estimate covariances among their growth factors. We used linear growth models with continuous outcomes; models were estimated using the robust maximum likelihood (MLR) estimator, to account for missing data (21). In addition, (a) the coefficients for each intercept factor were fixed to zero, (b) the intercepts were fixed to zero, (c) the means and variances of both the intercept and slope factors were estimated, (d) the factor co-variances between each slope-intercept pair were estimated, (e) cross-domain factor covariances were estimated, (f) residual variances were estimated and allowed to vary across time points, and (g) residual covariances were assumed to be zero.

Model fit was evaluated using RMSEA, CFI, TLI, and SRMR. RMSEA values of less than 0.05 indicate a close fit, and values up to 0.08 represent reasonable errors of approximation, and TLI and CFI values ≥0.95 represent good fit (22); a cut-off

value of <0.09 for the SRMR (23). Variances in the model were also explored to determine whether there was justification to incorporate predictor variables into subsequent analyses to explain the parameter estimates.

In the first model (Models 1a) we (a) explored the growth of loneliness, depression, social anxiety and social restrictions over the first six months of the pandemic, (b) evaluated how the initial severity of social restrictions and the rate of change in social restrictions affected changes in loneliness, depression, and social anxiety, and (c) determined whether change in loneliness, depression, and social anxiety affected change in each other over time. In the second model (Model 1b), we added demographic information into the model to explore whether individual differences predicted change in loneliness, depression, and social anxiety over time, while controlling for severity of initial social restrictions and the change in social restrictions by having those variables in the model. Our data met the criteria for using MLGC, including having a minimum sample size of at least 200 participants at each time point (24). We used $p < 0.05$.

We conducted two sensitivity analyses as follows: (1) exploration of the growth of loneliness, depression, and social anxiety for the full sample, where social restrictions data were not available for all participants, to determine whether the same patterns of change in loneliness, depression, and social anxiety were observed for the full sample (Model SA1; results found in **Supplementary Tables 7, 8**) and (2) exploration of the model fit statistics, patterns of change in loneliness, depression, and social anxiety, and the effects of initial and change in social restrictions on loneliness, depression, and social anxiety for participants who had complete data at all three time points (Model SA2; results found in **Supplementary Tables 9, 10**).

RESULTS

In Model 1a, baseline and change in loneliness, depression, social anxiety and secerity of social restrictions did not fit the data particularly well (RMSEA = 0.076 [0.073, 0.078], CFI = 0.790, TLI = 0.752, SRMR = 0.085). Adding the predictors to the model (Model 1b) provided a much better model fit (RMSEA = 0.057 [0.054, 0.061], CFI = 0.928 TLI = 0.881 SRMR = 0.045).

The most variability in the model was in severity of restrictions at six months into the pandemic (covariance = 30.05 at T3 compared to 15.18 at T1 and 6.83 at T2); depression, loneliness, and anxiety also showed the most variability at six months (T3; see **Table 2** under covariances). **Table 2** also shows that the strongest associations were between loneliness and depression at T3 (0.61), loneliness and social anxiety at T3 (0.50), and depression and social anxiety at T2 (0.50). All correlations between T1 and T2 variables were $rs \geq 0.425$, and T2 and T3 variables were $rs \geq 0.437$, $p < 0.001$. Correlations between social restriction severity and loneliness, depression, and social anxiety at each time point was always small ($rs < -0.09$).

Exploration of the intercepts showed social restrictions to be high across the sample at baseline; loneliness and social anxiety were relatively low, comparable to pre-COVID data (25), but

depression was slightly higher (26). Examination of the estimates for the slopes (see **Table 2**) showed a significant reduction in loneliness over the first six months of the pandemic (−0.47), a significant, but small change in depression over time (0.09), an increase in social anxiety (0.65), and a reduction in social restrictions (−0.92).

Table 3 shows where a person started on loneliness did not predict change in loneliness and where a person started on depression did not predict change in depression, but where they started on social anxiety did predict change in social anxiety: those higher on social anxiety at baseline (T1) had a faster rate of change in social anxiety throughout the pandemic, such that those higher on social anxiety at baseline increased on social anxiety faster people who scored lower at baseline. Where people started on depression and social anxiety predicted change in loneliness over the course of the project: people higher on depression or social anxiety reduced slower on loneliness. In addition, the rate of change in social restrictions affected the rate of change in social anxiety, with levels of social anxiety increasing fastest where restrictions were easing (reducing) fastest.

Our model results showed that the following were significant predictors of loneliness at baseline (**Table 4**): being younger (18–25 years), being a carer, being a parent, being unemployed, having lower than average wealth, and living alone. Infact, of all our predictor variables, it was only gender that did not predict loneliness. The following variables significantly predicted depression and social anxiety at baseline (T1): being in the 18–25 year age group, lower than average wealth, and being unemployed.

Age influenced the rate of change in depression and social anxiety: those aged 18–25 years were slower to reduce on depression, and faster to increase on social anxiety compared to adults older than 25 years. The rate of change in social anxiety was additionally predicted by lower wealth and unemployment: those individuals who had lower perceived wealth and were unemployed increased faster on social anxiety over the first 6 months of the pandemic than those who had more wealth and were employed. None of the variables predicted change in loneliness, suggesting that the rate of change across T1–T3 was negligible between participants.

Sensitivity analyses (see **Supplementary Tables 7, 8**) showed that the MLGC model for the full sample of data from participants who completed the survey (Model SA1), where the single model included the growth in loneliness, depression, and social anxiety, but did not include social restriction data because those were not available for all countries, was a good fit to the data (RMSEA = 0.064 [0.058, 0.070], CFI = 0.948, TLI = 0.880, SRMR = 0.028). As with our analyses with the smaller subsample, exploration of the intercepts and slopes showed small, but significant reductions in loneliness and depression, and a small increase in social anxiety over six months (see **Supplementary Table 7**). Further, the same associations between loneliness, depression, and social anxiety were observed, and the same predictors of each were observed with these data as was found for the subsample where the effects of

TABLE 2 | Estimated sample statistics for Model 1b: covariances, correlations, and change in loneliness, depression, social anxiety, and SARS-CoV-2 social restrictions.

Estimated sample statistics													
Means		**Loneliness**			**Depression**			**Social anxiety**			**Restrictions severity**		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
		45.76	46.00	45.91	8.38	7.82	8.02	3.72	3.75	4.03	23.09	19.47	18.66
Covariances		**Loneliness**			**Depression**			**Social anxiety**			**Restrictions severity**		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Loneliness	T1	125.05											
	T2	111.01	136.78										
	T3	112.60	123.21	143.93									
Depression	T1	36.39	36.31	37.43	35.42								
	T2	33.43	40.91	39.42	26.05	33.76							
	T3	33.92	38.20	43.40	25.62	26.97	35.32						
Social anxiety	T1	17.04	16.52	16.66	8.95	7.51	7.56	10.10					
	T2	14.97	17.40	17.55	8.11	9.02	8.37	7.22	9.90				
	T3	17.34	19.09	20.01	8.75	8.12	9.75	7.75	7.75	11.01			
Restrictions severity	T1	−2.18	−2.46	−1.72	0.02	−1.15	−0.63	−0.58	−0.39	−1.10	15.18		
	T2	−0.84	−0.79	−1.54	−0.73	−1.03	−0.82	−0.33	−0.48	−0.77	5.77	6.83	
	T3	−2.69	−2.80	−2.69	−0.02	−1.40	.43	−0.14	.20	−0.22	13.74	8.87	30.05

Correlations													
		Loneliness			**Depression**			**Social anxiety**			**Restrictions severity**		
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Loneliness	T1	1.00											
	T2	0.85	1.00										
	T3	0.84	0.88	1.00									
Depression	T1	0.55	0.52	0.52	1.00								
	T2	0.52	0.60	0.57	0.75	1.00							
	T3	0.51	0.55	0.61	0.72	0.78	1.00						
Social anxiety	T1	0.48	0.45	0.44	0.47	0.41	0.40	1.00					
	T2	0.43	0.47	0.47	0.43	0.49	0.45	0.72	1.00				
	T3	0.47	0.49	0.50	0.44	0.46	0.50	0.74	0.74	1.00			
Restriction severity	T1	−0.05	−0.05	0.04	0.00	−0.05	−0.03	−0.05	−0.03	−0.09	1.00		
	T2	−0.03	−0.03	0.05	−0.05	−0.07	−0.05	−0.04	−0.05	−0.09	0.57	1.00	
	T3	−0.04	−0.04	0.04	0.00	−0.04	0.01	−0.01	0.01	−0.01	0.64	0.62	1.00

Model results				
	Estimate	**Standard error (SE)**	**Estimate/SE**	**_p_-value**
Intercept loneliness	46.04	0.22	208.31	<0.001
Slope loneliness	−0.47	0.03	−14.33	<0.001
Intercept depression	8.31	0.12	72.45	<0.001
Slope depression	−0.09	0.02	−4.20	<0.001
Intercept social anxiety	3.44	0.06	60.44	<0.001
Slope social anxiety	0.65	0.01	47.56	<0.001
Intercept social restrictions	22.38	0.09	254.82	<0.001
Slope social restrictions	−0.92	0.02	−38.49	<0.001

Latent growth curve model (LGCM) includes data from the subsample whose country level data on social restrictions during the first six months of the COVID-19 pandemic could be retrieved (N = 1,562). Linear growth models were estimated, with continuous outcomes; models were estimated using the robust maximum likelihood (MLR) estimator, to account for missing data (20).

TABLE 3 | Parameter estimates for Model 1b: predicting associations between change in loneliness, depression, social anxiety, and SARS-CoV-2 social restrictions.

	Model results			
	Estimate	**Standard error (SE)**	**Estimate/ SE**	**p-value**
Intercept of loneliness → slope of loneliness	−0.14	0.08	−1.85	0.07
Intercept of depression →				
Slope of depression	−0.07	0.12	−0.60	0.55
Intercept of loneliness	0.66	0.02	29.43	<0.001
Slope of loneliness	−0.31	0.10	−3.02	0.003
Intercept of social anxiety →				
Slope of social anxiety	1.68	0.36	4.62	<0.001
Intercept of loneliness	0.60	0.02	28.42	<0.001
Slope of loneliness	−0.54	0.15	−3.70	<0.001
Intercept for depression	0.61	0.02	25.58	<0.001
Slope of depression	−0.09	0.08	−1.16	0.25
Slope of depression →				
Intercept of loneliness	−0.12	0.07	−1.58	0.12
Slope of loneliness	1.50	0.62	2.41	0.02
Slope of social anxiety →				
Intercept of loneliness	0.92	0.18	5.03	<0.001
Slope of loneliness	−0.58	0.23	−2.48	0.01
Intercept of depression	0.85	0.17	5.07	<0.001
Slope of depression	0.43	0.21	2.08	0.04
Intercept of social restrictions →				
Slope of social restrictions	3.06	0.21	14.94	<0.001
Intercept of loneliness	−0.16	0.11	−1.41	0.16
Slope of loneliness	−0.02	0.02	−1.13	0.26
Intercept of depression	−0.16	0.07	−2.32	0.02
Slope of depression	0.00	0.01	0.32	0.75
Intercept of social anxiety	−0.05	0.03	−1.57	0.12
Slope of social anxiety	−0.12	0.01	−2.08	0.04
Slope of social restrictions →				
Intercept of loneliness	−0.50	0.37	−1.35	0.18
Slope of loneliness	−0.03	0.05	−0.58	0.57
Intercept of depression	−0.21	0.21	−1.00	0.32
Slope of depression	−0.04	0.04	−1.16	0.25
Intercept of social anxiety	−0.05	0.03	−1.58	0.12
Slope of social anxiety	−0.07	0.02	−2.84	0.01

LGCM includes data from the subsample whose country level data on social restrictions during the first six months of the COVID-19 pandemic could be retrieved (N = 1562). Linear growth models were estimated, with continuous outcomes; models were estimated using the robust maximum likelihood (MLR) estimator, to account for missing data (20).

social restrictions could also be included in the model (see **Supplementary Table 8**).

Further sensitivity analyses (Model SA2) using data from participants who had complete data was also conducted and showed that it was appropriate to use robust maximum likelihood (MLR) estimator to account for such a large amount of missing data from T1 to T3. Indeed, we found the same overall effects using just data for those with data at all three

time points (**Supplementary Tables 9, 10**) as we did for our full subsample where missing data were accounted for using MLR.

TABLE 4 | Parameter estimates for Model 1b: demographic predictors of change in loneliness, depression, and social anxiety.

	Model results			
	Estimate	**Standard Error (SE)**	**Estimate/ SE**	**p-value**
Predictors of intercept of loneliness				
Gender	0.04	0.02	1.71	0.09
Age group (18–25 years)	−0.10	0.02	−4.58	<0.001
Being a carer	−0.06	0.02	−2.63	<0.001
Being a parent	0.05	0.02	2.38	0.02
Wealthy	−0.19	0.02	−8.51	<0.001
Unemployed	−0.14	0.02	−6.69	<0.001
Living alone	−0.16	0.02	−7.66	<0.001
Predictors of slope of loneliness				
Gender	0.05	0.06	0.83	0.41
Age group (18–25 years)	0.12	0.07	1.81	0.07
Being a carer	0.02	0.06	0.39	0.72
Being a parent	−0.12	0.07	−1.68	0.09
Wealthy	0.02	0.08	0.25	0.81
Unemployed	0.05	0.06	0.84	0.40
Living alone	0.07	0.06	1.28	0.20
Total contact with COVID-19[1]	0.08	0.12	0.62	0.53
Has had COVID (positive test)[1]	−0.12	0.18	−0.68	0.50
Predictors of intercept of depression				
Gender	−0.04	0.02	−1.76	0.08
Age group (18–25 years)	−0.19	0.02	−8.33	<0.001
Being a carer	−0.03	0.02	−1.51	0.13
Being a parent	0.01	0.02	0.38	0.71
Wealthy	−0.24	0.02	−10.29	<0.001
Unemployed	−0.12	0.02	−5.03	<0.001
Living alone	−0.04	0.02	−1.77	0.08
Predictors of slope of depression				
Gender	0.11	0.07	1.54	0.12
Age group (18–25 years)	0.20	0.10	2.08	0.04
Being a carer	−0.02	0.07	−0.34	0.73
Being a parent	−0.03	0.07	−0.36	0.72
Wealthy	−0.02	0.08	−0.19	0.85
Unemployed	−0.02	0.07	−0.22	0.83
Living alone	0.02	0.06	0.27	0.79
Total contact with COVID-19[1]	0.01	0.13	0.06	0.96
Has had COVID[1]	−0.02	0.18	−0.13	0.90
Predictors of intercept of social anxiety				
Gender	−0.02	0.02	−0.67	0.50
Age group (18–25 years)	−0.14	0.03	−5.81	<0.001
Being a carer	−0.04	0.02	−1.85	0.07
Being a parent	0.03	0.02	1.09	0.28
Wealthy	−0.12	0.03	−4.78	<0.001
Unemployed	−0.14	0.03	−5.39	<0.001
Living alone	0.01	0.02	0.59	0.56

(Continued)

TABLE 4 | (Continued)

	Model results		
	Estimate	**Standard Error (SE)**	**Estimate/ SE**	**p-value**
Predictors of slope of social anxiety			
Gender	0.02	0.04	0.46	0.65
Age group (18–25 years)	−0.20	0.06	−3.42	0.001
Being a carer	−0.04	0.05	−0.87	0.38
Being a parent	0.00	0.04	−0.02	0.99
Wealthy	−0.15	0.05	−2.79	0.01
Unemployed	−0.17	0.05	−3.12	0.002
Living alone	−0.01	0.04	−0.13	0.90
Total contact with COVID-19[1]	−0.01	0.18	−0.06	0.95
Has had COVID[1]	0.04	0.27	0.15	0.88

[1]Total contact with COVID-19 (0 = know others with COVID-19 (friends, family, and co-workers), 1 = does not know anyone with COVID-19; has had COVID-19 (0 = has had a positive test result for COVID-19 or has had symptoms, 1 = no symptoms or positive test result for COVID-19); both variables used as control variables in the LGCM. LGCM includes data from the subsample whose country level data on social restrictions during the first six months of the COVID-19 pandemic could be retrieved (N = 1,562). Linear growth models were estimated, with continuous outcomes; models were estimated using the robust maximum likelihood (MLR) estimator, to account for missing data (20).

DISCUSSION

The social restrictions mandated to bring the spread of SARS-CoV-2 under control prior to this study had not been examined as predictors of change in individual well-being in the first months of the pandemic. Even though many studies explored the change in depression, loneliness, they did not include in their analyses the rate of change in government-initiated restrictions on social interaction. In the current study, we filled this knowledge gap, and showed that social restrictions negatively impacted the course of social anxiety. Specifically, levels of social anxiety increased fastest where restrictions were easing fastest. This is consistent with features of social anxiety symptoms where lack of social exposure can maintain symptom severity (27, 28). The effect of social restriction severity on depressive symptoms was also examined, and our findings showed that changes in social restrictions did not influence the rate at which people reduced on depressive symptoms. With the effects of severity of social restrictions controlled in our model, we found there was a significant reduction in loneliness, a small, but significant reduction in depression, and an increase in social anxiety over the first six months of the pandemic.

Our findings provide information about how changing social restrictions affected loneliness, depression, and social anxiety, but also provide further evidence of the longitudinal relationships between loneliness and mental health symptomatology. Those higher on loneliness at the start of the pandemic were also higher on depression and social anxiety, suggesting that people reporting one of those issues were more likely to report others, consistent with previous studies showing the close relationships between loneliness and mental health symptom severity (15, 29). These findings further demonstrate that the rate of change in loneliness,

social anxiety, or depression affects the rate of change of the other constructs, supporting the potential for psychological therapies to effectively reduce both loneliness and mental health symptom severity (30). Previous research in young people with and without a mental disorder have demonstrated that interventions focussed on addressing loneliness also showed a reduction in social anxiety and depression (29), and psychotic symptomatology (31, 32). In the context of the SARS-CoV-2 pandemic, the reduction in loneliness that accompanied the easing of social restrictions did not lead to reductions in depression and was associated with an increase in social anxiety. It is plausible that relationships between mental health symptomatology observed here are due to the nature of our community sample not looking to address mental health symptomatology through an intervention or perhaps be an artefact of the naturalistic but stressful global environment experienced during the pandemic.

Consistent with previous studies during the SARS-CoV-2 lockdowns (9, 13, 14), we also found that being 18–25 years of age, unemployed, lower than average wealth, and living alone, all predicted higher loneliness, depression, and social anxiety at the start of the pandemic. While no demographic differences predicted the rate of change in loneliness, age predicted the rate of change in depression (those older than 25 years reuced faster), and the rate of change in social anxiety was predicted by age and unemployment, with those younger than 25 years and unemployed being *faster* to increase on social anxiety than those older than 25 years, and employed. These findings are consistent with research that social anxiety also tends to disportionately affect younger people (16–29 years) (33) and adversely affects employment due to decreased social functioning (34).

Study Limitations

We looked at the impact of *easing* social restrictions rather than *imposing* social restrictions as we did not include data collected pre-pandemic. It is plausible that loneliness and poor mental health symptoms increased *before* T1 data were collected and our data do not speak to the impact of longer-term social restrictions on loneliness and mental health. Additionally, our sample was demographically skewed toward more educated and mostly female participants, similar to other online studies (15).

Research and Clinical Implications

Our findings support existing literature demonstrating associations between loneliness, depression, and social anxiety over time and address a gap in knowledge about how loneliness and mental health symptoms are related prospectively. These findings are novel: they highlight the impact of social restrictions on mental health outcomes, with specific negative consequences on social anxiety. Loneliness has a reciprocal relationship with social anxiety (15). In the current study, reductions in social anxiety did not accompany reductions in loneliness as restrictions eased. Nonetheless, our study reinforces the importance of measuring related mental health symptom severity in studies focussed on understanding loneliness.

Our findings emphasise the critical need to identify, monitor, and actively intervene as communities recover from lockdowns, with particular importance of assisting vulnerable people (i.e., those unemployed, lower wealth, and younger). Mental health practitioners may see slow or little change in social anxiety symptoms in young people and those unemployed, even as communities move toward reduced social restrictions. While there are valid public health concerns prompting restrictions, our findings should serve as a call to action to assist young people, across different services, from youth mental health, youth centres, educational institutions, and employment.

CONCLUSION

As social restrictions eased, loneliness reduced, depression marginally reduced, and social anxiety increased in the first six months of the SARS-CoV-2 pandemic. Social anxiety remains an overlooked mental health symptom and may increase as we attempt to reintegrate socially. Young people, those who are unemployed, living alone, and from lower wealth are all vulnerable groups disadvantaged during SARS-CoV-2 pandemic. Finally, those aged 18–25 and those unemployed continue to experience more social anxiety symptoms even after social restrictions were eased.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/58zg2/?view_only=118ed3253c944195aa0c25f352b9aab0.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Swinburne University Human Research Ethics Committee. The participants provided their consent to participate in this study online.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.818030/full#supplementary-material

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Examining the Impacts of the Coronavirus Pandemic and Social Distancing on the Health of People With Mobility Disabilities

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Objective: To understand the effects of the coronavirus pandemic on the health and participation of people with mobility disabilities living in the community.

Methods: Participants responded to a survey designed to assess the effects of the coronavirus pandemic on their health and access to health care. Participants identified if various life situations were worsened, unchanged, or improved during the pandemic. Participants could provide further information on their improved or worsened lived experience in open-ended questions.

Results: A total of 39 people with mobility disabilities responded to the survey. Results indicate that many experienced a worsening of life situations related to health, including access to medications, health care services, and transportation.

Conclusions: Results show that many experiences were caused by the lack of appropriate policies, rather than the pandemic itself. Therefore, there is a need to modify pandemic preparedness plans and other policies to meet the needs of people with disabilities.

Keywords: coronavirus, disability, health, pandemic, social distancing

INTRODUCTION

The coronavirus outbreak was formally named as a pandemic by the World Health Organization in the spring of 2020 (1). Although the pandemic continues to have an impact on all people living in the United States, research shows that people with disabilities are disproportionately affected by the pandemic and the subsequent social distancing orders across the country (2). Despite this fact, the experiences of people with disabilities are regularly disregarded by public health experts and policymakers (3). The disproportional effects on health and health care that people with disabilities are experiencing may very well represent the most prominent and least publicly recognized crisis that Americans are facing at this time (4).

For people with disabilities who rely on social supports for daily care needs, social distancing was never a realistic choice. Even so, social distancing mandates and widespread panic resulted in many community-dwelling people with disabilities going without necessary care. Throughout the United States, reports document instances of personal care assistants abandoning people with paralysis in their homes, often leaving them unable to get out of their beds (5). This situation has literally translated into people with disabilities going days without bathing, toileting, or eating,

which can lead to adverse effects on health, such as the development of pressure sores, urinary tract infections, and malnutrition. In addition to the physical effects on health, social abandonment, and isolation can have numerous effects on the mental health of people with disabilities, including psychological well-being (6) and increased anxiety, depression, and suicidal ideation (7).

To provide context to these events, independent living and deinstitutionalization movements have sought to shift care from institutional settings (e.g., nursing homes) to home- and community-based settings (8). Although these movements have provided people with disabilities opportunities for greater choice and control over the setting in which they live, the shift to community living has had the unintended consequence of siloing many of them during the coronavirus pandemic. For people receiving home- and community-based services under a Medicaid waiver, emergency "backup" plans are identified as a key component of person-centered planning (9). However, virtually no research has been conducted that identifies the effectiveness of these backup plans during a true emergency (10). Because of this lack of emergency preparedness, the coronavirus pandemic has often been devastating to some people with disabilities living in the community.

Specifically, some people with physical/mobility disabilities may be at increased risk for unmet social support and health care needs during the coronavirus pandemic due to their complex health needs, low socioeconomic status, and a lack of external social support (11). For some people with mobility disabilities, interruptions in public transportation alone may affect all facets of life if those services provide the only option for accessible and affordable travel (12). Additionally, many of the solutions provided to the community at large, such as pharmaceutical delivery, may not be financially feasible to someone who has a limited income (13). Given that some people with mobility disabilities are likely to have complex heath care needs, even these subtle changes to daily living activities may result in substantial impacts on health (14).

Unfortunately, if people with mobility disabilities did experience a health care need during a time of social distancing mandates, reports show that many health care professionals closed their doors to the public, making health care inaccessible (15). Although telemedicine was presented as a solution to many people opting to continue meeting with their medical providers using a remote format, people with disabilities report many barriers to receiving equitable levels of remote care (16). Reports also show that many health care facilities implemented practices to postpone "elective" surgeries or procedures to address the burden of hospital care (17). For people with mobility disabilities, however, these interruptions to community-based rehabilitation services have translated to increased recovery time or loss of function (18).

Detailed, firsthand accounts of the lived experiences of people with mobility disabilities as they relate to the pandemic are lacking (19). Although a growing literature base has focused on statistically documenting disparities in disease burden or outcomes, there has been comparatively little focus in the academic literature on the experiences of people with disabilities

during the pandemic and how those experiences might inform public health policy and practice in the future. This paper is a timely contribution and can serve as a call for more work on the topic. Thus, the purpose of the present study is to explore and capture the impacts of the coronavirus pandemic on the lived experiences of people with mobility disabilities living in the community, particularly impacts on physical and mental health, access to everyday health needs (e.g., medical supplies, prescription medications), and access to health care (e.g., doctors, specialists, counselors).

METHODS

Participants

We conducted this research within the context of the Research and Training Center on Promoting Interventions for Community Living (RTC/PICL), which includes a study designed to test the effectiveness of a multifaceted intervention in increasing the community participation of people with mobility disabilities. Although the presented sub-study to document the effects of the coronavirus pandemic was not the original focus of the larger RTC/PICL study, we felt a quick pivot was important to gain timely insight on pandemic-related effects for people with mobility disabilities. Thus, participants actively enrolled in the RTC/PICL study were asked if they would like to participate in a sub-study to document the experiences of people with mobility disabilities during the coronavirus pandemic. Inclusion criteria for participants enrolled in the original RTC/PICL included being 18 years or older, being one's own guardian, living in the community, and having a mobility disability, with or without other disabilities. To conduct this study and the larger RTC/PICL study, researchers partnered with Centers for Independent Living (CILs), which are community-based, nonresidential agencies that provide an array of advocacy and other services to people with disabilities. At the start of the coronavirus pandemic (April-June 2020), three of the participating CILs in the United States—located in Indiana, Ohio, and Pennsylvania—elected to recruit a sub-sample of RTC/PICL participants to participate in a survey to document the effects of the coronavirus pandemic on enrolled consumers. These three CILs recruited a sample of 39 consumers to participate. Participants received a $25 incentive payment for participating.

Measures

Our team developed a survey to document the experiences of people with mobility disabilities during the coronavirus pandemic. Approximately half of these questions asked participants about effects related to community-based services and supports (e.g., personal assistance services, social relationships, grocery access), which are analyzed in a corresponding manuscript (20). The other set of questions focused on the health and access to health care of people with mobility disabilities, which is the focus of this manuscript. Specifically, participants responded to eight questions related to health, including "How has the coronavirus/social distancing affected your (a) access to medications, (b) access to transportation, (c) access to medical supplies, (d) access

TABLE 1 | Participant characteristics.

Characteristic	*n* (%)
Age	
M = 53.28, *SD* = 16.41, Range = 24-92	
18-34	7 (17.9)
35-64	23 (59.0)
65+	9 (23.1)
Gender	
Male	15 (38.5)
Female	24 (61.5)
Race*	
American Indian/Alaskan Native	1 (2.6)
Black/African American	5 (12.8)
White	31 (79.5)
Other	3 (7.7)
Hispanic/Latino	1 (3)
Missing	1 (2.6)
Marital status	
Married	8 (20.5)
Separated, divorced, widowed	14 (35.9)
Never been married	13 (33.3)
Unmarried couple	4 (10.3)
Education	
Less than high school diploma	2 (5.3)
High school graduate	9 (23.7)
Less than bachelor's degree	13 (34.2)
Bachelor's degree	10 (26.3)
Master's degree or higher	4 (10.5)
Missing	1 (2.6)
Household income	
$10,000 or less	11 (28.2)
$10,001 to $20,000	12 (30.8)
$20,001 to $40,000	10 (25.6)
More than $40,000	6 (15.4)
Employment status	
Employed	12 (30.8)
Not employed	27 (69.2)
Benefits	
Supplemental security income	10 (25.6)
Social Security disability insurance	17 (43.6)
Social Security retirement	6 (15.4)
None	5 (12.8)
Other	9 (23.1)

M, Mean; SD, Standard Deviation.
*No participants identified as Asian or Native Hawaiian/Pacific Islander.

to medical providers; (e) access to health services, (f) access to mental health services, (g) mental health, and (h) physical health?" Examples of services were provided (e.g., examples of dental care, physical/occupational therapy, dialysis, and chemotherapy were provided for "health services"). Participants could respond that their access or condition had either remained unchanged, worsened, improved, or was not applicable. If

participants selected "worsened" or "improved," they then had the opportunity to describe how their condition had worsened or improved via an open-ended response option.

Finally, participants self-reported their frequency of in-person visits to health-related facilities (i.e., health care providers, pharmacies, exercise facilities) in the last 7 days. Participants had previously responded to this question in a pre-survey questionnaire during their participation in the larger RTC/PICL study prior to the coronavirus pandemic. Thus, the survey questions served as a post-measure for comparative analyses.

Data Collection

After the CIL staff had informed the participants about the sub-study and confirmed participation interest, participants were asked if they would prefer to complete the survey online or over the phone. Participants who chose to complete the survey online were sent an electronic survey link via email. These participants provided electronic consent to participate and responded independently to all survey questions, including open-ended response options. Participants who chose to complete the survey over the phone were called by one of the research team members. These participants provided oral consent to participate, and responses were recorded by the research team. Open-ended responses were transcribed in real-time by the researcher during the call, and responses were read back to the participant to confirm the accuracy of recorded responses. All study procedures were approved by the Institutional Review Board (IRB) at the University of Kansas.

Data Analysis

Descriptive statistics were calculated for demographics-related variables. For qualitative analysis, key themes were determined prior to analysis based on the open-ended response topics in the survey. Two research team members independently selected open-ended responses using an inductive approach to identify illustrative quotations relevant to each theme. These researchers met to compare selected quotations and to reach consensus on representative quotations to include for each theme. For quantitative analysis, a frequency analysis was conducted to consider the number of applicable responses indicating unchanged, worsened, or improved. Participants could elect to skip survey questions or to respond "not applicable" to any of the response topics, so total responses to each survey topic vary somewhat, as described in the results. Finally, the average number of visits to health-related facilities before and after the coronavirus pandemic were calculated.

RESULTS

Demographics

Table 1 depicts demographic characteristics of participants. Results show that participants were a mean of 53.3 years of age and were mostly female (62%), White (80%), and unmarried (80%). Additionally, most respondents reported having at least some college education (71%) and an annual household income of ≤$20,000 (59%).

TABLE 2 | Self-reported worsened, unchanged, and improved life situations during the coronavirus pandemic.

Themes	Worsened access (%)	Unchanged access (%)	Improved access (%)
Access to medical providers (*n* = 38)	60.5	34.2	5.3
Access to health services (*n* = 35)	48.6	51.4	0.0
Access to transportation (*n* = 38)	42.1	55.3	2.6
Access to medical supplies (*n* = 34)	23.5	76.5	0.0
Access to medications (*n* = 37)	18.9	75.7	5.4
Access to mental health services (*n* = 19)	47.4	52.6	0.0
Physical health (*n* = 37)	40.5	56.8	2.7
Mental health (*n* = 37)	48.6	43.2	8.1

Worsened, Unchanged, and Improved Life Situations

Table 2 depicts self-reported life situations that worsened, remained unchanged, or improved during the coronavirus pandemic. Representative quotations from participants who provided open-ended responses related to their improved or worsened experiences are included below.

Access to Medical Providers

Participants with worsened access to medical providers (60.5%) described the effects of service policies made obsolete by the pandemic:

"I have not been able to obtain an appointment for referral to a specialist until yesterday when they called me and stated they are now authorized to do new patient appointments over the phone. Until then, I had been unable to schedule the appointment with the urologist for over a month."

Participants also noted the effects of staff layoffs:

"Reaching my primary care physician via phone has also been a challenge as they have laid off their entire staff except for one person."

In addition, participants noted the effects of limited appointment windows:

"Appointments at my doctor's office are only happening during the morning, so getting an appointment, especially with my own doctor, is difficult to impossible."

Finally, participants noted the effects of office closures:

"My three doctors were all down during the coronavirus. Two will still be down for the next month. Doctors and dentists were literally not accessible during the coronavirus. If there was an emergency, I would have to use the emergency room."

Participants who reported improved access (5.3%) did not elaborate on ways their access had improved.

Access to Health Services

Participants with worsened access to health services (48.6%) described the effects of the postponement of elective surgeries:

"I am waiting for a hip replacement and have to wait for them to let the doctors do surgeries. And I am in pain but thank goodness for medications."

Participants also noted personal decisions to delay services due to perceived risk:

"Physical therapy was prescribed, but not begun due to the coronavirus. Exercise facilities have been closed for a month. As a result, I am significantly less flexible and losing strength."

Finally, participants noted the effects of facility closures:

"Everything is on hold. I have an abscess[ed] tooth right now, and [the dentist] told me to call back in a month. They put me on antibiotics, but that doesn't help the swelling and the pain."

Access to Transportation

Participants with worsened access to transportation (42.1%) described the effects of service disruptions:

"I had to cancel my doctor's and dentist [appointments] and I am going to have to look for new providers that are in walking distance to my house... When I had transportation, [my providers] were always driving distance away. Now, I need to get other providers that are walking distance from my house."

Participants also noted effects of disruptions on access to prescribed medications:

"[I have] difficulty getting to the pharmacy and no delivery available per my insurance."

Finally, one respondent who reported improved access noted that their paratransit service was able to provide increased schedule flexibility and reduced transportation costs:

"Fewer people are riding paratransit, so they are more able to accommodate my schedule. Rides are free until the coronavirus threat subsides."

Access to Medical Supplies

Participants with worsened access to medical supplies (23.5%) described the barriers in obtaining prescriptions for supplies:

"Because of COVID and minimal medical supply, [I] can't get [nebulizer] tubing... without a special prescription, and none of my doctors are open, they just tell me to go to the emergency room or keep trying."

Participants also noted effects of insurance-related delays:

"I am having difficulty getting adjustments to my current wheelchair seating due to call centers being overwhelmed to check coverage with my insurance company."

In addition, participants noted effects of supply shortages:

"Getting over-the-counter supplies like protein drink and rubbing alcohol, disinfectants, incontinence supplies is more difficult due to shortages."

Participants also noted their perceived risk to obtain supplies:

"The DME provider loaning me equipment poses a potential risk [to my health]."

Participants noted effects of changes to store return policies:

"An elbow brace that I had bought at CVS ended up being too small and I was not allowed to return or exchange it due to their recent policy changes due to the risk from COVID-19."

Finally, participants noted effects of provider closures:

"My wheelchair needs repairs, and I usually go in to have these done because my apartment is too small to do repairs in. However, the provider is not allowing the public in at this time, which is forcing me to wait."

Access to Medications

Participants with worsened access to medications (18.9%) described effects due to office closures:

"[I had] difficulty getting changes to medications due to no appointment or referral appointments until recent updates in telephone appointments."

Participants also noted effects of prescription delays:

"I have had to wait longer for physician renewal of prescriptions."

In addition, participants noted supply shortages:

"[I have] difficulty in finding over-the-counter medications and supplies due to shortages of supply in stores and online shopping."

Participants noted the effects of telecommunication barriers:

"[My doctor] is going to do a phone call about my [prescription], but wants to do a video call and my internet is not secure and it drops and stuff. [My doctor] said this time she will do a phone call, but next time if I need a refill or anything, it will need to be a video call or in person. If I can't do that, I won't get a refill and she may drop me."

Finally, participants who reported improved access suggested that the ability to receive prescriptions through the mail and refill prescriptions via telehealth services made accessing their medications easier:

"I [used] to have to see the doctor every 90 days to get [my] prescription refilled… So now I can get the prescriptions without having to see the doctor, because there isn't anything wrong, just [my disability], so it's actually kind of improved."

Access to Mental Health Services

Participants with worsened access to mental health services (47.4%) described effects of provider policies to not accept new patients:

"I was not currently receiving mental health services, but with my increased depression from all this social isolating I should be, but I don't know how to find anyone taking new patients right now."

Participants also noted concerns around family members or caregivers overhearing confidential information:

"[My] therapist calls me every two weeks, and we do that over the phone… Hard to talk when everybody is in the house, and you've got to say personal things. I can't wait to go back into her office."

In addition, participants noted effects of telecommunication barriers:

"I've had to do my counseling on video calls, and I have poor internet, so it's difficult."

Finally, participants noted anxiety about using telehealth for mental health services:

"In order for my insurance to pay for mental health services, I have to be treated by a licensed therapist. All licensed therapists [are] not doing home visits… I don't anticipate much progress if I don't feel safe or comfortable talking through a webcam."

Physical Health

Participants with worsened physical health (40.5%) described the effects of inactivity:

"My physical health has decreased because I cannot work out, and because of my knee I cannot walk. So basically, weight gain is an easy thing to do because there is nothing else to do."

Participants also described increased pain from inactivity:

"Because I don't go out except in my own yard, the amount of my exercising has gone way down, and my mobility pain has risen."

Finally, one respondent who reported improved physical health noted the effects of increased time to focus:

"Since the isolation, I have time to focus on the things that are important in life."

Mental Health

Participants with worsened mental health (48.6%) described effects of not leaving the home:

> "I am teetering on the depressed side right now, as I have not left my home in a month. My anxiety has been worrisome as well."

Participants also noted increased anxiety around the pandemic:

> "My anxiety is sky high as I'm afraid of getting COVID-19 and dying."

In addition, participants noted the effects of social isolation:

> "The isolation has become the hardest obstacle. I speak to friends, but I miss the physical interactions. Because of increased anxiety, I'm having a lot of difficulty sleeping and staying focused during the day."

Finally, participants who reported improved mental health (8.1%) described effects of slowed pace, increased time alone, and decreased social expectations:

> "It's actually improved my mental health because it's allowed me to take things in and properly assess things in my life [instead of] having my mind race a mile a minute."

Frequency of Health-Related Facility Visits

Participants reported the number of in-person visits made to visit (a) a doctor or health care provider, (b) a pharmacy, and (c) an exercise facility, before the pandemic and during the survey period. Overall, results displayed in **Table 3** show that participants reported decreased numbers of visits to all health-related facilities during the pandemic.

DISCUSSION

Our results highlight the numerous adverse effects that the coronavirus pandemic has had on the health and access

TABLE 3 | Self-reported frequency of visits to health-related facilities before and during the coronavirus pandemic.

	Average number of visits	
Variable	**Pre-pandemic**	**During-pandemic**
How many times have you visited doctors or health care providers in the past 7 days? (n = 38)	1.50	0.18
How many times have you visited pharmacies in the past 7 days? (n = 37)	1.03	0.61
How many times have you visited exercise facilities in the past 7 days? (n = 38)	0.47	0.00

Data were excluded if they did not have a matching pre- and post-test data point.

to health care of people with mobility disabilities. In every survey health topic area, at least some respondents reported worsened access or health during the pandemic. Collectively, these responses document the experiences of people with disabilities during a pandemic, which may help inform future emergency preparedness planning and response efforts. In general, our results highlight that many of the barriers experienced by people with disabilities were not due directly to the coronavirus infection, but rather to subsequent social policies and practices that may have been mitigated with effective emergency preparedness planning and response. In fact, previous research (21) has suggested that people with disabilities may be four times more likely to be injured or to die during disaster situations than people without disabilities "not because of their 'vulnerable' position, but because urban health policy, planning, and practice have not considered their needs" (22).

First, our results highlight the need to quickly adapt existing health care policies to accommodate people with mobility disabilities. Participants cited numerous barriers due to inflexible policies, such as policies that intake appointments were not allowed to be conducted *via* telehealth, medications could not be prescribed over the phone, and stores could no longer accept medical supply returns or exchanges. These examples highlight the socially induced barriers that may be presented when policies remain inflexible to accommodate people with disabilities during a pandemic. Given that many people with disabilities are covered by Medicaid and/or Medicare, federal policies to require or allow providers to accept new patients *via* telehealth or make prescriptions over the phone would likely have been helpful and can still be considered now or in the future. Similarly, insurance policies disallowing coverage for prescription deliveries seem short-sighted and potentially cost-ineffective and should be flexible during times of social distancing mandates.

Second, our results highlight telecommunication barriers. Although many medical professionals provided telemedicine as a way to continue medical care, this format presents additional barriers for some people with disabilities (16). Research shows that people with disabilities are more likely to live in poverty and are less likely to have access to internet services (23). Among those with internet access, our respondents indicated that internet reliability and speed were both barriers to effective telehealth experiences. Additionally, certain services, such as physical, occupational, or speech therapy may be less effective or even impossible when not conducted in-person. Similarly, remote delivery of psychiatric services may be problematic when a family member or care attendant is consistently present in the home. As one of our participants noted, it is "hard to talk when everybody is in the house, and you've got to say personal things," a finding also echoed by other researchers (24).

Third, our results highlight the reduced service capacity observed due to cited office closures, staff layoffs, and treatment postponements. Although these strategies were employed to reduce virus exposure risk through health care settings, our results show that these access delays may result in dangerous and immediate risk to people with disabilities who are unable to obtain necessary medical supplies and services.

Among other issues, participants noted delays in getting a hip replacement, completing physical therapy, being able to access exercise facilities, getting repairs to wheelchairs, and getting emergency dental treatment. Thus, when developing emergency preparedness plans, it is imperative to also consider the severity of effects that unmet health care needs may have on people with disabilities. For example, policies may need to be put in place that make exceptions to which services are suspended, or for whom, so that people with disabilities still receive needed care.

Fourth, our results highlight barriers due to supply shortages. Our participants cited multiple difficulties in obtaining necessary medications and medical supplies. Although some shortages occurred due to manufacturer and supplier closures due to rising infection rates, reports show that many shortages occurred because people were "panic buying" for emergency or backup supplies and did not necessarily have a history of use (25). Thus, these shortages may have occurred due in part to inadequate policies in place to discourage hoarding or to reserve medications and supplies for people with disabilities who did have a history of use. To prepare for similar events in the future, emergency preparedness planners may need to reassess the supplies needed in their consumable medical supply list.

Fifth, our results highlight the poor health outcomes that may be observed during a pandemic, unrelated to the coronavirus itself. With respect to physical health, participants reported adverse effects due to inactivity, muscle atrophy, increased pain, and weight gain. Participants also reported adverse effects on mental health due to increased anxiety, prolonged time spent at home, and social isolation. Although it may be arguable that these effects are unavoidable due to the coronavirus pandemic and social distancing, it is possible that these effects may have been exacerbated due to underlying health conditions, inflexible health care policies, office closures, reduced service capacity, telecommunication barriers, and supply shortages.

Finally, it is worth noting that some respondents reported positive experiences related to the pandemic and social distancing policies. For example, some individuals appreciated the time and space for introspection and the opportunity to re-focus. One participant reported increased flexibility in not needing to visit the doctor before getting refills for a maintenance medication. Others appreciated the option for telehealth and fewer physical trips to the doctor. And, finally, another reported improved access to paratransit services, with more flexibility in scheduling and reduced costs due to the pandemic. These positive experiences can also be used to inform policy. For example, telehealth as an option reimbursable by insurance even post-pandemic may increase access to health care for some people with disabilities. Increased access to broadband and appropriate technology for people with disabilities would improve this option even more. Similarly, continued flexibility in scheduling and reduced costs for paratransit might increase not only access to health care for people with disabilities, but also to other forms of community participation.

These results contribute to the preliminary research needed to document the impact of the coronavirus pandemic on the health of people with mobility disabilities to better inform emergency preparedness planning and response now and in the future. Although this manuscript does not explore all possible solutions to address the identified impacts, it is imperative to first learn directly from the people whose lives were affected. Indeed, no policy affecting the lives of people with disabilities should be enacted without their representation. Thus, in order to move forward with identifying solutions, it is critical to first learn from the experiences of people with disabilities so that they can have a voice and authority to advocate for social policies that affect their lives.

Limitations

There are a number of limitations in the present study. First, participants were a convenience sample of people with mobility disabilities from a small sample size, which included representation from only three different areas of the country. Therefore, the study may not accurately reflect the range of experiences people with varying disabilities throughout the United States experience in a pandemic. Additionally, the diversity of this sample is lacking in that the majority of our participants were White females. Second, participants did not elaborate on why their experiences remained unchanged. Therefore, information related to why a situation may have remained unchanged remains unknown. Finally, we developed the survey as a team in response to the ongoing pandemic, and therefore the survey was not assessed for validity or reliability. However, due to the novelty of the situation, it was necessary to develop our own survey in a short time period.

CONCLUSIONS

The purpose of this study was to document the pandemic-related health experiences of people with mobility disabilities living in the community. Although all possible solutions are not elaborated upon here, this research highlights the importance of including people with disabilities in all levels of emergency planning and response (26). It is only through pausing to learn from the detailed, firsthand experiences of people with disabilities that policymakers, researchers, stakeholders, and disability advocates can learn how to adequately prepare and plan for their needs—so that we all may move forward *together*.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Kansas Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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Young Adults' Loneliness and Depression During the COVID-19 Pandemic: A Moderated Mediation Model

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Since the outbreak of the COVID-19 pandemic in December 2019, millions of people have been infected with the disease. The COVID-19 pandemic also produced severe mental health problems, such as loneliness and depression. The present study aimed to examine the mediating role of cognitive reappraisal and moderating role of resilience in the relationship between young adults' loneliness and depression during the pandemic by adopting a cross-sectional research approach. In March 2020, 654 young adults (18–29 years old) were recruited to complete the measures for loneliness, depression, emotion regulation, and resilience. Results found that loneliness was positively and moderately associated with depression ($r = 0.531$, $p < 0.001$), and that both loneliness and depression were separately negatively associated with cognitive reappraisal ($r = -0.348$, $p < 0.001$; $r = -0.424$, $p < 0.001$) and resilience ($r = -0.436$, $p < 0.001$; $r = -0.419$, $p < 0.001$).The results indicated that both loneliness and depression were not associated with expressive suppression ($r = 0.067$, $p = 0.087$; $r = -0.002$, $p = 0.961$). The moderated mediation model results revealed that only cognitive reappraisal partially mediated the relationship between loneliness and depression ($b = -0.301$; Boot 95% CI = -0.388, -0.215). In addition, the results of the moderated mediation model indicated that resilience moderated the association between loneliness and depression ($b = 0.035$, $p < 0.001$, Boot 95% CI = 0.014, 0.055), while also moderated the impact of cognitive reappraisal on depression ($b = -0.031$, $p < 0.001$, Boot 95% CI = -0.058, -0.005). These findings have practical implications that broaden our understanding of depression in young adults and shed light on how to enhance cognitive reappraisal and resilience as a means of combating depression in this age group during the COVID-19 pandemic.

Keywords: protective factors, cognitive reappraisal, resilience, loneliness, depression

INTRODUCTION

The COVID-19 pandemic has been declared as a public health emergency (WHO, 2020). The disease not only heightened the risk of death, but also caused mental health problems in China and the rest of the world (Bao et al., 2020; Cao et al., 2020; Duan and Zhu, 2020; Xiang et al., 2020). Since the virus began to spread in early 2020, the threat of death from infection, strict social distancing regulations, and the delayed opening of schools and universities across China have had an inevitable negative impact on mental health and led to an increase in loneliness, death anxiety, and depression among the general public (Chen et al., 2020; Hoffart et al., 2020; Li and Wang, 2020; Liu et al., 2020; Qiu et al., 2020; Wickens et al., 2021; Wu et al., 2021a), medical staff (Wang J. et al., 2020), college students (Cao et al., 2020; Fu et al., 2021; Ramo and Lim, 2021), and the older (Ogrin et al., 2021). During the pandemic, loneliness has been a common occurrence among those who are socially isolated (Pietrabissa and Simpson, 2020; Smith and Lim, 2020; Tull et al., 2020; Mansour et al., 2021; Wickens et al., 2021), especially young adults (Groarke et al., 2020; Ramo and Lim, 2021). Although transient loneliness does not lead to psychological and behavioral disorders, long-term or severe loneliness may result in certain emotional disorders and deteriorating mental health (Wang et al., 2018). Loneliness was thus connected to a series of negative physical and mental health problems (Holt-Lunstad et al., 2015; Lim et al., 2016; Palgi et al., 2020). Previous study has shown that loneliness at an earlier time point could predict depression and social anxiety at subsequent time points (Lim et al., 2016). However, in the earlier time of the COVID-19 pandemic when death threats and negative emotions were diffused, individuals were more anxious of infecting the COVID-19 virus rather than social anxiety. In addition, studies have indicated that among the factors associated with loneliness, depression has the greatest impact (Fuente et al., 2018).

Although scholars have not yet agreed on whether there is a causal relationship between loneliness and depression, the current study adopted the hypothesis that loneliness is a risk predictor of depression. Some studies have shown that loneliness and depression may be mutually (Cacioppo et al., 2006), but others have argued that loneliness is a notable result of depression (Erzen and Cikrikci, 2018). Longitudinal research has also demonstrated that loneliness predicts depression (Chang, 2017), not only at a specific moment but also vertically in time (Louise et al., 2010; Qualter et al., 2010; Vanhalst et al., 2012). Moreover, studies have revealed an association between loneliness and depressive symptoms (Cacioppo et al., 2006; Chang, 2017) and shown that loneliness can predict a heightening of depressive symptoms over time (Fuente et al., 2018). Recently, studies have revealed that loneliness has a significant effect on depression at a moderate level (Erzen and Cikrikci, 2018). In addition, many researchers have become interested in exploring the relationship between loneliness and depression among young adults (Cacioppo et al., 2006; Richardson et al., 2017; Groarke et al., 2021). In younger individuals, loneliness is tied to abnormal coping strategies adopted to deal with emotional problems (Vanhalst et al., 2012), which makes this group more prone to depression (Van Winkel et al., 2017; Kuczynski et al., 2021).

For example, ruminant thinking (Zhang et al., 2019) and coping strategies (Fuente et al., 2018) played mediating roles in the relationship between loneliness and depression. The link between loneliness and depression has been made especially clear throughout the COVID-19 pandemic (Elmer et al., 2020; Hoffart et al., 2020; Misirlis et al., 2020; Wu et al., 2021b). Evidence has confirmed that young adults are vulnerable to loneliness and indicated an increased level of loneliness among young adults due to the pandemic (Lisitsa et al., 2020; Padmanabhanunni and Pretorius, 2021). In these cases, induced loneliness caused by the pandemic was significantly connected with depression (Elmer et al., 2020; Rossi et al., 2020). Thus, loneliness could be viewed as a predictor of depression (Rossi et al., 2020; Santini et al., 2020; Thakur and Jain, 2020).

Another aim of this study was to explore the roles that emotion regulation and resilience had played in the lives of young adults during the COVID-19 pandemic. The protective factors of emotion regulation could be considered as important psychological resources. Psychological resources can help mediate individual's responses to traumatic experiences (Conversano et al., 2020; Giuseppe et al., 2020; Guicciardi and Pazzona, 2020; Rossi et al., 2020), and then individual's potential adaptive defense mechanism could help them overcome traumatic experiences brought on by COVID-19. Adaptive emotion regulation strategies have been shown to protect individuals who are exposed to community-based disasters (Ehring and Quack, 2010). The process model of emotion regulation was developed by Gross and John (2003) and includes two types of emotion regulation strategies. One of the strategies is cognitive reappraisal, which is an antecedent-focused strategy that reduces negative emotional effects, consciously changes the interpretation of emotion-evoked events and focuses on positive aspects of the situation (Gross and John, 2003). The other emotional strategy is expressive suppression, which is a response-focused strategy that individuals tries to inhibit any external cues related to their emotion state when their internal emotional responses have already been produced (Gross and John, 2003). Although loneliness is a negative emotional experience, commonly used adaptive regulation strategies (i.e., cognitive reappraisal) are associated with improved well-being and lower levels of loneliness (Kearns and Creaven, 2017). Previous studies indicated that the inability to regulate daily emotion responses was shown to be significantly associated with mental and behavioral problems, lower levels of resilience (Webb et al., 2012), and the development of depression (Ehring and Quack, 2010). Emotion regulation difficulties have also been linked to greater levels of loneliness (Gonçalves et al., 2019; Visted et al., 2019; Groarke et al., 2021) and were treated as predictors of loneliness in the context of the COVID-19 pandemic (Groarke et al., 2021). Researches have also revealed that emotion regulation strategies played a mediating role in the relationship between interpersonal stress and depression among undergraduate students (Moriya and Takahashi, 2013). Generally, cognitive reappraisal, as a adaptive strategy, may be considered as a psychological resource for young adults affected by COVID-19 pandemic (Kuhlman et al., 2021), whereas expressive suppression, as a maladaptive strategy, was associated

with negative outcomes such as more negative affect and depression (Tyra et al., 2021). Cognitive reappraisal has been found to be negatively related to depression (Joormann and Stanton, 2016; Picó-Pérez et al., 2017; Sachs-Ericsson et al., 2021). And researchers have identified cognitive reappraisal as an important protector that has helped prevent young adults who are impacted by COVID-19 or other instances of prolonged stress from developing mental health issues (i.e., depression, anxiety, and sleep problems) (Xu et al., 2020; Kuhlman et al., 2021). Considering the association between cognitive reappraisal and depression and the fact that loneliness is a risk factor of depression (Rossi et al., 2020; Santini et al., 2020; Thakur and Jain, 2020), therefore, it is theoretically possible that cognitive reappraisal could influence the association between loneliness and depression. Previous research has found that the emotion regulation strategies played a mediation role in college students' depressive symptoms during the COVID-19 pandemic (Ye et al., 2022). However, another study found that cognitive reappraisal was negatively associated with anxiety and depression, but expressive suppression was not associated with them during the early COVID-19 pandemic (Tyra et al., 2021). Considering both emotion regulation strategies may be used to cope with the influences from COVID-19, mediation analyses would be conducted to explore the impact of both emotion regulation strategies (i.e., cognitive reappraisal and expressive suppression) on the relationship between loneliness and depressive symptom. Therefore, we hypothesized that emotion regulation played a mediating role in the relationship between loneliness and depression in young adults.

Resilience is an important psychological resource that could also influence the association between loneliness and depression in young adults. However, few studies have explored the role of resilience in this relationship. Resilience is defined as "the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of threat" (American Psychological Association [APA], 2020). Generally, resilience is a positive quality that allows individuals to face adversity and is considered to be a protective mechanism that individuals can use to maintain mental health in the face of stress and trauma (Michael, 1987; Wu et al., 2020). The risk-protective model suggests that the adverse impacts of risk factors on an individual's health status can be mitigated by resilience (Garmezy et al., 1984). In addition, low level of resilience to stress has been shown to correlated with an increased lifetime risk of antidepressant and anxiolytic drug use (Hiyoshi et al., 2015; Ran et al., 2020). Resilience could thus be a crucial component of reducing stress and psychological pain during traumatic events. Empirical results have indicated that resilience is negatively associated with depressive symptoms (Liu et al., 2015; Ye et al., 2020) and plays a protective role by reducing the influence of stress and the negative effects of depression (Kukihara et al., 2014; Liu et al., 2015). Furthermore, resilience has been shown to play a mediating role in the relationship between loneliness and depression among older adults in nursing homes (Zhao et al., 2018). Throughout the COVID-19 pandemic, depressive symptomology has been negatively correlated with resilience (Ye et al., 2020). In addition, resilience not only moderated the association between chronic pain and depression

FIGURE 1 | The proposed moderated mediation model.
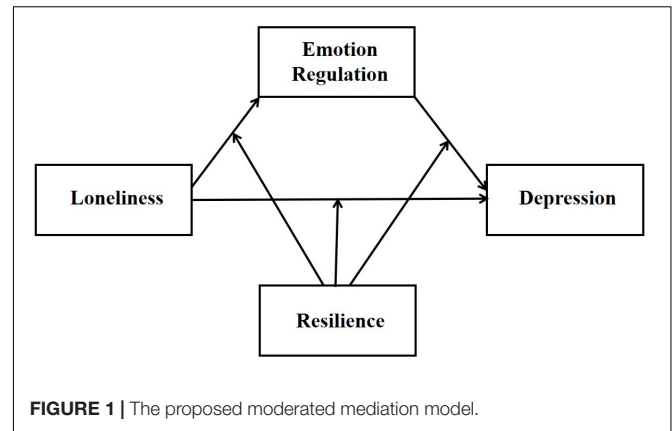
(Bauer et al., 2016) but also acted as a potential moderator in cases where individuals struggle with loneliness and sleep problems related to the COVID-19 pandemic (Grossman et al., 2021). In other words, the role of resilience buffers the deterioration of depression in individuals. Therefore, resilience could be considered as one of the protective factors that could moderate the relationship between loneliness and depression in young adults during the COVID-19 pandemic.

In summary, this study aimed to construct a model to explore the impact of cognitive reappraisal and resilience on loneliness and depression in young adults during the COVID-19 pandemic. Thus, we hypothesized (1) higher levels of loneliness was positively associated with higher risk of depression symptoms, (2) emotion regulation strategies and resilience were negatively associated with loneliness and depression, (3) when not considering the buffering effect of resilience, loneliness predicted the risk of depressive symptoms through emotion regulation strategies (mediation), and (4) loneliness predicted the reduced risk of depression symptoms through both emotion regulation strategies (mediator) and resilience (moderator) (see **Figure 1**). In this study, no specific hypothesis was made regarding the mediating effect of emotion regulation strategies. The mediating role of suppression and reappraisal would be examined, seperately.

MATERIALS AND METHODS

Participants

In March 2020, this study recruited randomly 654 participants online from three colleges located in Guangdong Province, China. The participants included 325 males (49.694%) and 329 females (50.306%) aged 18–29 ($M = 19.980$, $SD = 1.801$). Moreover, 98.471% of sample consisted of undergraduate students, and about three-quarters of the participants (72.02%) had a family income of more than $300 per head.

Procedure

All of our data was collected using a web-based survey designed through an online survey platform called Wenjuanxing. Informed consent was collected at the beginning of the survey,

TABLE 1 | Demographic characteristics of the sample.

Characteristic		n (%)	UCLS-8 (*M ± SD*)	SDS (*M ± SD*)
Gender	Male	325 (49.694)	16.169 ± 4.541	35.068 ± 7.390
	Female	329 (50.306)	16.660 ± 4.531	35.055 ± 7.376
Age (years)	>20	474(72.477)	16.399 ± 4.630	35.156 ± 7.603
	21–29	180 (27.523)	16.461 ± 4.303	34.811 ± 6.759
Region	Urban	357 (54.587)	16.499 ± 4.485	34.950 ± 7.183
	Rural	297 (45.413)	16.317 ± 4.609	35.195 ± 7.614
Education	Undergraduate	644 (98.471)	16.443 ± 4.543	35.028 ± 7.372
	upgradute	10 (1.529)	14.700 ± 4.165	37.200 ± 7.800
Marital Status	Married[a]	10 (1.529)	14.700 ± 4.165	37.200 ± 7.800
	Unmarried	644 (98.471)	16.443 ± 4.543	35.028 ± 7.372
Smoking	Yes	25 (3.823)	16.400 ± 4.752	39.840 ± 9.831
	No	629 (96.177)	16.417 ± 4.535	34.871 ± 7.208
Drinking	Yes	65 (9.939)	16.723 ± 4.665	38.785 ± 8.907
	No	589 (90.061)	16.382 ± 4.528	34.650 ± 7.078
Self-rated health	Bad or average	60 (9.174)	19.870 ± 4.073	43.283 ± 7.951
	Good	199 (30.428)	17.472 ± 4.163	35.749 ± 6.935
	Very good	395 (60.398)	15.360 ± 4.411	33.466 ± 6.594

[a]*Including married, divorced, and widowed.*

and it was clear to participants that they could withdraw from the investigation at any time. Participants could work through the questionnaire at their own pace, and they could only move on to the next page once they had completed all of the items on the page they were currently working through. Before completing the final online survey, there was a pre-test. The questions included in the pre-test did not appear in the final survey in order to allow for the identification and correction of any possible errors in the questionnaire. This study was approved by the Institutional Review Board at first author's affiliation.

Measures

Demographic Information
The demographic variables were measured in this study which included gender, age, marital status (single, married, divorced, widowed), education level (undergraduate, upgradute), region (urban, rural), and self-rating health [from 1 ("very bad") to 5 ("very good")], see **Table 1**.

Depression
Depression was measured according to the Chinese version of the Self-Rating Depression Scale (SDS), which includes 20 items. Each item was rated on a 4-point scale (1 = *never*, 4 = *always*). Higher scores indicated a higher level of depression, and there was a good reliability that the Cronbach's α coefficient for the SDS was 0.94.

Loneliness
Loneliness was measured according to the Chinese version of the short-form version of the University of California Los Angeles' Loneliness Scale (UCLS-8), which consists of eight items. Each item was rated on a 4-point scale (1 = *never*, 4 = *always*). Higher scores indicated a higher level of loneliness, and the Cronbach's α coefficient for the UCLS-8 was 0.87.

Resilience
To measure resilience, we used the Chinese version of the Connor-Davidson Resilience Scale (CD-RISC10), which includes 10 items. Each item was rated on a 5-point scale (0 = *never*, 4 = *always*), with higher scores indicating a higher level of resilience. The Cronbach's α coefficient for the SDS was 0.88.

Emotion Regulation
Emotion regulation strategies were measured using the Chinese version of the Emotion Regulation Questionnaire (ERQ) developed by Gross and John (2003), which consists of 10 items that cover cognitive reappraisal and expressive suppression or which consists of 10 items, including cognitive reappraisal and expressive suppression. Each item was rated according to a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Higher scores suggested a greater tendency to use a certain strategy. For the present sample, the Cronbach's α coefficient was 0.71 for the expressive suppression scale and 0.76 for the cognitive reappraisal scale.

Analyses
In this study, there was not an extensive amount of missing value data in the participants' responses, so no data were deleted. We used SPSS 23.0 for data analyses, and set the *p*-value threshold at 0.05 (two-tailed) for statistical significance. First, we calculated descriptive statistics and correlations for the interested variables. Secondly, we separately calculated the mediation effect and the moderated mediation effect using Hayes's PROCESS windows (Model 4, Model 59) (Hayes, 2013) to further explore the relationship of the interest variables (**Figure 1**). The covariates included age and gender. The non-parametric bootstrap method was used to test mediation effects with 5000 resamples. And finally, the simple slope analysis was used to further explore the moderation effect.

RESULTS

Descriptive Statistics
Table 1 indicated the demographic data collected from all participants. We found that self-rated health were associated with loneliness ($r = 0.355$, $p < 0.001$) and depression ($r = 0.319$, $p < 0.001$) which indicated individuals with worse physical health might have higher level of loneliness and depression in this study where the scores of depression just indicated a risk tendency to be depressed rather than a clinically significant level of depression.

The results were depicted in **Table 2**, including means, standard deviations, and correlations for all of the variables in the study. Our findings suggested that loneliness in young adults was positively correlated with depression ($r = 0.531$, $p < 0.001$), and that both loneliness and depression in this age group were negatively associated with cognitive reappraisal ($r = -0.348$, $p < 0.001$; $r = -0.424$, $p < 0.001$) and resilience ($r = -0.436$, $p < 0.001$; $r = -0.419$, $p < 0.001$). However, the results indicated that none of loneliness ($r = 0.067$, $p = 0.087$), depression ($r = -0.002$, $p = 0.961$) and resilience ($r = 0.055$, $p = 0.156$) in this study were associated with expressive suppression.Therefore,

	M	SD	1	2	3	4	5	6	7
1. Loneliness	16.416	4.539	—						
2. Resilience	18.651	4.175	−0.436***	—					
3. CR	29.622	5.560	−0.348***	0.341***	—				
4. ES	15.520	4.300	0.067	0.055	0.165***	—			
5. Depression	35.061	7.377	0.531***	−0.419***	−0.424**	−0.002	—		
6. Age	19.980	1.801	−0.001	−0.003	0.052	0.021	−0.018	—	
7. Gender			0.054	−0.132**	−0.028	−0.191***	−0.001	−0.073	—

CR, cognitive reappraisal; ES, expressive suppression. **$p < 0.01$. ***$p < 0.001$.

the young adults in this study who frequently used cognitive reappraisal rather than expressive suppression were more likely to have higher levels of resilience. Therefore, cognitive reappraisal and resilience were negatively associated with loneliness and risk of depression symptom. Hypotheses 1 and 2 were thus supported.

Testing for Mediation Effect

As shown in **Tables 3**, **4**, mediation analysis was conducted using PROCESS windows (Model 4) in SPSS in order to examine whether emotion regulation strategies mediates the association between loneliness and depression. **Table 3** revealed the mediating role of cognitive reappraisal. As predicted, loneliness was significantly associated with depression, $b = 0.866$, $p < 0.001$, 95% $CI = [0.760, 0.972]$ (Model 1). The results show that loneliness significantly negatively predicts cognitive reappraisal, $b = -0.426$, $p < 0.001$, 95% $CI = [-0.514, -0.338]$ (Model 2). As Model 3 demonstrates, cognitive reappraisal significantly negatively predicted loneliness, $b = -0.364$, $p < 0.001$, 95% $CI = [-0.452, -0.276]$. The direct effect of loneliness on depression was also significant (Model 3), $b = 0.711$, $p < 0.001$, 95% $CI = [0.603, 0.819]$. We generated 5000 bootstrapping samples from the original data set (n = 654). The indirect effect of loneliness on depression via cognitive reappraisal was significant, $b = 0.155$, 95% Boot $CI = [0.102, 0.216]$, $p < 0.001$. The direct effect was also significant, $b = 0.711$, 95% *Boot* $CI = [0.603, 0.819]$, $p < 0.001$. The mediation effect accounted for 17.90% of the total effect. However, the results did not show the mediating role of expressive suppression in **Table 4**. Although the results showed that loneliness was associated with expressive suppression, $b = 0.073$, $p = 0.044$, 95% $CI = [0.002, 0.145]$ (Model 2) and the direct effect of loneliness on depression was also significant in Model 3, $b = 0.871$, $p < 0.001$, 95% $CI = [0.765, 0.978]$, but expressive suppression did not significantly predict depression in Model 3, $b = -0.077$, $p = 0.184$, 95% $CI = [-0.192, 0.037]$. We also generated 5000 bootstrapping samples from the original data set (n = 654). But the indirect effect of loneliness on depression via expressive suppression was not significant, $b = -0.077$, *Boot* 95% $CI = [-0.205, 0.043]$, $p > 0.05$. And loneliness was not significantly associated with expressive suppression, $b = 0.073$, *Boot* 95% $CI = [-0.008, 0.153]$. Therefore, the mediation effect cound not be explained by expressive suppression. Hypothesis 3 was thus supported that only cognitive reappraisal played a mediating role in the relationship between loneliness and depression.

Testing for the Moderated Mediation Effect

To examine the relationship between loneliness, emotion regulation (only cognitive reappraisal), and depression, a moderated mediation model was conducted. We conducted moderated mediation analysis using PROCESS windows (Model 59) in SPSS to examine the proposed model (see **Figure 1**). As shown in **Table 5**, in Model 1, loneliness was significantly related with cognitive reappraisal, $b = -0.305$, $p < 0.001$. Resilience was significantly related with cognitive reappraisal, $b = 0.303$, $p < 0.001$, but it did not play a moderating role in the relationship between loneliness ans cognitive reappraisal, $b = -0.011$, $p = 0.253$. Model 2 indicated that the relationship of loneliness and cognitive reappraisal with depression, respectively, were moderated by resilience. The conditional indirect effect of loneliness on depression via cognitive reappraisal was significant, $b = -0.301$, $p < 0.001$, *Boot* 95% $CI = [-0.388, -0.215]$. The conditional direct effect of loneliness on depression was significant, $b = 0.591$, $p < 0.001$, *Boot* 95% $CI = [0.485, 0.698]$. The conditional indirect effect moderated by resilience was significant, $b = 0.035$, $p < 0.001$, *Boot* 95% $CI = [0.014, 0.055]$. The conditional direct effect moderated by resilience was also significant, $b = -0.031$, $p < 0.001$, *Boot* 95% $CI = [-0.058, -0.005]$. Hypothesis 4 was thus supported.

We plotted depression against cognitive reappraisal separately according to different levels of resilience which was used resilience valued at ± 1SD above and below the mean value (**Figure 2**). The results of the simple slope tests suggested that lower cognitive reappraisal was negatively correlated with higher levels of depression among low resilience participants, $b = -0.49$, $p < 0.05$. However, the result of cognitive reappraisal and depression was not significant among high resilience participants, $b = -0.09$, $p > 0.05$. Cognitive reappraisal was thus negatively correlated with depression among low resilience participants. However, this association was not significant among high resilience participants. The results of Model 2 also indicated that resilience played a moderating role in the relationship between loneliness and depression. We also plotted depression against loneliness separately according to different levels of resilience (**Figure 3**). The results indicated that higher levels of loneliness were positively correlated with higher levels of depression among low resilience participants, $b = 0.72$, $p < 0.001$. However, for high resilience individuals, this effect was still significant, though weaker than the low resilience individuals, $b = 0.46$, $p < 0.01$.

TABLE 3 | Testing the mediation effect of cognitive reappraisal on depression.

Predictors	Model 1 (depression)			Model 2 (CR)			Model 3 (depression)		
	b	SE	t	b	SE	t	b	SE	t
Gender	−0.459	0.492	−0.934	−0.151	0.410	−0.369	−0.514	0.489	−1.096
Age	−0.082	0.136	−0.603	−0.165	0.114	−1.454	−0.142	0.130	−1.092
Loneliness	0.866***	0.054	16.019	−0.426***	0.045	−9.459	0.711***	0.055	12.930
ERQ: CR							−0.364***	0.045	−8.100
R^2		0.283			0.124			0.349	
F		85.643***			30.756***			87.018***	

*ERQ, Emotion Regulation Questionnaire; CR, cognitive reappraisal. ***p < 0.001.*

TABLE 4 | Testing the mediation effect of expressive suppression on depression.

Predictors	Model 1 (depression)			Model 2 (ES)			Model 3 (depression)		
	b	SE	t	b	SE	t	b	SE	t
Gender	−0.459	0.492	−0.934	−1.678	0.331	−5.066	−0.5894	0.501	−1.176
Age	−0.082	0.136	−0.603	−0.165	0.092	0.168	−0.081	0.136	−0.594
Loneliness	0.866***	0.054	16.019	0.073*	0.036	2.017	0.871***	0.054	16.084
ERQ: ES							−0.077	0.058	−1.329
R^2		0.283			0.043			0.285	
F		85.643***			9.666***			64.749***	

*ERQ: Emotion Regulation Questionnaire; ES, expressive suppression. *p < 0.05. ***p < 0.001.*

TABLE 5 | The moderated mediation effect of loneliness on depression.

Predictors	Model 1 (CR)			Model 2 (depression)		
	b	SE	t	b	SE	t
Loneliness	−0.305***	0.049	−6.247	0.591***	0.056	10.547
Resilience	0.303***	0.054	5.604	−0.418***	0.063	−6.644
Loneliness × resilience	−0.011	0.010	−1.144	−0.031**	0.013	−2.383
CR				−0.301***	0.044	−6.805
CR × resilience				0.035***	0.010	3.653
R^2		0.170			0.414	
F		26.554***			65.259***	

*CR, cognitive reappraisal. **p < 0.01. ***p < 0.001.*

The results of bias-corrected percentile bootstrap further indicated that resilience played a moderated role in the relationship between loneliness and depression through cognitive reappraisal. The findings showed that there was a significant indirect relationship between loneliness and depression via cognitive reappraisal among low resilience participants, $b = 0.19$, $SE = 0.04$, 95% $CI = [0.12, 0.27]$. However, this indirect relation was not significant among high resilience participants, $b = 0.07$, $SE = 0.02$, 95% $CI = [0.02, 0.12]$. These results suggested that resilience moderated the path between loneliness and depression and the path between cognitive reappraisal and depression.

In summary, our findings revealed that cognitive reappraisal played a mediating role in the relationship between loneliness and depression and that resilience moderated the association between loneliness and depression while also moderating the impact of cognitive reappraisal on depression.

DISCUSSION

In this study, the results indicated that loneliness positively correlated with depression in young adults and that this relationship was mediated by cognitive reappraisal. Additionally, the moderation effect revealed that resilience buffered (moderated) these relationships during the COVID-19 pandemic. However, inconsistent with our hypotheses on the moderation effect, we only found that resilience moderated the association between loneliness and depression, and moderated the impact of cognitive reappraisal on depression. Overall, our findings broaden our understanding of loneliness and depression (Cindy et al., 2020; Palgi et al., 2020; Rossi et al., 2020; Groarke et al., 2021) and contribute toward research that links depression with resilience (Zhao et al., 2018; Ye et al., 2020; Salah et al., 2021).

FIGURE 2 | The interaction between cognitive appraisal and resilience and its impact on depression.

FIGURE 3 | The interaction between loneliness and resilience and its impact on depression.
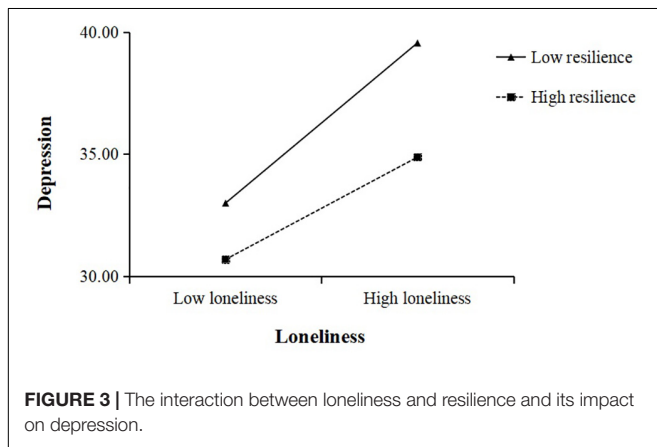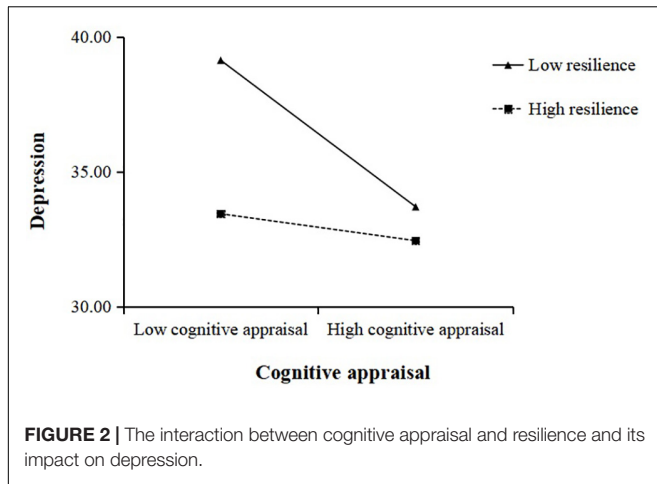
Young adults face a high risk of increased loneliness associated with depression. Our findings were consistent with previous research (Cindy et al., 2020; Palgi et al., 2020; Rossi et al., 2020; Groarke et al., 2021) and indicated that young adults have shown high rates of loneliness during the COVID-19 pandemic (Cindy et al., 2020; Lee et al., 2020; Rhew et al., 2020; Smith and Lim, 2020; Ramo and Lim, 2021). Young adulthood is an important period of cognitive and personality development, and individuals going through this period are vulnerable to mental health problems (Lee et al., 2020; Ramo and Lim, 2021). Loneliness may be one of the worst experiences that young adults encounter, and evidence from different countries indicates that young adults have had the highest increase in rates of psychological distress during the pandemic (Losada-Baltar et al., 2020; McGinty et al., 2020; Pierce et al., 2020; Rossell et al., 2021).

Modeling predictors of depression have identified cognitive reappraisal and resilience as protective factors among young adults. This finding highlights the importance of monitoring cognitive reappraisal and resilience in young individuals. In our study, cognitive reappraisal was found to play a mediating role between loneliness and depression, which indicates that adaptive emotion regulation strategies could be used to reduce perceived loneliness and, subsequently, depression in the context of COVID-19. These findings align with previous studies on

trauma (Nickerson et al., 2015; McRae, 2016). Our study showed that cognitive reappraisal is an effective emotional regulation strategy that could change people's views toward negative events and thus confirmed the cognitive reappraisal theory (McRae, 2016). Therefore, cognitive reappraisal has a mediating impact on emotion in that it allows individuals to assume a positive rather than a negative perspective toward a certain event, which could help them alter their emotional response and promote their mental health (McRae, 2016). In addition, our results also revealed that none of loneliness, depression or resilience in this study was associated with expressive suppression which was consistent with one recent study (Tyra et al., 2021), but inconsistent with prior studies that expressive suppression was significantly associated with higher loneliness (Gubler et al., 2020) and greater depression (Zhang et al., 2021). One possibility was that there was no insufficient time to develop severe depressive symptoms which made the relationship of expressive suppression with loneliness and depression be difficult to be detected at the assessment. Another possibility was that emotion regulation strategies may have different outcomes due to the different situation. At the early stages of the COVID-19 pandemic with very high uncertainty, the assessment may affect by the frequently changing guidelines and restrictions (Wang C. et al., 2020) which could explain why no significant associationwas found between expressive suppression and loneliness or depression.

Our results indicated that resilience is negatively associated with loneliness and depression, which is consistent with previous research findings (Zhao et al., 2018). Thus, resilience and loneliness affect young adults' risk for depression as a result of the COVID-19 pandemic. Young adults with higher levels of resilience experienced lower levels of loneliness and depression because they were able to cope more successfully when faced with the stressors of the COVID-19 pandemic (Kaye-Kauderer et al., 2021). Studies have found that resilience can help individuals manage negative events (Olsson et al., 2003) and remain optimistic (Guo et al., 2018). As hypothesized, resilience moderated the association between loneliness and depression, which is a finding that aligns with previous studies that have focused on adolescents (Fleming and Ledogar, 2008), and improved the participants' responses to negative events (Olsson et al., 2003). As we hypothesized based on the resilience theory (Wang et al., 2015), compensatory factors helped neutralize possible negative effects on mental health, even during the COVID-19 pandemic (Yang et al., 2020). Our study also supported previous research that claims resilience plays an adaptive and compensatory role during times of psychological adversity (Olsson et al., 2003; Wang et al., 2015; Reyes et al., 2019). Therefore, Resilience protects against depression caused by loneliness during the COVID-19 pandemic.

In this study, we constructed and tested a hypothetical model based on the findings of previous studies and theories in order to determine if loneliness can be a risk factor of depression. We also examined the mediating role of cognitive reappraisal and investigated whether resilience moderates the mediation model in the context of the COVID-19 pandemic. Clearly, the

model revealed that young adults can maintain their mental health during the COVID-19 pandemic if they are resilient and use cognitive reappraisal strategies. Resilience is associated with individuals who have the ability to manage stress (Olsson et al., 2003); however, psychological problems that emerge as the result of continuous exposure to traumatic events, such as death anxiety and negative emotions, are still inevitable (WHO, 2020). Therefore, cognitive reappraisal is one of the most effective strategies that young adults can use to address the negative emotional responses that stem from psychological adversity (McRae, 2016).

Resilience as one of potential moderators is supported by many studies (Grossman et al., 2021; Liu et al., 2021; Sylvia et al., 2021). Our results indicated that resilience might play a moderated role in the relationship between loneliness and depression during the COVID-19 pandemic.When people in high levels of loneliness, individuals with high resilience were less prone to depression than those with low resilience. Thus, resilience exerted a clear moderating effect by attenuating the relationships of perceived loneliness on depression. Furthermore, there were individual differences in the effects of cognitive reappraisal strategies on resilience. When cognitive reassessment strategies were less employed, individuals with low resilience were more prone to depression than those with high resilience. But,when individuals with high resilience than those with low resilience adopt more cognitive reappraisal strategies to regulate negative emotion, they had lower levels of depression. Therefore, the findings further indicated that resilience regulated the mediating effect of cognitive reappraisal between loneliness and depression.

This study had several limitations for interpretability of the findings. First, the main aim of our research was to explore the protective factors of the relationship between loneliness and depression in the context of the COVID-19 pandemic. Though our study explains how loneliness is associated with depression and examines the mediating role of cognitive reappraisal, its generalizability is limited because we only focused on Chinese young adults and the impact of COVID-19 on young adults' mental health may vary between different countries and cultures. Second, the results ignored the effects of the participants' distance from COVID-19 outbreak sites, which may have significantly affected the state of their mental health. Third, as a cross sectional study which only offered correlational effect, it could not provide causal relationship among loneliness and depression. It would be necessary to conduct longitudinal study to further examine the causal relationship between loneliness and depression during the COVID-19 pandemic and other trauma event which may develop and lead to mental disorders. Fourth, the effects of these variables before and after the pandemic were not evaluated. This study was conducted during the COVID-19 pandemic, therefore we did not measure the loneliness and depression of the participants before the pandemic. Finally, it was not clear whether the model (see **Figure 1**) was purely driven by loneliness or it's a shared mechanism with loneliness and social anxiety (e.g., hypervigilance to social threats). Previous studies have revealed a high correlation between loneliness and social anxiety (Lim et al., 2016, 2022;

Eres et al., 2021), but we did not examine this relationship in the current study.

Therefore, further investigation should not only use more representative samples and verify the findings, but also should focus more on the different mechanisms of loneliness and social anxiety on affecting others and explicitly measure the effect that COVID-19 pandemic might bring on the variables (e.g., perceived stress directly triggered by the epidemic). Thus, more psychological constructs, such as social anxiety, social support and self-esteem, may be involved in the future studies to better understand how individuals cope with the adverse consequences of COVID-19 and may respond more adaptively in future pandemics.

The current study revealed that the protective factors of cognitive reappraisal and resilience mediate the relationship between loneliness and depression, which was a finding that could have useful clinical implications. Our research indicated that young adults who use cognitive reappraisal more frequently were able to partially mediate the relationship between loneliness and depression. Moreover, we found that the resilience of young adults not only moderates the relationship between loneliness and depression, but also moderates the effect of cognitive reappraisal on depression. Therefore, the protective factors of cognitive reappraisal and resilience have alleviated the impact of loneliness on depression among Chinese young adults during the COVID-19 pandemic. These findings suggested that governments and educational institutions should cooperate with one another in order to confront the issue of deteriorating mental health among young people and provide timely and effective services that could promote adaptability and positive psychological health among this age group. In summary, our findings shed light on the relationship between loneliness and depression and broaden our understanding of how to use protective factors (such as cognitive reappraisal and resilience) to create public health interventions during the COVID-19 pandemic, especially among young adults.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board at San Yat-sen University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FL designed the research, analyzed the data, and drafted the manuscript. MY designed the research and drafted the manuscript. JL collected the data and drafted the manuscript.

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Perceived Peer Relationships in Adolescence and Loneliness in Emerging Adulthood and Workplace Contexts

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Background: A common life-course hypothesis is that negative early-life experiences contribute to poor health in later-life. However, little is known about perceived peer relationships during adolescence and the feeling of loneliness in emerging adulthood. This study explores the perception of adolescent peer relationships in a school context and its association with loneliness in adulthood and in workplace contexts.

Methods: This study used data from a cohort sample of 2,520 adolescents from the Taiwan Youth Project ($N = 2,520$), consisting of eleven waves of data collected from 2000 to 2017. Major measures included the Loneliness Scale (6-item de Jong Gierveld short scale) and perceived peer relationships (classroom cohesion and perceived popularity among classmates) in middle school. Multivariate multinomial logistic regressions were used to estimate the associations of perceived peer relationships during adolescence and workplace characteristics with loneliness in adulthood.

Results: Positive perceived peer relationships in adolescence were significantly related to decreased risk of serious social loneliness [Relative risk ratios (RRR) 0.70, 95% CI: 0.58–0.85] and severe social/emotional loneliness (RRR = 0.76, 95% CI: 0.63–0.91) in adulthood. Workplace satisfaction was a protective factor of severe social/emotional loneliness in employed adults.

Conclusion: Adolescents who perceived peer relationships in middle school as positive were less likely to report social and emotional loneliness during adulthood. Satisfaction in the workplace characteristics was also associated with lower risk of loneliness in adulthood. Theoretical and policy implications are discussed.

Keywords: loneliness, perceived peer relationships, workplace, life course, childhood circumstances, young adults (18–34 yrs), Taiwan youth project

INTRODUCTION

Despite global support for improving the psychological well-being of adolescents over the past few decades, youth psychological well-being, including loneliness, still remains a great concern (Cacioppo and Cacioppo, 2018). In addition to Rook's definition of loneliness as *an enduring condition of emotional distress that arises when a person lacks appropriate social partners for desired activities, particularly for activities that provide a sense of social integration and opportunities for emotional intimacy* (Rook, 1984), loneliness is interpreted as a condition wherein mismatch occurs between personal social needs and perceived social interactions (Rook, 1984; McWhirter, 1990; Schwartz-Mette et al., 2020). Prior studies have found loneliness to be perceived isolation that has negative physical and mental outcomes (Cacioppo and Hawkley, 2009). For instance, research suggests that loneliness may be associated with poor psychological well-being, including self-esteem (Cacioppo et al., 2006; Miller, 2011; Musetti and Corsano, 2021), as well as fatigue and mortality (Davies et al., 2021). Lonely people were found to be more likely to focus on negative cues in their social relationships, which in turn negatively impacts health and leads to a vicious cycle (Cacioppo and Cacioppo, 2018).

A large body of evidence supports the long-term impact of early life experience on psychological outcomes (Hyland et al., 2018; Lin and Chiao, 2020; Musetti et al., 2021b). The adolescent years involve formulating a social identity, which has long been recognized as an important developmental stage and largely determined by a range of influences that includes parents, peers, and school (Musetti et al., 2021a). Adolescence is a critical period that shapes how relationship characteristics, particularly peer relationships, are longitudinally linked to the development of psychological well-being during adult life (Miething et al., 2016), including two domains of loneliness. Emotional loneliness is related to the lack of an intimate relationship such as partner and best friend; social loneliness is referred to as the lack of a broader, engaging social network, including families, relatives, friends, and neighbors (Weiss, 1973). Perception of peer relationships during adolescence is hypothesized to be an important source of developing social relationships as well as affecting loneliness in later life.

Research has identified various factors associated with a range of domains of loneliness (Hyland et al., 2018; Chiao et al., 2019; Lin and Chiao, 2020). These factors include individual socio-economic characteristics, such as age, gender, and work characteristics, partnership status, individual self-esteem (Mund et al., 2020), and family cohesion (Fujimori et al., 2017; Chiao et al., 2019). Relatively few studies have highlighted the importance of perceived peer relationships, popularity among classmates, and academic performance (Mouratidis and Sideridis, 2010; Putarek and Keresteš, 2016; Schwartz-Mette et al., 2020). Accordingly, the role of such relationship factors in adolescence and how they affect loneliness are under-explored. Moreover, little is known about peer influences in school contexts during adolescence and their prospective link to loneliness during young adulthood. This is particularly true in the context of Asian countries, including Taiwan.

The school attachment hypothesis (Dornbusch et al., 2001; Denny et al., 2011) provides a strong theoretical framework for this study. School attachment refers to connectedness between the school environment and its members. Interactions with peers and families in the school environment are proposed to produce cumulative social exposure in a context where the adolescent is growing and living (Dornbusch et al., 2001). Peers in the present study are referred to as classmates and their relationships are likely to have both inhibiting and activating effects on psychological well-being. Due to education policies, each middle-school student in Taiwan has his or her homeroom, in which they spend most of their school hours. Classrooms in middle and high schools thus are an important environment in Asian schools for the development and establishment of peer relationships. The perceived peer relationships in such classroom contexts include peer acceptance and popularity. Class cohesion specifically represents acceptance among classmates (Dornbusch et al., 2001; Denny et al., 2011; Schwartz-Mette et al., 2020).

In their 30s, many individuals are getting married, becoming parents, and developing their careers. From a life course perspective, entrance into employment is an important milestone in adulthood that warrants attention. Yet, there is limited research on work and workplace characteristics and their association with loneliness during adulthood. Studies have suggested that occupational loneliness is not only related to the work context, such as wages, work benefits, and occupational sector, but also to the individual's social environment (Dornbusch et al., 2001; Fernet et al., 2016; Gunes and Bilek, 2020). Social companionship and emotional deprivation at work have been found to be underlying factors for loneliness (Creed and Reynolds, 2001; Wright, 2005). Our study examines if workplace characteristics are associated with loneliness among employed participants.

Prior research has demonstrated that specific indicators of loneliness tend to cluster within certain loneliness domains (Hyland et al., 2018; Chiao et al., 2019; Lin and Chiao, 2020). We have extended this line of inquiry and created a representation of the latent structure of the loneliness during adulthood. Such a latent structure consists of multiple clusters that characterize the underlying relationships of social and emotional loneliness domains. As suggested by prior research, these identified clusters may include non-loneliness, emotional loneliness, social loneliness, and both emotional and social loneliness (Hyland et al., 2018; Chiao et al., 2019). Notwithstanding the above findings, empirical research on loneliness clusters has not adequately explored their associations with perceived peer relationships.

To bridge the knowledge gap, we explore perceived peer relationships during early adolescence and its prospective association with loneliness clusters during emerging adulthood, with a focus on school and workplace contexts. We leverage longitudinal data from a Taiwanese sample to examine two research questions. First, what aspects of perceived peer relationships in adolescence increase the risk of loneliness in young adulthood? We specifically examine classroom cohesion and popularity and their association with loneliness clusters in adulthood. Second, what workplace factors influence employed

young adults' risk of loneliness? We explore how workplace characteristics in adulthood, including workplace satisfaction, work-life balance, and frequency of alcohol consumption on the job, may contribute to loneliness among employed persons. These workplace characteristics are hypothesized to affect social companionship and emotional deprivation at work (Wright, 2005; Wootton et al., 2021). We also explored whether there is a workplace context pathway by which perceived peer relationships in adolescence have an effect on loneliness clusters during adulthood. We proposed the following hypotheses:

H1. Positive perception of peer relationships in adolescence, namely classroom cohesion and popularity among classmates, would be negatively associated with adult loneliness in emotional and social domains.

H2. Supportive workplace characteristics in adulthood, including workplace satisfaction, work-life balance, and less drinking on the job, would be negatively related to adult loneliness among the employed sample.

H3. The association between workplace characteristics and adult loneliness would be conditional on the level of perceived peer relationships in adolescence.

MATERIALS AND METHODS

Participants

The dataset used in this study is from the Taiwan Youth Project (TYP), which recruited a cohort of junior high school students from the 2000 and 2002 classes. These students were 13–15 years old and from Northern Taiwan. The study was initiated in 2000 and had eleven follow-ups in 2001, 2002, 2003, 2005, 2006, 2007, 2009, 2011, 2014, and 2017. The TYP survey used a multi-stage random sampling framework to obtain school-based representative samples of middle school students in Northern Taiwan, including Taipei City, New Taipei City, and Yi-Lan County. Additional details of the sampling design and data collection procedures are described elsewhere (Chiao et al., 2019; Lin and Chiao, 2020).

The TYP surveys provide longitudinal information on a range of school, family and demographic variables from early adolescence to emerging adulthood. To achieve the research objectives, waves of data used were primarily when participants were adolescents (waves 1 and 2 in 2000–2001), and adults in their 30s (wave 12 in 2017). We restricted our analyses to participants with complete responses for the major measures collected in 2017 (wave 12). This yielded an analytical sample of 2,520 young adults and a subsample of 2,287 working adults. We assessed differences in individual characteristics between employed and unemployed samples. Difference in distributions between the total and the employed samples indicated that the employed sample was more likely than the unemployed sample to be male gendered, have a partner, and have a higher level of classroom cohesion and family cohesion.

TABLE 1 | Descriptive characteristics of the total sample and the employed sample of young adults used in this study [percent or mean (Std Dev)], Taiwanese Youth Project.

Variable	Percent or Mean (Std Dev)	
	Total sample	The employed sample
Age (range: 30 - 33)	31.31 (1.20)	31.32 (1.14)
Male (%)	52.82	55.01
Residence (%)		
Taipei City	36.90	37.25
Taipei county	37.74	37.82
Yi-Lan county	25.36	24.92
Individual characteristics in early adolescence (at aged 15)		
Perceived peer relation with classmates		
Classroom cohesion (range: 1 – 4)	2.99 (0.58)	3.00 (0.57)
1. My classmates are always willing to help whenever I need them	3.02 (0.67)	3.02 (0.67)
2. I like to interact with my classmates	3.25 (0.77)	3.27 (0.76)
3. My classmates are close to each other as if we were a family	2.68 (0.80)	2.70 (0.80)
Popularity among classmates (range: 1 – 4)	2.52 (0.85)	2.53 (0.85)
Academic performance (range: 1 – 5)	3.15 (1.21)	3.16 (1.21)
Family cohesion (range: 1 – 4)	2.81 (0.65)	2.81 (0.66)
Feelings of loneliness (%)	45.89	45.47
Self-esteem (range: 1 – 4)	2.69 (0.57)	2.69 (0.57)
Individual characteristics in adulthood (at aged 30s)		
Partner status (%)		
Single, without a partner	33.57	33.58
Has a partner	26.63	27.98
Ever married	39.80	38.43
Work characteristics		
Currently employed (%)	90.97	
Work satisfaction (range: 1 – 4)		2.98 (0.51)
1. Working environment (range: 1 – 4)		3.01 (0.63)
2. Job duty (range: 1 – 4)		3.00 (0.56)
3. Working hours (range: 1 – 4)		2.93 (0.73)
Satisfaction of work benefits (range: 1 – 4)		2.74 (0.59)
1. Compensation/salary (range: 1 – 4)		2.79 (0.71)
2. Employee benefit (range: 1 – 4)		2.85 (0.71)
3. Promotion opportunity (range: 1 – 4)		2.57 (0.75)
Satisfying co-worker (range: 1 – 4)		3.14 (0.54)
Satisfying supervisor (range: 1 – 4)		2.97 (0.70)
Had work at night or on holiday (%)		36.25
Frequency of alcohol drinking on the job (range: 0 – 4)		0.20 (0.55)
Loneliness clustering in adulthood (%)		
Non-loneliness	44.13	44.08
Serious social loneliness	24.80	25.14
Severe emotional/social loneliness	31.07	30.78
N	2,520	2,287

Std Dev = standard deviation. Percentages may not sum to 100 owing to rounding.

The TYP dataset is publicly available and can be used for research with the approval of Academia Sinica in Taiwan.[1] All TYP participants gave informed written consent at the start

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[1] http://www.typ.sinica.edu.tw

of their interviews. The study protocol was approved by the Research Ethics Committee of National Yang Ming Chiao Tung University (Taipei, Taiwan) (IRB Number: YM106103E-2).

Measures

Loneliness Clusters

The outcome variable of loneliness during adulthood was measured by the self-reported 6-item de Jong Gierveld Scale (DJGS), which includes emotional and social dimensions (Weiss, 1973; Rook, 1984; McWhirter, 1990; De Jong Gierveld and Van Tiburg, 2010) in wave 12. The DJGS scale consists of a 3-item emotional scale ("There are plenty of people I can rely on when I have problems," "There are many people that I can count on completely" and "There are enough people that I feel close to") and a 3-item social scale ("I experience a general sense of emptiness," "I miss having people around" and "Often, I feel rejected"). These items have three response categories: "no," "more or less", and "yes." Based on prior studies (Dornbusch et al., 2001; Chiao et al., 2019; Lin and Chiao, 2020), each item was recoded into a dichotomous score, indicating whether subjects were extremely lonely (coded as 1) or not lonely (coded as 0). We further conducted latent class analysis (LCA) to estimate the probabilities of individual young adults clustered in a number of loneliness domains (Hyland et al., 2018; Chiao et al., 2019; Lin and Chiao, 2020). Informed by model fit indices (AIC and BIC), along with conceptual interpretations, the LCA results yielded three mutually exclusive groups: 44% in the non-loneliness group (reference group), 25% in the serious social loneliness group, and 31% in the severe emotional/social loneliness group. Recommended by prior studies (Hyland et al., 2018; Chiao et al., 2019), the non-loneliness group consisted of individuals with an average score within one standard deviation below the sample mean. The group of severe emotional/social loneliness consisted of young adults who were more likely to report social and emotional loneliness. In contrast, the group of serious social loneliness included young adults who were more likely to report social loneliness. The label of *severe* captures greater intensity than the label of *serious* (**Appendix 1**).

Perceived Peer Relationships

The primary predictor variable of perceived peer relationships was operationalized by classroom cohesion and adolescent popularity (waves 1 and 2 in 2000–2001). Classroom cohesion was the average of three items: (1) "My classmates are always willing to help whenever I need them"; (2) "Our classmates are close to one another as if we were a family"; and (3) "I like to interact with my classmates." The respondents rated each item on a 4-point scale, with a higher score representing a more cohesive relationship (Cronbach's α = 0.65) (Yi et al., 2009). Adolescent popularity was assessed by respondents' perceptions of their popularity during middle school. This information was obtained from the question, "Are you worried about not being popular?" Responses were on a 4-point scale, and ranged from strongly disagree to strongly agree. Research suggests that academic performance is related to classroom popularity (Alon, 2009), especially in Asian countries (Yi et al., 2009). We included an academic performance variable operationalized as individual's average academic score in the previous semester. Responses were

categorized ordinally to five categories: top 5 in the class; rank 6–10; 11–20; 20–30; and below 30 in ranking.

Family Background

Family characteristics consisted of family cohesion during adolescence, (waves 1 and 2 in 2000-2001), and choice of partnership during young adulthood (wave 12 in 2017). Family cohesion measure used a self-reported 4-item scale, with a higher score representing stronger family cohesion (Cronbach's α = 0.78) (Yi et al., 2009; Chiao et al., 2019). Choice of partnership during adulthood was grouped into three categories (single without a partner, single with a partner, and ever married).

Psychological Well-Being

Measures of psychological well-being during adolescence included self-esteem and feelings of being lonely when attending middle school in 2000-2001 (waves 1 and 2). Self-esteem was assessed by six items of the Rosenberg's Self-Esteem Scale (Cronbach's α = 0.72) (Rosenberg, 1979). Higher scores represent higher level of self-esteem. Feelings of loneliness were measured by asking adolescents if they had felt lonely during the past two weeks. Responses were dichotomized as slightly serious, serious, and very serious feelings of being lonely (coded as 1)"; and, "no feelings of being lonely (coded as 0)" (De Jong Gierveld and Van Tiburg, 2010; Lin and Chiao, 2020).

Work Characteristics

Workplace characteristics during adulthood were assessed by multiple measures in 2017 (wave 12). Respondents first reported whether they were currently employed. The subjects were then asked about levels of satisfaction about work (work environment, job duties, and working hours), the benefits of their employment (compensation/salary, employee benefits, and promotion opportunities), and work-related social companionship (with co-workers and supervisors). Responses ranged from very dissatisfied (coded as 1) to very satisfied (coded as 4). In addition, the subjects were also asked whether or not they needed to work at night or on holidays (yes/no), and frequency of alcohol drinking for work purposes, ranging from never (coded as 0) to daily (coded as 4). Prior studies have shown that alcohol consumption is significantly related to loneliness (Stickley et al., 2014; Chiao et al., 2019). Yet, little is known about whether alcohol drinking related to work is associated with loneliness. In addition to general workplace characteristics, we also specifically addressed behavioral aspect of work characteristics.

Statistical Analyses

To examine whether perceived peer relationships with classmates in adolescence are longitudinally associated with loneliness during adulthood, we employed a two-part model analysis. The first part assessed whether perceived peer relationships in adolescence were associated with adult loneliness among all 2,520 young adults. We adopted multinomial regression techniques to estimate the likelihood of being within a certain loneliness cluster with respect to perceived peer relationships, academic performance, family cohesion, and other related characteristics.

In the second part of the analysis, we created a subsample of 2,287 employed individuals from the total sample to

determine whether workplace characteristics during adulthood were associated with loneliness, adjusting for perceived peer relationships during adolescence. To explore whether the effect of workplace characteristics on loneliness varied by perceived peer relationship during adolescence, we assessed interactions between workplace contexts and adolescent peer relationships. Statistically significant interactions were included in our final analytical models. All analyses were conducted using STATA 16.0 (STATA Corp., College Station, TX, United States) and were adjusted for sample clustering in the survey design.

RESULTS

Table 1 presents descriptive statistics for the study sample. The average age of participants in 2017was 31.31 years old (std dev = 1.20). About half (52.82%) of the sample were males. The mean scores for classroom cohesion, popularity during adolescence, and academic performance were 2.99, 2.52, and 3.15, respectively.

About 91% of the sample reported currently being employed. Among those employed, the mean score for work satisfaction was 2.98, for benefits was 2.74, for relationships with co-workers was 3.14, and for relationships with supervisors was 2.97. About 36% had to work at night or on holidays, and the average frequency of alcohol drinking related to work was 0.20. Among this sub-sample, 44% experienced non-loneliness, while 25% experienced serious social loneliness and 31% severe emotional/social loneliness.

Factors Associated With the Adult Loneliness Clusters

Our first multinomial logistic regression model examined the association between perceived peer relationships during adolescence and loneliness during adulthood (**Table 2**). The results indicated that a higher level of classroom cohesion was significantly associated with a lower relative risk of serious social loneliness or severe emotional/social loneliness, compared to non-loneliness (RRR = 0.70, 95% CI 0.58–0.85; RRR = 0.76, 95% CI 0.63–0.91, respectively). Adolescent popularity among classmates was not significantly associated with adult loneliness. Compared to non-loneliness, higher academic performance was significantly associated with a lower relative risk of serious social or severe emotional/social loneliness in adulthood (RRR = 0.87, 95% CI 0.80–0.95; RRR = 0.90, 95% CI 0.83–0.98). Feelings of loneliness during adolescence was associated with a higher relative risk of severe emotional/social loneliness in adulthood (RRR = 1.62, 95% CI 1.30–2.01). Higher adolescent self-esteem was associated with a lower relative risk of severe emotional/social loneliness in adulthood (RRR = 0.80, 95% CI 0.65–0.97).

Factors Associated With the Loneliness Clusters Among Employed Adults

The second part of analysis focused on the employed sample. The multivariate multinomial logistic regression model investigated the association between work-related characteristics and experiencing serious social loneliness and severe emotional/social

TABLE 2 | Multivariate multinomial logistic regression results for latent structure of loneliness among young adults, Taiwanese Youth Project (N = 2,520).

Covariate	Loneliness Cluster/Class Contrast	
	Serious Social Loneliness *vs.* Non-Loneliness RRR (95% CI)	Severe Emotional/ Social Loneliness *vs.* Non-Loneliness RRR (95% CI)
Individual characteristics in early adolescence (at aged 15)		
Perceived peer relation with classmates		
Classroom cohesion	0.70 (0.58, 0.85)**	0.76 (0.63, 0.91)**
Popularity among classmates	1.04 (0.91, 1.19)	0.92 (0.80, 1.05)
Academic performance	0.87 (0.80, 0.95)**	0.90 (0.83, 0.98)*
Family cohesion	0.80 (0.67, 0.94)**	0.72 (0.62, 0.84)**
Feelings of loneliness	1.16 (0.92, 1.45)	1.62 (1.30, 2.01)**
Self-esteem	1.12 (0.93, 1.34)	0.80 (0.65, 0.97)*
Individual characteristics in adulthood (at aged 30s)		
Partnership status (ref = Has a partner)		
Single, without a partner	0.89 (0.69, 1.16)	1.99 (1.54, 2.56)**
Ever married	0.71 (0.56, 0.90)**	0.87 (0.68, 1.11)
Currently employed	1.04 (0.74, 1.46)	0.86 (0.62, 1.19)
Age	1.07 (0.98, 1.17)	1.11 (1.03, 1.21)**
Male	1.58 (1.28, 1.95)**	1.49 (1.21, 1.84)**
Residence (ref = Taipei City)		
Taipei county	1.23 (0.98, 1.55)	1.12 (0.90, 1.39)
Yi-Lan county	0.97 (0.75, 1.24)	0.82 (0.65, 1.03)

RRR = relative risk ratio; CI = confidence interval.
*p < 0.05; **p < 0.01.

loneliness. In addition to perceived peer relationships, we included work-related variables, while taking a wide range of individual covariates into account (**Table 3**). Results showed that young adults who were satisfied with their work and related benefits had lower risk of severe emotional/social loneliness. Higher levels of satisfaction with co-workers was associated with lower risk of social loneliness and severe emotional/social loneliness. The higher the frequency of alcohol drinking related to work corresponded with higher risk of serious social loneliness (RRR = 2.30, 95% CI 1.07–4.91). Interestingly, a significant interaction between frequent alcohol drinking related to work and adolescent popularity was observed (RRR = 0.67, 95% CI 0.51–0.88), indicating that young adults who reported a higher level of popularity during adolescence and frequently consumed alcohol for work had a lower risk of serious social emotional loneliness. Among the employed sub-sample, classroom cohesion and family cohesion during adolescence were still associated with loneliness during adulthood.

In addition, having ever been married was associated with a lower risk of serious social loneliness (RRR = 0.74, 95% CI 0.57–0.94). On the other hand, being single was associated with a higher risk of severe emotional and social loneliness (RRR = 1.96; 95% CI 1.50–2.57). Male gender and age were both positively associated with severe emotional and social loneliness (RRR =

TABLE 3 | Multivariate multinomial logistic regression results for work characteristics associated with latent structure of loneliness in employed young people, Taiwanese Youth Project (N = 2,287).

Covariate	Loneliness cluster/Class contrast	
	Serious Social Loneliness vs. Non-Loneliness RRR (95% CI)	Severe Emotional & Social Loneliness vs. Non-Loneliness RRR (95% CI)
Individual characteristics in early adolescence (at aged 15)		
Perceived peer relation with classmates		
Classroom cohesion	0.75 (0.61, 0.94)*	0.75 (0.61, 0.92)**
Popularity among classmates	1.14 (0.98, 1.34)	0.93 (0.79, 1.09)
Academic performance	0.87 (0.79, 0.96)**	0.89 (0.81, 0.98)*
Family cohesion	0.80 (0.67, 0.96)*	0.74 (0.62, 0.87)**
Feelings of loneliness	1.21 (0.96, 1.53)	1.46 (1.12, 1.89)**
Self-esteem	1.13 (0.93, 1.38)	0.83 (0.67, 1.03)
Individual work characteristics in adulthood (at aged 30s)		
Work characteristics		
Work satisfaction	0.79 (0.59, 1.05)	0.53 (0.41, 0.70)**
Satisfaction of work benefits	0.96 (0.75, 1.22)	0.79 (0.63, 0.99)*
Satisfying co-worker	0.64 (0.50, 0.81)**	0.67 (0.53, 0.85)**
Satisfying supervisor	0.94 (0.77, 1.15)	0.86 (0.71, 1.03)
Had work at night or on holiday	1.03 (0.82, 1.28)	0.89 (0.71, 1.11)
Frequent alcohol consumption for work	2.30 (1.07, 4.91)*	1.41 (0.79, 2.51)
Interaction term		
Popularity in early adolescence × Alcohol drinking on the job	0.67 (0.51, 0.88)**	0.89 (0.74, 1.07)
Partnership status (ref = Has a partner)		
Single, without a partner	0.88 (0.67, 1.16)	1.96 (1.50, 2.57)**
Ever married	0.74 (0.57, 0.94)*	0.89 (0.69, 1.16)
Age	1.06 (0.96, 1.16)	1.15 (1.05, 1.25)**
Male	1.63 (1.30, 2.04)**	1.47 (1.16, 1.86)**
Residence (ref = Taipei City)		
Taipei county	1.33 (1.04, 1.69)*	1.18 (0.93, 1.50)
Yi-Lan county	0.95 (0.72, 1.25)	0.90 (0.69, 1.18)

RRR = relative risk ratio; CI = confidence interval.
*p < 0.05; **p < 0.01.

1.47; 95% CI 1.16–1.86 and RRR = 1.15, 95% CI 1.05–1.25, respectively).

DISCUSSION

Using a large community cohort sample in Taiwan, we examined the association between perceived peer relationships in adolescence and loneliness in adulthood. We also investigated how workplace characteristics in adulthood influenced employed young adults' risk of loneliness. Our analysis supports the literature on the existence of three clusters within the

latent structure of loneliness: non-loneliness, serious social loneliness, and severe emotional/social loneliness (Hyland et al., 2018; Chiao et al., 2019; Lin and Chiao, 2020; Schwartz-Mette et al., 2020). In addition, young adults who perceived peer relationships during adolescence as positive, particularly strong classroom cohesion, had a reduced risk of social loneliness and severe social/emotional loneliness during adulthood, independent of academic performance, family background, and other psychological well-being measures, such as depressive symptomatology and self-esteem. This result partly supports the school attachment hypothesis (Dornbusch et al., 2001; Denny et al., 2011), which proposes that positive perceived peer relationships with classmates is likely to exert a protective and profound impact on psychological well-being, such that an individual is less likely to experience social and/or emotional loneliness.

Key life transitions such as graduation from school and entry into the labor market are likely to help guide researchers' understanding of loneliness in social contexts. In workplace contexts, experiences of loneliness will vary among employed young adults. Our analysis supports prior studies (Creed and Reynolds, 2001; Wright, 2005; Gunes and Bilek, 2020), indicating that loneliness clusters are related to various dimensions of work-related characteristics, including work satisfaction, work compensation, work benefits, relationships with colleagues/supervisors, shifts worked, and alcohol consumption for work. Our findings demonstrate that both school and work contexts can influence loneliness in adulthood.

Given the development of perceived social relationships that may arise in school and in the workplace, our results indicate that satisfaction with colleagues is related to a *decreased* risk of serious social loneliness (Creed and Reynolds, 2001; Gunes and Bilek, 2020). We further examined such social relationship construction over the individual's life course by testing the interrelationship between work-related characteristics and peer relationships in school context. Our results showed that employed adults who frequently consumed alcohol for work were more likely to experience serious social loneliness, adjusting for individual characteristics. This association may suffer from reverse causality, namely that being socially lonely leads to more alcohol drinking related to work. Notwithstanding causality, this is consistent with the hypothesis that alcohol consumption and loneliness are linked (Chiao et al., 2019; Wootton et al., 2021). However, among young adults who reported higher levels of popularity during early adolescence, drinking alcohol for work was not associated with social loneliness. Our findings suggest that alcohol drinking for work can have negative consequences for individuals' mental health, namely, social loneliness, but can be buffered by healthy relationships in other contexts. Taiwan, similar to other East Asian countries such as Japan and South Korea, has an alcohol-drinking culture that is linked to work. This common *work tradition* remains a social norm that potentially impacts young adults' mental health, particularly loneliness, in East Asian cultures.

Employed adults who were satisfied with their job, work compensation and benefits, were less likely to report severe

emotional/social loneliness, underscoring the critical role that work satisfaction plays in experience of loneliness (Creed and Reynolds, 2001; Gunes and Bilek, 2020). Our findings also demonstrated that those who were ever married were less likely to report social loneliness compared to single adults. Specifically, single adults were more likely to report severe emotional/social loneliness, corroborating evidence for the role that social relationships play in influencing poor mental health outcomes (Chiao et al., 2019).

Interestingly, we found a gender difference in loneliness clusters. Young men were more likely than young women to report serious social loneliness during adulthood and severe emotional/social loneliness (Miething et al., 2016; Putarek and Keresteš, 2016). This suggests that men and women have a different propensity for the multiple domains of loneliness during adulthood, whereby Taiwanese men seem to be more likely than Taiwanese women to experience emotional and social loneliness during adulthood. More research is needed to explore the social, cultural, and emotional implications of gender differences in loneliness, particularly in Taiwanese society. On the other hand, status attainment theories (Blau and Duncan, 1967; Duncan, 1968) propose a causal inference on parental or early personal status and occupation in later life via macrosocial processes such as industrialization, which could be another possible social mechanism for gender differences.

There are several limitations to our study. First, attrition is important to note in this 17-year follow-up study. Attrition analysis suggested significant differences between the lost-to-follow-up (LTFU) respondents and this study's analytical sample in terms of age, gender, and background school related factors. Firstly, subjects in the LTFU group were more likely to being older, female, and to have reported lower levels of perceived peer relationships during early adolescence. Accordingly, the association between perceived peer relationships and adult loneliness may have been underestimated. Secondly, most of the measures were self-reported, which may have been influenced by recall bias or social desirability bias. Nevertheless, the de Jong Gierveld loneliness scale did not use the term "loneliness" in its questions, the use of which may reduce the social desirability of certain answers and be associated with negative stigma. The third limitation is the use of secondary data. Information to construct loneliness clusters was only available during emerging adulthood. Future research is needed to better understand how loneliness clusters change over time and are influenced by peer relationships in adolescence. Longitudinal data on loneliness is needed to conduct a latent transition analysis model. Lastly, the sample is from Northern Taiwan and thus may not be representative of all Taiwanese youth.

CONCLUSION

To our knowledge, this is a unique study on loneliness that examines a non-Western society where school and work lives occupy more than two-thirds of daily life throughout an individual's life course. In this context, we investigated the linkage between perceived peer relationships in a school context and in the adult work environment with a latent structure of loneliness. The longitudinal data provide possible causal links between perceived peer relationships in a school context during adolescence and loneliness clusters during young adulthood. Based on a life-course perspective, our findings further suggest that the association between adult alcohol consumption for work and the risk of social loneliness depends on the individual's level of popularity during adolescence. Our results underscore the need for understanding specific life-course factors that are associated with various domains of loneliness in order to identify appropriate interventions and policies to prevent loneliness and promote mental and social well-being (Pitman et al., 2018).

Several research questions arise from our study for future research: To what degree is poor satisfaction with workplace characteristics related to loneliness from a life course perspective? Are factors related to being in one loneliness cluster versus another similar for various family socioeconomic status groups and/or various social networks? To what degree is loneliness shaped in work contexts by levels of perceived peer relationships during adolescence? In addressing the above questions, studies will need to consider the endogeneity and reciprocal causation that may exist between work-related characteristics and the loneliness clusters.

DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee of National Yang Ming Chiao Tung University (Taipei, Taiwan) (IRB Number: YM106103E-2). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

CC was responsible for development of the study hypotheses, data analysis, critical revision, and finalizing of the manuscript. K-CL was responsible for development of the study hypotheses, data analysis, and drafting the manuscript. LC contributed to critical revision. All authors were involved in the writing of the manuscript, and approved the final submission.

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APPENDIX

Appendix 1 | Latent class analysis (LCA) for conditional probabilities for the three-cluster model of loneliness among young adults using the 6-item de Jong-Gierveld short scale.

	Latent class		
Indicator of loneliness item	Non-loneliness	Serious social loneliness	Severe emotional and social loneliness
1. There are plenty of people I can rely on when I have problems.	0.14	0.87	0.84
2. There are many people I can trust completely.	0.10	0.94	0.87
3. There are enough people I feel close to.	0.19	0.85	0.87
4. I experience a general sense of emptiness.	0.37	0.14	0.99
5. I miss having people around.	0.77	0.65	0.94
6. I often feel rejected.	0.25	0.28	0.71
Latent class probabilities	0.44	0.25	0.31

Model	L^2	df	p-value	BIC	AIC
One-cluster model	2563.15	57	< 0.01	20008.44	19973.42
Two-cluster model	527.67	50	< 0.01	18027.81	17951.95
Three-cluster model	199.44	43	< 0.01	17754.44	17637.72

AIC = Akaike's information criterion; BIC = Bayesian information criterion.

Effects of COVID-19-Related Anxiety and Sleep Problems on Loneliness and Feelings of School Refusal in Adolescents

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Background: COVID-19-related anxiety, sleep problems, and loneliness may be risk factors for school refusal in children and adolescents. However, few studies have examined the mechanisms by which these risk factors cause school refusal. This study examined the process by which COVID-19-related anxiety, sleep problems, and loneliness cause school refusal, using structural equation modeling.

Methods: In this cross-sectional questionnaire-based study, 256 (109 male, 147 female, mean age: 15.37 ± 0.48 years) senior high school students were asked to complete the Stress and Anxiety associated with Viral Epidemics-6 questionnaire to assess COVID-19-related anxiety, the Athens Insomnia Scale (AIS), Sleep Debt Index (SDI), and chronotype (MSFsc) to assess sleep problems, the Three-Item Loneliness Scale (TILS) to assess loneliness, and Feelings of School-Avoidance Scale (FSAS) to assess school refusal.

Results: Structural equation modeling showed that sleep problems affected loneliness ($\beta = 0.52$) and feelings of school refusal ($\beta = 0.37$), and that loneliness affected feelings of school refusal ($\beta = 0.47$). There was no significant pathway of COVID-19-related anxiety on sleep problems, loneliness, or feelings of school refusal. The indirect effect of sleep problems on feelings of school refusal through loneliness was significant. The results of hierarchical multiple regression analysis showed that AIS ($\beta = 0.30$) and SDI ($\beta = 0.13$) scores were associated with TILS, and AIS ($\beta = 0.26$) and MSFsc ($\beta = -0.14$) scores were associated with FSAS scores.

Conclusion: The findings of this study showed that sleep problems affected feelings of school refusal *via* both direct and indirect pathways through the exacerbation of loneliness. To prevent school refusal in adolescents, addressing the indirect pathway *via* loneliness could be effective in improving insomnia and sleep debt, while addressing the direct pathway could be effective in improving insomnia and chronotype.

Keywords: chronotype, COVID-19, insomnia, loneliness, school refusal, sleep debt

INTRODUCTION

Continued absence from school, that is, school refusal, is a serious problem that has significant short- and long-term consequences, such as worsening of peer relationships, poorer academic achievement (1, 2), early school leaving, and later unemployment and health problems (3–5).

In Japan, prolonged school absenteeism (≥30 days per year), excluding those caused by illness and financial reasons, is defined as school refusal. The number of Japanese children with school refusal has increased over eight consecutive years (6). In 2020, it was reported that the number of students per 1,000 students in elementary school, junior high school, and senior high school who demonstrated school refusal was 10, 41, and 14, respectively. However, the rate of return to school has been decreasing over the years. Over 98% of Japanese children go to senior high school (6), and graduation from senior high school has become almost the minimum requirement for a young Japanese person to obtain employment (7). Therefore, school refusal tends to hinder career options and social independence.

Several issues, such as anxiety, loneliness, and sleep problems, are associated with school refusal. It has been reported that children with school refusal may suffer from significant overt anxiety symptoms such as fears of separation, tests or teachers, or transition (5). Recently, approximately 12% of Japanese students avoided going to school due to anxiety about the coronavirus disease 2019 (COVID-19) infection (COVID-19-related anxiety) after COVID-19 pandemic (6). Loneliness is also a factor associated with school refusal. A previous multi-regression analysis showed that loneliness was associated with feelings of school refusal ($\beta = 0.24$) among adolescents (8).

Of sleep problems, insomnia, chronotype (an individual's preference for sleep timing), and sleep debt (chronic short sleep duration due to sleep restriction or sleep deprivation) are associated with school refusal (9–11). For example, children suffering from insomnia (sleep onset problems, difficulties maintaining sleep) showed significantly higher scores in school refusal behavior than did children without sleep problems (9). In addition, expanded sleep duration (i.e., elimination of sleep debt) through sleep education may lead to a reduction in the number of children with school absenteeism (11).

The relationships among anxiety, loneliness, and sleep problems have been also reported in previous studies (12–14). A systematic review and meta-analysis showed that loneliness is correlated with self-reported sleep problems (12). Hom et al. (15) conducted six studies on the relationship between sleep problems and loneliness. These studies showed that the bivariate association between insomnia and loneliness was significant and moderate in magnitude, and that these relationships were stronger in younger participants (15). Furthermore, Lack of sleep leads to a behavioral profile of social withdrawal and loneliness (16), and insomnia affects suicidal ideation *via* loneliness (17).

In addition, an association between sleep problems and loneliness was shown to be strong among individuals with more COVID-19-related anxiety (13). Recently, it was revealed that COVID-19-related anxiety contributes to increased insomnia, depression, and anxiety (14, 18). In previous studies before

COVID-19 pandemic, sleep debt and insomnia were associated with anxiety symptoms, but chronotype was not (19–21).

Thus, COVID-19-related anxiety, sleep problems, and a higher level of loneliness may be risk factors for school refusal among children and adolescents. However, few studies have examined the mechanisms by which these risk factors cause school refusal. This study aimed to examine the following process model using structural equation modeling (SEM; **Figure 1**): COVID-19-related anxiety affects sleep problems, loneliness, and feelings of school refusal; sleep problems affect loneliness and feelings of school refusal; and loneliness affects feelings of school refusal.

MATERIALS AND METHODS

This study was approved by the Ethics Committee of Tokyo Kasei University (ID: Ita-E2021-15). All study participants provided their informed consent to take part in this study, in accordance with the Declaration of Helsinki.

Participants

The data analyzed in the in-person-survey were collected from July to August 2021. The study sample comprised 277 students from a public senior high school in Kanagawa Prefecture. Of these students, 256 (109 male, 147 female, mean age: 15.37 ± 0.48 years) students who had completed the following measures and who had a sleep debt index (SDI) score of zero or more (22) were selected and analyzed.

Measures
Demographic Data
The participants were asked to provide their age and sex.

COVID-19-Related Anxiety
The Stress and Anxiety associated with Viral Epidemics-6 (SAVE-6) is a validated 6-item self-report questionnaire that assesses anxiety and distress in response to viral epidemics (14, 23). The scores for the SAVE-6 in relation to the COVID-19 pandemic were summed, with higher scores indicating greater anxiety and distress.

Sleep Problems
To measure sleep problems, we used the Athens Insomnia Scale (AIS) for insomnia, the sleep-corrected Midpoint of Sleep on Free days (MSFsc) for evaluating chronotype, and the Sleep Debt Index (SDI) to assess sleep debt.

The AIS is a validated 8-item self-report questionnaire that assesses insomnia severity (24–26). The AIS score was summed, with higher scores indicating more severe insomnia. A cut-off score of 5.5 points for AIS was previously determined; therefore, in the present study, respondents with AIS scores of ≥6 were considered to have clinical insomnia.

The SDI and MSFsc were measured by self-reported responses to the following seven questions: (1) How long do you sleep at night during weekdays? (2) How long do you sleep on the weekend? (3) Considering your own "feeling best performance" rhythms, for how long would you sleep if you were entirely free

FIGURE 1 | Structural equation modeling of hypothesized model.
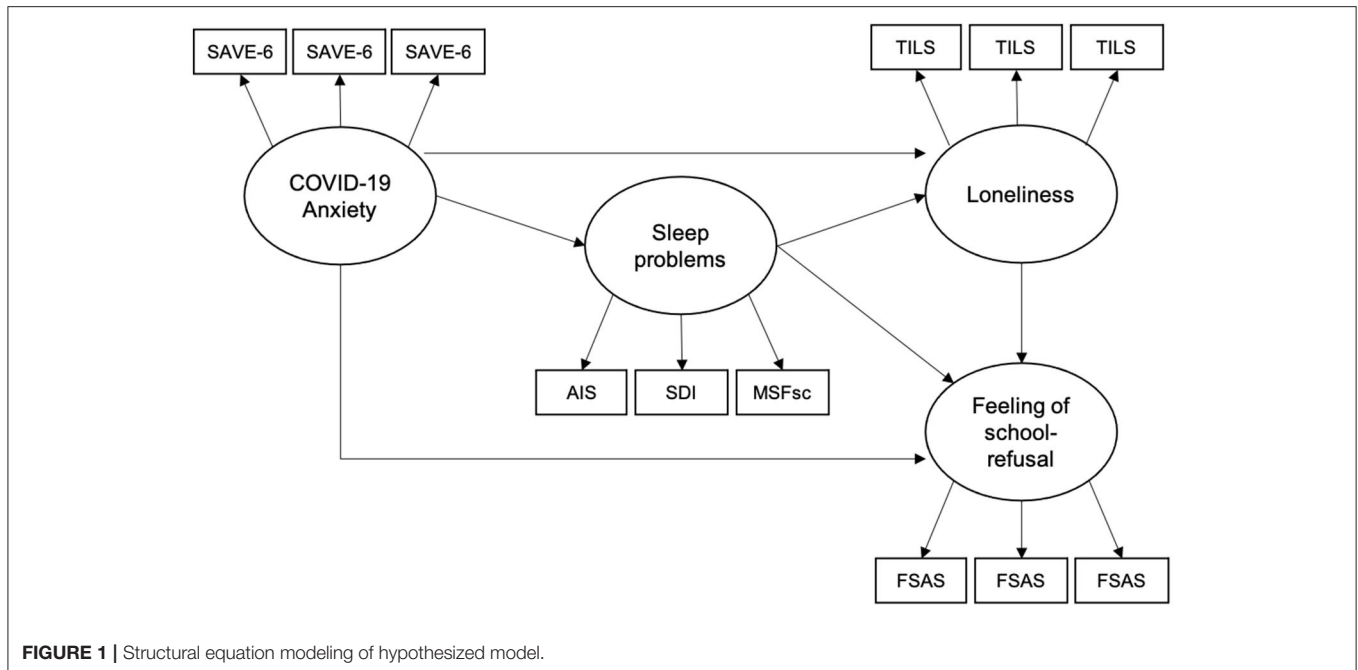
for the day? (4) What time did you get up on weekdays in the last month? (5) What time did you get up on weekends in the last month? (6) What time did you fall asleep on weekdays in the last month? (7) What time did you fall asleep on weekends in the last month? SDI and MSFsc values were calculated as previously described (22, 27). A higher score for SDI indicated more sleep debt and a higher score for MSFsc indicated a delayed sleep phase.

Loneliness

The Three-Item Loneliness Scale (TILS) is a validated three-item self-report questionnaire that assesses loneliness (28, 29). The score for the TILS was summed, with higher scores indicating more severe loneliness.

Feelings of School-Refusal

Feelings of school refusal were measured using the Feelings of School-Avoidance Scale (FSAS), "aversion to attending school" (30). The subscale consists of six items, such as "I want to miss school" and "I want to go home as soon as classes are over," where higher scores indicate stronger aversion to attending school. The alpha coefficient was 0.81, and criterion-related validity was confirmed for social support, self-esteem, and trait anxiety.

Model Setting

We hypothesized the following model: COVID-19-related anxiety affects sleep problems, loneliness, and feelings of school refusal; sleep problems affect loneliness and feelings of school refusal; and loneliness affects feelings of school refusal (**Figure 1**). The model was set with COVID-19-related anxiety, sleep problems, loneliness, and school refusal as latent variables. All latent variables consisted of three observed variables with high factor loads, except for sleep problems. Sleep problems consisted

of the AIS, SDI, and MSFsc scores. Error variances were omitted from the model. SEM was performed to confirm the accuracy of the hypothesized model.

Statistical Analysis

Data were analyzed using SPSS and AMOS Graphics version 26.0 (IBM Inc., Tokyo, Japan). Pearson product-moment correlation analyses were conducted to examine the relationships between the SAVE-6, AIS, SDI, MSFsc, TILS, and FSAS scores. In general, an r value of $>.1$ was taken to indicates a small effect size, a value $>.3$ to indicate a moderate effect size, and a value $>.5$ to indicate a large effect size (31).

Structural equation modeling was performed to confirm the accuracy of the hypothesized model. We evaluated the following fit indices: chi-square (χ^2), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). These are absolute fit indices, and it is suggested that these indices should be reported at a minimum (32, 33). A good model fit of χ^2 provided an insignificant result at a threshold of 0.05. However, when large samples are used, the χ^2 statistic is essentially a statistical significance test that is sensitive to sample size, meaning that the χ^2 statistic nearly always rejects the model (32). GFI, AGFI, and CFI can range between 0 and 1, and the closer the values are to 1, the better is the fit of the model. When the SRMR and RMSEA values were $\leq.08$, the indices indicated that the model fits well (32, 33).

We used bias-corrected bootstrapped estimates (34) to examine whether sleep problems mediated the relationship between COVID-19-related anxiety and loneliness, and whether loneliness mediated the relationship between sleep problems and school refusal. These estimates are robust to deviations from

TABLE 1 | Descriptive variables of measures.

	Mean	SD
SAVE-6	7.26	4.68
MSFsc	3.82	1.61
SDI	1.31	0.83
AIS	4.82	2.69
TILS	1.20	1.50
TSAS	4.64	3.64
Weekday		
Sleep-onset-time (h:m)	0:25	1:06
Wake-up-time (h:m)	6:23	0:37
Total sleep time (h)	6.33	0.79
Weekend		
Sleep-onset-time (h:m)	0:14	1:17
Wake-up-time (h:m)	7:52	1:33
Total sleep time (h)	7.53	1.21

AIS, Athens Insomnia Scale; FSAS, Feelings of School Avoidance Scale; MSFsc, sleep-corrected mid-sleep time on free days; SAVE, stress and anxiety to viral epidemics; SD, standardized deviation; SDI, Sleep Debt Index; TILS, Three-Item Loneliness Scale.

TABLE 2 | Correlation between the scales.

	MSFsc	SDI	AIS	TILS	FSAS
SAVE-6	0.08	−0.03	0.07	0.20**	0.16**
MSFsc		−0.26**	−0.13*	−0.05	−0.22**
SDI			0.27**	0.19**	0.21**
AIS				0.33**	0.43**
TILS					0.49**

AIS, Athens Insomnia Scale; FSAS, Feelings of School Avoidance Scale; MSFsc, sleep-corrected mid-sleep time on free days; SAVE, stress and anxiety to viral epidemics; SDI, Sleep Debt Index; TILS, Three-Item Loneliness Scale.
*p < 0.05.
**p < 0.01.

normality of indirect effects (35, 36). We chose 10,000 bootstrap samples, as recommended in the recent resampling literature, to improve the Monte Carlo accuracy (37). The mediators were significant if the 95% bootstrapped confidence interval (CI) did not include zero.

Finally, hierarchical multiple regression analysis adjusted for age and sex was conducted to determine which sleep problems, insomnia (AIS), sleep debt (SDI), and chronotype (MSFsc) were associated with loneliness and feelings of school refusal. In general, an R^2 value of >.02 was taken to indicates a small effect size, a value >.13 to indicate a moderate effect size, and a value >.26 to indicate a large effect size (31).

RESULTS

The means and standard deviations of the scores are presented in **Table 1**. Correlation analysis showed that the TILS was significantly small to moderate correlated (r) with the SAVE-6 ($r = 0.20$, $p < 0.001$), SDI ($r = 0.19$, $p < 0.001$), AIS ($r = 0.33$,

$p < 0.01$), and FSAS ($r = 0.49$, $p < 0.001$), and that FSAS was significantly small to moderate correlated with SAVE-6 ($r = 0.16$, $p < 0.001$), MSFsc ($r = −0.22$, $p < 0.001$), SDI ($r = 0.21$, $p < 0.001$), and AIS ($r = 0.43$, $p < 0.001$; **Table 2**).

The result of SEM showed that the hypothesized model had a relatively good fit ($\chi^2_{48} = 104.146$, $p < 0.001$, GFI = 0.937, AGFI = 0.897, CFI = 0.945, SRMR = 0.053, RMSEA = 0.068; see **Figure 2**). The results also showed that sleep problems affected loneliness ($\beta = 0.52$, 95% CI: 0.34 to 0.70, $p < 0.001$) and feelings of school refusal ($\beta = 0.37$, 95% CI: 0.15 to 0.64, $p < 0.01$), and loneliness affected feelings of school refusal ($\beta = 0.47$, 95% CI: 0.19 to 0.62, $p < 0.01$; **Figure 2**).

There was no significant pathway for COVID-19-related anxiety affecting sleep problems ($\beta = 0.01$, 95% CI: −0.20 to 0.20), loneliness ($\beta = 0.15$, 95% CI: −0.004 to 0.31), or feelings of school refusal ($\beta = 0.04$, 95% CI: −0.01 to 0.19). The indirect effects of sleep problems on feelings of school refusal due to loneliness were significant (95% CI: 0.13 to 0.38).

The results of hierarchical multiple regression analysis showed that AIS ($\beta = 0.30$, $p < 0.001$) and SDI ($\beta = 0.13$, $p = 0.08$) were associated with TILS ($R^2 = 0.18$, $p < 0.001$), whereas AIS ($\beta = 0.26$, $p < 0.001$) and MSFsc ($\beta = −0.14$, $p = 0.01$) were associated with FSAS ($R^2 = 0.24$, $p < 0.001$; **Table 3**).

DISCUSSION

The purpose of this study was to examine the following process model using the SEM: COVID-19-related anxiety affects sleep problems, loneliness, and feelings of school refusal; sleep problems affect loneliness and feelings of school refusal; and loneliness affects feelings of school refusal.

There were significant correlations between the scales for COVID-19-related anxiety, sleep problems, loneliness, and feelings of school refusal. These findings were consistent with those of previous studies (9–14). It has been suggested that sleep problems are associated with aversion to loneliness and with feelings of school refusal. On the other hands, COVID-19-related anxiety was not correlated with sleep debt and insomnia as well as chronotype. Previous studies reported both sleep debt and insomnia were associated with anxiety symptoms (20, 21). The COVID-19-related anxiety and traditional anxiety symptoms (e.g., state–trait anxiety) might have different status.

Structural equation modeling showed that the hypothesized model fit well. Unlike previous studies (14, 18), this study revealed that COVID-19-related anxiety did not affect sleep problems, loneliness, or school refusal. The participants in previous studies (14, 18) were from the general population (age range: 13–90 years) or healthcare workers, including medical institutions designated for treating patients with COVID-19. Therefore, sleep in adolescents may not be aggravated by COVID-19-related anxiety. In addition, a previous report that suggested that students in Japan avoided going to school due to COVID-19-related anxiety (6), was conducted early during the COVID-19 pandemic. The present study was conducted approximately 19 months after the first reported case of COVID-19 in January 2020. This implies that the association
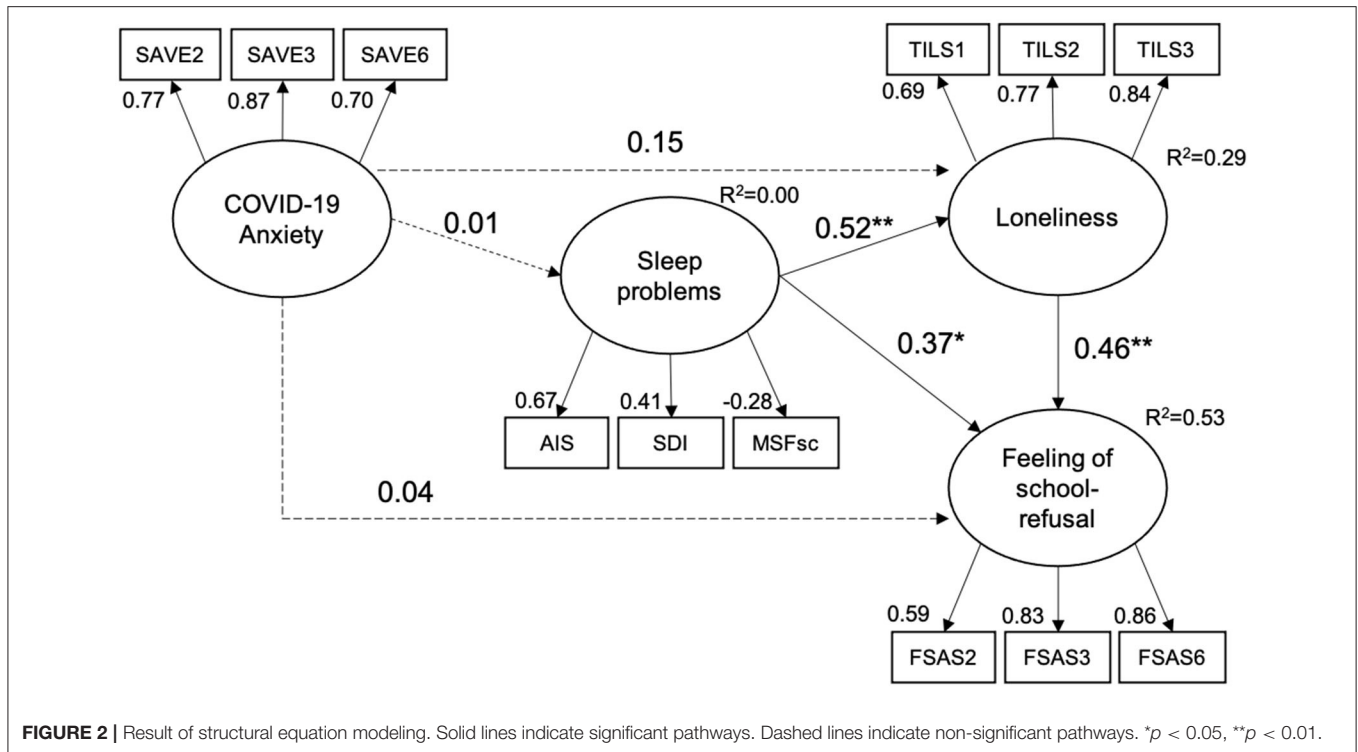
FIGURE 2 | Result of structural equation modeling. Solid lines indicate significant pathways. Dashed lines indicate non-significant pathways. *$p < 0.05$, **$p < 0.01$.

TABLE 3 | Results of hierarchical multiple regression analysis.

	Loneliness			Feelings of school-refusal		
	β	t-Value	p-Value	β	t-Value	p-Value
MSFsc	0.02	0.00	n.s.	−0.14	−2.51	0.01
SDI	0.13	1.74	0.08	0.02	0.35	n.s.
AIS	0.30	4.74	<0.001	0.26	4.64	<0.001
R^2	0.18		<0.001	0.24		<0.001

AIS, Athens Insomnia Scale; MSFsc, sleep-corrected mid-sleep time on free days; SDI, Sleep Debt Index. n.s., not significant.
Adjusted for age and sex.

between COVID-19-related anxiety, sleep, loneliness, and school refusal in adolescents may have changed during the course of the pandemic.

No previous study has shown that sleep problems affect school refusal by both a direct and an indirect pathway through exacerbation of loneliness. Maeda et al. (11) showed that a sleep education program for primary school students successfully achieved a more routine nighttime sleep pattern and a regular life rhythm, which prevented school refusal during subsequent junior high school years. Therefore, sleep-enhancing interventions, such as sleep education, may be effective in preventing loneliness and school refusal among high school students with sleep problems. In addition, among sleep-related factors, insomnia commonly affected loneliness and school refusal. On the other hand, sleep debt is likely to affect loneliness only, while chronotype affects school refusal only. In this light, as prevention of school refusal in adolescents, an indirect pathway approach *via* loneliness could be effective in improving insomnia and sleep debt, while a direct pathway approach could be effective in improving insomnia and chronotype.

Recently, cognitive behavior therapy for insomnia (CBT-I) has been effective for adolescents or young adults with insomnia (38, 39), and CBT-I plus bright-light therapy has been effective for adolescents with a chronotype of delayed sleep-wake phase (40). However, to the best of our knowledge, no effective CBT approach has been developed to improve sleep debt. Besides sleep problems, perceived social support has also been associated with loneliness (41). To prevent loneliness and school refusal, a comprehensive CBT approach targeting sleep problems and social support should be developed.

This study had some limitations. First, this cross-sectional study could not identify a causal relationship among COVID-19-related anxiety, sleep problems, loneliness, and school refusal. To clarify this, future prospective follow-up studies are needed to evaluate the influences of COVID-19-related anxiety and sleep problems on longitudinal changes in loneliness and school refusal. The participants in this study were from a public senior high school. To ensure generalizability, future research should be conducted on senior high school students nationwide. Finally, we measured the symptoms solely using self-reported scales and limited sociodemographic data. Using objective sleep measures and other sociodemographic data such as intelligence quotient or academic achievement, social isolation, family history, or economic status in future studies may help to illuminate specific sleep variables that contribute to worsening loneliness and school refusal.

CONCLUSION

The findings of this study revealed that sleep-related factors, such as insomnia, sleep debt, and chronotype, may trigger loneliness and school refusal among adolescents. Although the present study was conducted on senior high school students, it is necessary to examine whether this model, with direct and indirect pathways, can also be applied to elementary and junior high school students.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Tokyo Kasei University (ID: Ita-E2021-15). Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

IO: conceptualization, funding acquisition, methodology, project administration, and roles/writing—original draft. YH: conceptualization and investigation. OS, YK, and YT: investigation and project administration. All authors contributed to the article and approved the submitted version.

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Social Support and Depressive Symptoms Among Adolescents During the COVID-19 Pandemic: The Mediating Roles of Loneliness and Meaning in Life

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Identifying which factors influence depressive symptom during the COVID-19 pandemic is highly significant for psychological crisis interventions among adolescents. Social support is likely to be one of the main factors. However, the underlying mechanism is still not well understood in the context of COVID-19. The current study examines whether loneliness and meaning in life mediate the association between social support and depressive symptoms in adolescents. A sample of 1,317 high school students in China were surveyed using the Perceived Social Support Scale, the Chinese Child Loneliness Scale, the Meaning in Life Questionnaire, and the Beck Depression Inventory-II. The results showed that social support predicted depressive symptoms directly and indirectly by enhancing loneliness and diminishing the sense of meaning in life. These findings help in providing new entry points in the design of effective depression prevention and intervention for adolescents during the COVID-19 pandemic.

Keywords: social support, loneliness, meaning in life, depressive symptoms, adolescents

INTRODUCTION

The current COVID-19 pandemic has had global consequences with its high rate of infection and low predictability affecting the mental health of the public, particularly with regard to depression. Depressive symptoms have increased during the pandemic compared to periods before the outbreak (1). Moreover, most mental health problems associated with this outbreak are persistent (2). Thus, increased levels of depression has become a significant psychological crisis during the COVID-19 outbreak.

Therefore, COVID-19 crisis poses a pervasive threat to the overall health of all populations. However, the effect of the global pandemic on adolescents of great concern. Given that adolescence is a transitional and critical period in human development, poor mental health can compromise adolescents' developmental potential. However, during this period, adolescents seem especially sensitive to traumatic and stressful events, thereby leading to depression (3). For instance, a recent cross-sectional study found the prevalence of depression to be 43.7% among Chinese adolescents during the COVID-19 outbreak (4). Moreover, with the development of the pandemic, the results of two large-scale surveys has showed that the prevalence was increasing (5). In line with this, the possibility of the pandemic's continuing impact on depression suggests the importance of understanding the underlying mechanisms of pandemic-related depression in order to tailor interventions.

COVID-19 is a public health emergency that has caused great harm to the physical and mental health of the public and requires urgent risk management. As a country with a collectivism culture background, social support is a common risk management model in China. Research shows that social support plays a positive role in economic risk management, special group risk management and disease risk management (6, 7). Social support has been shown to be a protective factor for mental and physical health problems (8), helping to reduce negative emotions and the likelihood of mass incidents in public (9). COVID-19 is a national, public event with the potential for infection and death that may be beyond the scope of normal risk management. Therefore, the mechanism of the impact of social support on adolescents' mental state in the context of the pandemic needs to be explored further, which will provide reference for the pandemic-induced mental health recovery strategy.

Social support has been broadly conceptualized as the degree to which people in our social networks are responsive to our needs in the present and perceived to be responsive in the future (10). Social support includes received and perceived social support. Received social support refers to the amount of support received while perceived social support refers to its adequacy and availability (11). Research has shown that perceived social support is more closely related to mental health than received social support (12). The main-effect hypothesis argues that social support plays a role of universal gain in maintaining positive emotional experiences and mental conditions of individuals (13). Social support has been shown to be a protective factor for mental and physical health problems; lower levels of social support were more likely to lead to depressive symptoms (14). The more social support an individual receives or perceives to receive, the better they can manage sources of stress and deal with negative events. Therefore, this study proposes the following hypothesis:

Hypothesis H1: Social support is negatively associated with depressive symptoms among high school students during COVID-19.

Before the COVID-19 outbreak, researchers had used different groups to explore mediating variables between social support and depression. For example, in clinical patients, hopelessness (15), optimism (16), coping strategies (17), and self-efficacy (18) have been proved to play a mediating role between social support and depressive symptoms. In addition, self-esteem (19) and positive emotions (20) also mediated the relationship between social support and depressive symptom in adolescents. Dalian is one of the most seriously affected cities by the COVID-19 outbreak in China. It has suffered five major outbreaks since 2019. To control the outbreak, Dalian was locked down on November 9, 2021. By the time of investigation, students in Dalian have been studying at home for more than 10 days. However, due to the severity of the pandemic and the policy of home isolation, the learning environment and lifestyle of adolescents have undergone major changes, which may further aggravate the adverse effects on mental health (21). The existing mediating variables may not be able to properly explain the relationship between social support and depression based on the pandemic context.

Loneliness is the absence of imperative social relations and lack of affection in current social relationships (22). During the pandemic, governments implemented home isolation and home-schooling policies, isolating groups from previously available resources. Here, the sudden reduction in social networks may have contributed to loneliness, causing increased likelihood of loneliness among students. It should be noted that, loneliness can be reduced by social support through good social relationships. Research shows that the less support given by parents, teachers and peers, the more likely high school students are to feel lonely (23). Therefore, social support is negatively correlated with loneliness.

The Evolutionary Theory of Loneliness (ETL) suggests that social connections protect animals from hunting and resource scarcity (24). If a person becomes socially isolated, he or she will be deprived of the protection that society brings. In order to promote self-protection, individuals focus excessively on social threats. This focus bias perpetuates loneliness by creating more negative social expectations in individuals, leading to self-defeating social behaviors. In the long term, this self-reinforcing loop of loneliness may cause increased physical and mental health risks. Thus, ETL predicts that loneliness can has negative effects on physical and mental health. Therefore, in the current outbreak, loneliness may help establish a link between social support and depression. Accordingly, this research proposes the following hypothesis:

Hypothesis H2: Loneliness plays a mediating role between social support and depression symptom among high school students.

Meaning in life is defined as the strength and intensity of the efforts made by people to understand and enhance the meaning, importance, and purpose of their lives, including the presence meaning in life and search for meaning in life (25). According to Maslow's motivation theory, the most important motivation for individual action comes from the individual's most pressing needs. In the process of satisfying higher needs, individuals can experience a better sense of meaning in life (26). Therefore, from the perspective of motivation theory, the meaning in life is "continuous self-actualization." Devogler and Ebersole (27) stated that the motivational sources of meaning in life involved environmental factors (e.g., interpersonal relationships), and individual factors (e.g., attitudes and beliefs) (27). Environmental factors are divided into socioeconomic status factors and family environment factors. As a family environment variable, social support is one of the important motivations for individuals to obtain a sense of meaning in life. Cheng and Yusooff (19) proposed that enjoyment of life, social concern, physical and mental health, harmonious relationship and self-growth are the sources of the sense of meaning in life, which also implies the important role of social support.

Scholars from different countries have pointed out that social support plays an important role in defining the meaning in life, which can be further explained by the self-determination theory (SDT). Self-determination theory holds that individuals achieve self-actualization through the integration of goals and

motivations, which promotes personality perfection and mental growth (28). As a basic psychological need, the individual's search for meaning in life can affect the motivation tendency, while the perceived of meaning in life, as an embodiment of self-realization, is the result of individual's self-determination. The process of self-determination includes three parts: internal motivation, internalization of external motivation and emotional integration. The internal motivation reflects individual's interest in the behavior itself, and the internalization process of external motivation can be affected by personality factors and environmental factors such as social support. In short, social support is the external motivation necessary for deriving an individual's meaning in life. Further, positive interpersonal relationship and social support plays important roles in individuals' experience and construction of meaning in life.

In self-report studies, respondents noted that good social relationships help individuals feel valued in their life (29). Individuals with strong social support networks and positive relationships with family members and close friends felt more meaningful in life and work (30). Adolescents usually gain meaning in life from their personal experiences in relationships; they define their meaning in terms of their relationships with parents, friends, and other significant individuals (31). Furthermore, in a crisis environment of high uncertainty, maintaining a feeling of greater meaning in life can support and promote individuals' mental health, mitigating psychological harm (32). Accordingly, this research proposes the following hypothesis:

> Hypothesis H3: Meaning in life plays a mediating role between social support and depressive symptoms among high school students.

As reviewed above, both loneliness and meaning in life are associated with depressive symptoms. As such, loneliness and meaning in life might influence each other and contribute to depression. In that way, we should consider two potential mediating paths. One path is that the sense of loneliness increases depressive symptoms though meaning in life. The other path is that meaning in life decreases depressive symptoms through increases in the sense of loneliness.

Theoretical and experimental evidences have showed that the former was plausible. Solitary confinement can increase psychiatric symptoms of prisoners (33). Accordingly, deconstruction hypothesis proposed that loneliness simulates the impotence and worthlessness of death (34). Moreover, loneliness may lead to individual's state of deconstruction, they will only focus on specific real-time events and deal with their own situation from a narrow perspective. The hypothesis holds that meaningful thought is an important basis for self-awareness and emotion. Individuals in deconstruction state are prone to this kind of trouble, while lonely individuals will be in a state of mind that life is meaningless. In other words, deconstruction hypothesis predicted that loneliness may lead to a thought that meaningless in life.

A series of experiments have validated the predictions of deconstruction hypothesis. Dissatisfaction with the quality or quantity of social connections can lead to loneliness (35). Klein (36) used a spent money task to test the determinant of meaning in life. When controlled for participants' happiness after they spent money on other people, the result showed that meaning in life was positively correlated with the social connection to others, suggesting a correlation between loneliness and meaning in life. Stillman et al. (37) evaluated the relationship between loneliness and meaning in life by three different questionnaires and experiments. Four studies included laboratory-administered and naturally-administered loneliness experiences. The results showed that loneliness was associated with lower sense of life meaning. The experimental design of experiments 1 and 2 allows causal inference; therefore, it can be concluded that loneliness is the direct cause of a reduced sense of meaning in life. Accordingly, this research proposes the following hypothesis:

> Hypothesis H4: Loneliness and meaning in life mediate the relationship between social support and depressive symptoms among high school students through their chain-mediating effect.

AS a common risk management model, social support plays an essential role in mental health during pandemic. However, few studies have explored the serial mediating mechanism of "social support-depressive symptoms" during home-schooling in the COVID-19 outbreak period for high school students. Particularly, there is a lack of study of the relationship between social support, loneliness, meaning in life, and depressive symptoms. Based on the current literature, this study observes the relationship between social support and depressive symptoms and the mediating effect of loneliness and meaning in life.

The findings will provide ideas for the improvement of students' mental health during the COVID-19 outbreak. The ultimate goal of this study was to improve the effectiveness of social support interventions through reducing sense of loneliness and increasing the sense of meaning in life.

METHODS

Participants and Procedure

The survey began on November 19, 2021, and ended on November 20, 2021 during COVID-19 outbreak at a high school. The pandemic in Dalian began on November 4, and as of November 19, there were 285 confirmed COVID-19 cases and 36 asymptomatic infected persons in two high-risk areas and 45 medium-risk areas. Since November 9, the government has ordered all students to take online classes at home, while residents are not allowed to go out at will and leisure activities are restricted. The homeschooling style was the combination of live or recorded broadcasts and communication by WeChat or other social software.

The Ethics Committee of the Department of Psychology at Liaoning Normal University approved this study. After obtained the approval and cooperation of the teaching department of the high school, we asked the teacher in charge of classes to share the questionnaire link to the WeChat groups of the students' parents. The online questionnaire was hosted by Wenjuanxing (https://

		N (%)
Gender	Male	609 (46.24%)
	Female	708 (53.76%)
Grade	Senior one	460 (34.93%)
	Senior two	450 (34.17%)
	Senior three	407 (30.90%)
Residential area	Rural areas	128 (9.72%)
	Urban areas	1,189 (90.28%)

www.wjx.cn/). If the parents agree to their children answering the questionnaire, after replying "agree" in the group, the child will use the parents' mobile phone to fill in their responses. However, the questionnaire was collected anonymously. Children who did not obtain parental consent could not click the link to answer the questionnaire. On the front page of the online questionnaire, we explained the research intention to the students and emphasized the principle of voluntary, anonymous and truthful answers. They could click on the start button to automatically jump to the formal survey questions. Participants were free to withdraw from the survey at any time in 2 days.

The survey data showed that all parents at the school agreed to their children filling out the questionnaire. A total of 1,387 high school students were recruited online. After eliminating questionnaires that consistently selected the same options, 1,317 (mean age = 15.96 years, SD = 0.81, range = 15–17 years old) questionnaires were analyzed. Effective recovery rate is 94.9%. The sample characteristics are shown in **Table 1**. Although we did not calculate sample size before data collecting, we have found enough samples to explore the research question, which should be effective. In addition, we did not register the hypotheses and analysis plan before collecting data; therefore, we do not have any preregistration.

Materials and Measures
The Perceived Social Support Scale
The perceived social support scale (PSSS) was developed by Zimet et al. (38) and revised by Jiang (39), a Chinese researcher. The Cronbach's alpha coefficients of the PSSS was 0.83 among Chinese students. Confirmatory factor analysis indicated that χ^2/df = 2.09, IFI = 0.95, CFI = 0.95, RMSEA = 0.05 (40). PSSS includes 12 items to assess perceived support arising from three groups, namely family, friends, and significant others. Items were rated on a 7-point scale ranging from 1 (extremely disagree) to 7 (extremely agree), greater score indicating a higher level of perceived social support. Cronbach's alphas were 0.95 in the present study.

The Child Loneliness Scale
The Child Loneliness Scale (CLS) was developed by Asher et al. (41) and was revised into Chinese by Li et al. (42). Compared with the original scale, several items of the Chinese CLS were reword to fit adolescents in China. The Chinese CLS consisted of 21 items and four subscales: loneliness (e.g., "I have lots of

friends at school"), feelings of social adequacy vs. inadequacy (e.g., "I'm good at working with other children"), subjective estimations of peer status (e.g., "My classmates like me"), social dissatisfaction (e.g., "It's hard for me to let other classmates to like me"). Participants were asked to indicate how much each statement was a true description of themselves. The items were rated on a 5-point Likert scale ranging from 1 (not true at all) to 5 (always true), greater score indicates a higher level of loneliness. The modified scale has also been found to have good reliability and construct validity in the sample of high school students (42). Cronbach's alpha for the total scale was 0.74.

The Meaning in Life Questionnaire
The Meaning in Life Questionnaire (MLQ) was compiled by Steger et al. (43) and was revised by Wang (44). The Chinese revision of the MLQ was found to have good internal consistency, construct-convergent validity and discriminant validity in samples of Chinese adolescents (44). The MLQ consisted of 10 items and two subscales: the presence of meaning and the search for meaning. Participants respond to the items on a 7-point scale ranging from 1 ("absolutely untrue") to 7 ("absolutely true"). Higher scores indicating higher presence and search. In the current study, Cronbach's alphas for the total scale were 0.76.

Beck Depression Inventory-II
Depression symptoms was assessed by the Chinese version of Beck Depression Inventory-II (45, 46), a 21 items self-report measure of depressive symptoms over the past 2 weeks. Each item is rated on a 4-point Likert scale, ranging from 0 (absence) to 3 (severe presence). The Cronbach's alpha coefficients of the BDI-II-C was 0.89, and the test-retest reliability was 0.93 among adolescents of China. Confirmatory factor analysis indicated that χ^2/df = 2.87, IFI = 0.96, CFI = 0.97, RMSEA = 0.026 (46). Summed to derive a total score, greater scores indicating higher levels of depression symptoms. Cronbach's alpha for the total scale was 0.92.

Statistical Analysis
Data analysis was conducted using SPSS Statistics 19.0. Descriptive statistics were computed for all sociodemographic information available and all study variables. We used Chi-square test to examine group differences in terms of gender, grades and residential area. The PROCESS macro program was used for the mediation analysis, repeated sampling 5,000 times from the original data to calculate the 95% CI. If the 95% CI of the standardized path coefficient does not contain 0, it indicates that the mediating effect is significant. By logistic regression analysis, we test the predictive effect of the model on low and high depressive symptom scores.

RESULTS
Test of Validity and Common Method Bias
In this study, we only collected data with self-reporting method and common method bias (CMV) may occur (47). To further improve the rigor of the study, we used Harman's single-factor

Variables	M	SD	1	2	3	4
1 Depressive symptoms	6.47	8.03	1.00			
2 Social support	68.45	12.56	−0.55***	0.56***	1.00	
3 Meaning in life	53.29	10.46	−0.44***	−0.71***	−0.49***	
4 Loneliness	39.96	15.16	0.55***	0.56***	1.00	1.00

***$p < 0.001$.

test to test common method deviations before data analysis. The results showed that there were 9 factors with eigenvalues >1, which explained 62.75% of the variation, and the variation explained by the first factor was 34.45%, which was less than the critical value of 40% (47). Therefore, there is no serious common method biases in this study.

Preliminary Analysis
One thousand three hundred and seventeen high school students fulfilled the entry criteria of this study. The BDI-II mean score was 6.47 (SD = 8.03), 16.25% suffered from depression. Among the 214 students with depression, 50% (107/214) reported mild depression, 33.64% (72/214) moderate depression, and 15.42% (33/214) severe depression. The differences between control variables has no significance, such as gender, χ^2 (1, $N = 1{,}317$) = 1.421, $p = 0.233$, grades, χ^2 (2, $N = 1{,}317$) = 2.837, $p = 0.242$, and residential area, χ^2 (1, $N = 1{,}317$) = 0.003, $p = 0.960$.

Correlations
Partial correlations for both samples are reported in **Table 2**. Depressive symptoms was negatively correlated with social support and meaning in life and was positively correlated with loneliness. Social support was negatively correlated with loneliness and was positively correlated with meaning in life. Finally, meaning in life was negatively correlated with loneliness. The significant correlation between research variables provides a good foundation for subsequent research hypotheses and mediation testing.

Testing for the Mediation Effects
Based on the results of the correlation analysis and our hypothesis that loneliness and meaning in life mediate the relationship between social support and depressive symptoms, we used PROCESS Model 6 to test the mediating model. The scores on all variables in the path analysis were converted to z-scores. The first regression analysis tests the effects of social support on loneliness (path a1). The second regression model tests the combined predictive effects of social support and loneliness on meaning in life (paths a2 and d). The third regression predicts the depressive symptom by the independent variable social support and the two mediators (paths b1, b2, and c′). Here, path c′ depicts the direct effect of social support on the depressive symptom controlled for the effects of the two mediators. In contrast, path c

indicates the total effect of social support on depressive symptom without considering the mediators.

Model indices are depicted in **Table 3**. First, in the path of a1 → b1, social support had a significant negative effect on loneliness (β = −0.711, $p < 0.001$), while loneliness had a significant positive effect on depressive symptom (β = 0.296, $p < 0.001$). In the path of a2 → b2, social support had a significant positive effect on meaning in life (β = 0.440, $p < 0.001$), while meaning in life had a significant negative effect on depressive symptom (β = −0.153, $p < 0.001$). In the path of a1 → d → b2, loneliness had a significant positive effect on meaning in life (β = −0.172, $p < 0.001$). These results supported hypotheses 1–4.

For the prediction of depressive symptom (**Table 4**), social support was a statistically significant and negative predictor (effect of c = −0.545, $p < 0.001$) in the total effect model without consideration of the mediators. However, the explained variance increased by $\Delta R^2 = 0.141$ when the mediators, loneliness and meaning in life, were included in the model. The direct effect was reduced by inclusion of the mediators but remained significant [effect of c′ = −0.248, $p < 0.001$; 95% CI (−0.325, −0.171)], whereas the total indirect effect was significant [total indirect effect = −0.297, $p < 0.001$; 95% CI (−0.359, −0.239)]. Correspondingly, all three possible indirect effects were significant [effect of a1 → b1: = −0.210, 95% CI (−0.263, −0.161); effect of a2 → b2: = −0.067, 95% CI (−0.099, −0.041); effect of a1 → d → b2 = −0.019, 95% CI (−0.032, −0.010)].

Those findings indicated that loneliness and meaning in life mediated the association between social support and depressive symptoms, respectively, through the chain intermediary of loneliness and meaning in life. The final model for the whole sample is shown in **Figure 1**.

Logistic Regression Analysis
The model created included three independent or predictor variables of social support (X1), loneliness (X2), and meaning in life (X3), and one dependent or criterion variable of low depressive symptom score (BDI ≤ 13) and high depressive symptom score (BDI > 13). Social support, loneliness and sense of meaning in life were all entered in the regression equation ($p < 0.001$) (see **Table 5**). The regression equation was Logit (P) = −0.032X1 + 0.054X2 − 0.046X3. The test of the likelihood of regression equation was significant, $\chi^2 = 295.001$, df = 3, $p < 0.001$. It indicates that when using these variables of social support, loneliness and meaning in life, the estimated model has better fitness for the sample than the null model (when the coefficients of all variables are 0). The Wald test result showed that the three independent variables were significant ($p < 0.001$), indicating certain explanatory ability to the model.

In the low depressive symptom score group, 96.6% were correctly predicted; in the high depressive symptom score group, 30.4% were correctly predicted. Together these three variables accounted for 85.5% of the variance in low/high depressive symptom score individuals.

Model	Outcome	Predictors	β	SE	t	LLCI	ULCI
Model 1	Loneliness	SS	−0.711	0.021	−34.537***	−0.751	−0.671
			$R^2 = 0.505, F = 1192.797***$				
Model 2	MIL	SS	0.440	0.035	12.436***	0.371	0.510
		Loneliness	−0.172	0.034	−5.048***	−0.239	−0.105
			$R^2 = 0.331, F = 280.727***$				
Model 3	DS	SS	−0.248	0.039	−6.289***	−0.325	−0.171
		Loneliness	0.296	0.035	8.550***	0.228	0.364
		MIL	−0.153	0.031	−4.948***	−0.214	−0.092
			$R^2 = 0.364, F = 158.865***$				

*MIL, Meaning in life; SS, Social support; DS, Depressive symptom; LLCI, Boot CI lower limit; ULCI, Boot CI upper limit. The *** symbol indicates the value of p < 0.001.*

Model	Effect	SE	LLCI	ULCI	Ratio
Total effect (c)	−0.545	0.029	−0.601	−0.488	100%
Direct effects (c′)	−0.248	0.039	−0.325	−0.171	45.50%
Total indirect effect	−0.297	0.030	−0.359	−0.239	54.50%
SS → Loneliness → DS (a1 → b1)	−0.210	0.026	−0.263	−0.161	38.53%
SS → MIL → DS (a2 → b2)	−0.067	0.015	−0.099	−0.041	12.29%
SS → Loneliness → MIF → DS (a1 → d → b2)	−0.019	0.006	−0.032	−0.010	3.49%

FIGURE 1 | Roadmap of the influence of social support on depressive symptoms.
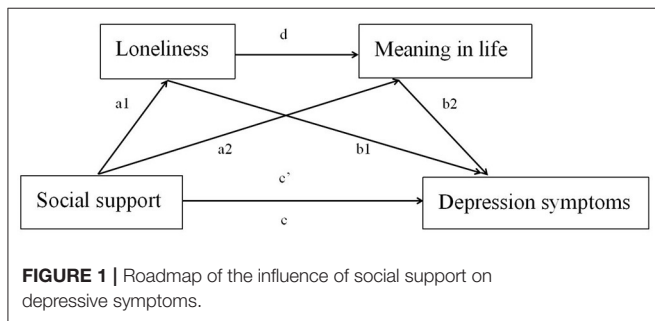
DISCUSSION

The current study had high school students as participants and aimed to investigate whether social support has effect on mental health in the context of pandemic. In addition, we also investigated whether adolescents' loneliness and meaning in life mediated the association between social support and depressive symptoms. We found one direct effect and three indirect effects: (1) social support → depressive symptoms, (2) social support → loneliness → depressive symptoms, (3) social support → meaning in life → depressive symptoms, and (4) social support → loneliness → meaning in life → depressive symptoms.

Relationship Between Social Support and Depressive Symptom

This study found that social support had a direct negative effect on the depressive symptoms of adolescents, which is

consistent with Liu et al. (48) and Marroquín et al. (49). The results of the current study supported and verified the main-effect model of social support and supported the view that "social support may mitigate the psychological consequences of social lockdown during the spread of COVID-19" (50).

Individuals who perceived a high level of social support experience reduced occurrences of emotional and behavioral problems which can directly alleviate adolescents' depressive symptoms (51, 52). Thus, high levels of perceived social support are conducive to adolescents coping well with the many pressures resulting from the COVID-19 outbreak. Particularly, they experienced enhanced confidence in solving difficulties and problems during the study-at-home period. In other words, low levels of perceived social support will negatively impact adolescents' mental health and may lead to adolescents' depression. In the end, perceived social support can help to reduce the incidence of adolescents' depressive symptoms during the COVID-19 pandemic. Thus, hypothesis H1 is supported.

Loneliness' Role Between Social Support and Depressive Symptoms in Adolescents

Results showed that social support had indirect effects on depressive symptoms through the mediating effect of loneliness. Loneliness has an inverse relationship to the number of family and friends and how much support an individual perceives to receive from them (53). Previous studies have also reported that providing social support

	B	SE	Wald χ^2	df.	Sig.	Exp (B)	95% Confidence intervals for EXP(B)	
							Lower	Upper
X1	−0.032	0.009	11.860	1	0.001	0.969	0.951	0.986
X2	0.054	0.008	51.283	1	<0.001	1.056	1.040	1.071
X3	−0.046	0.010	21.066	1	<0.001	0.955	0.937	0.974
Constant	0.234	0.871	0.072	1	0.788	1.263		

X1, Social support; X2, Loneliness; X3, Meaning in life.

was a core type of loneliness intervention (54). However, stay-at-home policies during the COVID-19 pandemic led to the sudden reduction of social networks among adolescents, thereby impacting students' access to social support. Additionally, stay-at-home policies also indicated significant decline in the enjoyment of social leisure activities as adolescents lost an important way to maintain intimate relationships (55).

Without close confidants and supportive social networks, adolescents might be faced with loneliness; so, an increased sense of loneliness may increase the risk of depression (56). A study demonstrated that lonely students were six times more likely to be affected by depressive symptoms (57). It is not difficult to conclude that loneliness plays a "bridging" role between social support and depressive symptoms through previous research supported by our results. Thus, hypothesis H2 is supported.

Meaning in Life' Role Between Social Support and Depressive Symptoms in Adolescents

The present results showed that meaning in life also played a mediating role between social support and depressive symptoms. This finding was in accordance with the existing literature. For example, a questionnaire survey explored the relationship between meaning in life and depressive symptoms in young men; the results showed that meaning in life is an important discriminative factor among lower, medium, and higher depressive symptoms. Here, the higher the meaning in life, the fewer depressive symptoms the participants had (58).

Furthermore, meaning in life refers to how people construct their daily experience rather than a general and unspecific type of meaning. This kind of daily sense of meaning in life can change in response to positive or ordinary life events; moreover, good social relations can contribute to the construction of meaning in life. In an experimental study, social relations were manipulated through instructions; participants were divided into a remembered, forgotten, complimented, or control group (59). The results suggested that no lasting personal bond led to a lowered sense of meaning in life. Therefore, as one aspect of social relationships, social support has been confirmed to be positively related to meaning in life (60). According to our results, hypothesis H3 is clearly established.

Loneliness and Meaning in Life' Role Between Social Support and Depressive Symptoms in Adolescents

Previous studies have confirmed the relationship between loneliness and meaning in life (61). The present study found that the two variables had a chain mediating effect in the process of social support affecting depressive symptoms, constituting an intermediate link in the influence path of social support → loneliness → meaning in life → depressive symptoms. This result suggests that loneliness and meaning in life not only mediated the relationship between social support and depressive symptoms independently but also affected depressive symptoms indirectly through loneliness.

In this case, loneliness is an important mediating variable of chain mediation. The Loneliness Model posits that individuals feel insecure when they do not feel social support and this sets off unconscious surveillance for social threats, eventually leading to cognitive biases (62). That is to say, lonely individuals perceive society as threatening and this results in negative social interactions in which they may enforce distancing from potential partners and attribute poor social connections to others. This vicious cycle of loneliness is accompanied by stress, hostility, and pessimism and can affect an individual's emotional and cognitive processes and outcomes.

Combined with Park's meaning-making model in a pressure context, the chain mediating effect of life meaning can be deeply explored. The meaning-making model proposes that, in the context of stress, individuals seek meaning in life to reduce the gap between situational meaning and global meaning and recover the meaning in their own life as much as possible (63). For example, economically disadvantaged individuals (situational meaning) may seek meaning in life by focusing on good personal achievement (global meaning); so, searching for meaning in life can benefit adolescents' development (64). Individuals with a strong sense of meaning in life actively promote situational meaning to assimilate with global meaning, while individuals with a weak sense of meaning in life reduce global meaning to accommodate situational meaning.

In sum, the mediating mechanisms played by loneliness and meaning in life between social support and depression are summarized as follows. The COVID-19 pandemic had led to adolescents feeling less social support and increasing loneliness. When this happens, individuals with weak senses of meaning in life blame those who provide them with social support,

while constantly reducing contact with the outside world to maintain their expectations, ultimately leading to an increase in depressive symptoms. While, individuals with a high sense of life meaning adjusted their emotions when they were lonely and actively faced the inconvenience caused by the pandemic. The sense of significance and purpose kept them in the process of self- enhancement, which benefits mental health and reduces depressive symptoms. Thus, hypothesis H4 is supported.

Limitations and Future Research

This study had several limitations. First, it used a sample of high school students during the COVID-19 outbreak, which may limit the generalizability of the findings to other populations. While the whole nation is under pressure due the pandemic, the results may not apply to adolescents in cities without outbreaks. A wider and more diverse sample may help to circumscribe the possible impact of the specific sample of this study. Second, the data was collected online and *via* self-report questionnaires; the use of a self-reported survey may be subject to social desirability bias. Furthermore, data on the psychiatric diagnoses of the participants could not be ascertained. Third, the use of the cross-sectional studies makes it impossible to infer the causal relationship between variables; future studies should extend our study using follow-up design and experimental studies.

Moreover, the participants were all from the same nation which may result in the ignorance of cultural differences in variables. Interestingly, residents of developing contexts have shown to report more meaning in life than those of developed ones (65). In a study of American college students, meaning in life did not mediate the relationship between loneliness and depressive symptoms (66). The researchers proposed that the loneliness may be a more significant factor in the influence of depression than meaning in life. Thus, in the future, the importance between meaning in social relationships and other domains of life could be compared among different cultures.

In addition, the depressive symptom scores indicate that a floor effect has occurred. The result of logical regression showed that low depressive symptom scores have little effect on the results. We analyzed three possible reasons for the floor effect in depressive symptom scores in the present study. First, this may be related to the choice of measurement scale. A meta-analyze research involved 49,656 Chinese participants revealed that the prevalence of depression during COVID-19 outbreak was 26.9% (67). The studies in the meta-analysis used a variety of depression scales, which may differ in prevalence diagnosis due to their classification criteria for depression. For example, Patient Health Questionnaire-9 (PHQ-9) is more directly reflects DSM-IV severe depressive episode criteria (68). Thus, the analysis of five studies found the prevalence of depression was 35.5%. Similarly, the analysis result of Self-rating Depression Scale (SAS) revealed that the depression prevalence was 34.1% in Chinese people. The alterations in depression prevalence ranged from 0.2 to 1.9 as a result of the analysis method, thus, the depression prevalence by BDI-II may be 25% or lower (69, 70). Second, this high school has paid more attention to mental health education. During the period of home isolation, qualified mental health teachers guided students through courses. Third, despite living in home isolation, the basic livelihood of the residents has been secured and depression may be alleviated due to the favorable supervision and rich experience of the state and government.

The present research aimed at exploring that as a risk management model, whether social support can decline depressive symptoms among high school students in the context of COVID-19 outbreaks. This aim confirmed the role of social support as an independent variable in the mediation model. In fact, social support may play as mediating or moderating role in the present model, which has been confirmed in the elderly. Liu et al. (71) found that social support mediates loneliness and depression in elderly. In individuals approaching retirement, social support had moderation effect between meaning in life and mental health (72). Multiple mediation models can be obtained by using the same variable. When constructing the mediation model, the research purpose and hypothesis should be clarified at first. This also inspires us that in order to obtain multidimensional depression intervention in the context of pandemic, we can use a variety of independent variables in future studies to explore the mediation model with depressive symptoms as the dependent variable. In addition, the mediation model in the present study also should be further explained and explored theoretically.

Despite these limitations, the current study considerably extends our understanding of the underlying mechanisms playing roles between social support and depressive symptom in adolescents during the COVID-19 pandemic. Based on the findings, individuals with more social support might have fewer depressive symptoms. Moreover, the current study reveals the mediating role of loneliness and meaning in life in the association between social support and depressive symptoms. The significant path from social support through loneliness and meaning in life to depressive symptoms further sheds light on the complex relationships among these variables. Considering the probable mechanisms, loneliness improvement programs may have a preventive function if implemented through developing social skills, increasing opportunities for social interaction, or recognizing maladaptive social cognition among adolescents (73).

Additionally, the results provide critical evidence for understanding that meaning in life may help adolescents put the COVID-19 pandemic into perspective and reduce attention to such social threats. The exploration of adolescents' senses of meaning in life is determined by the important factors that influence adolescents' depressive symptoms. Further studies should pay attention to the potential role of good relationships and personal growth in the development of meaning in life. Future studies should also try to examine the effect of different aspects of social support on adolescents, such as family function, friendship, and other social networks.

The purpose of this study is to explore the effect of social support as a risk management method on the mental health of high school students in the context of pandemic. We also explored the mechanism between social support and depressive symptoms. This study finds that adolescents with

higher levels of social support have fewer depressive symptoms than those with lower levels of social support. Loneliness, meaning in life, and the combination of the two are established as mediators of social support and depressive symptoms in adolescents. The confirmation of the path related to social support and depressive symptoms provides a reference for the mental health interventions among adolescents during COVID-19 outbreaks.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the Department of Psychology at Liaoning Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

YL and JH contributed to the conceptual conception of the manuscript. YL have written the draft of the manuscript. YL, JH, and JL provided important intellectual input at all stages and reviewed and revised the manuscript. Both authors approved it for publication. All authors contributed to the article and approved the submitted version.

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The Impact of Consumers' Loneliness and Boredom on Purchase Intention in Live Commerce During COVID-19: Telepresence as a Mediator

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This paper examines the relationship between consumer loneliness, boredom, telepresence, influencer-brand image congruence and purchase intention by investigating consumers of live commerce during the COVID-19 period. With the help of an online survey website, survey data was gathered on 550 Chinese customers who experienced live commerce shopping in China. Although previous studies have shown that consumer boredom and loneliness have an impact on purchase intention, the mechanism of influence remains unclear. As a result, additional research is needed to study the link between boredom and loneliness and customer purchase intention. Consumers' purchase intention was influenced by their feelings of loneliness and boredom. Telepresence played a mediating role in the impact of loneliness and boredom on purchase intention. Influencer-brand image congruence played a moderating role in the impact of consumers' boredom on purchase intention. The study results contribute to the research of factors impacting consumers' purchase intention. In addition, this study can help live commerce merchants better understand the impact factors of consumers' purchase intention and contribute to the development of live commerce.

Keywords: loneliness, boredom, telepresence, influencer-brand image congruence, purchase intention, live commerce

INTRODUCTION

Live commerce has been booming in China in recent years and has been welcomed by the market as a new type of shopping (Andronie et al., 2021; Liu et al., 2022). With the attributes of social business and the unique live streaming attributes, live commerce is rapidly improving its position in the consumer market. According to data, China's live commerce market size exceeds RMB 1.2 trillion in 2020, with an annual growth rate of 197%, and is expected to exceed RMB 4.9 trillion in 2023. Live commerce is rapidly taking over China's consumer market (iresearch, 2021). Meanwhile, on March 11, 2020, the World Health Organization (WHO) announced the emergence of the COVID-19 outbreak, which has now affected more than 223 countries and territories (Priyadarshini et al., 2020). Studies have shown that COVID-19 can cause physical and mental health damage

(Moreno et al., 2020; Xiang et al., 2020; Meda et al., 2021). Preliminary research suggests that the pandemic's mental challenge will continue to impact society and people for some time (Ahmed et al., 2020; Brenner, 2020). And because people fear that COVID-19 will threaten their lives, they reduce social activities to protect themselves and spend a lot more time at home, resulting in issues like feelings of loneliness and boredom (Brooks et al., 2020). Studies have shown that consumer emotions are closely related to purchase intention (Ma and Wang, 2021; Watson and Popescu, 2021; Zhou et al., 2021; Kliestik et al., 2022). When people feel negative psychological emotions, they buy products to relieve negative emotions and escape from reality (Hoffner and Lee, 2015; Gong et al., 2022). It is worth noting that people would alleviate their loneliness and boredom by purchasing through live commerce (Snyder and Newman, 2019). However, the literature on live commerce research during COVID-19 is insufficient. The mechanisms by which consumers' feelings of loneliness and boredom impact purchase intention remain unclear. Therefore, there is a need for further research on the mechanisms of how loneliness and boredom generated by consumers during the COVID-19 period affect purchase intention.

This study contributes to the body of knowledge about the factors that influence the purchasing intentions of online shoppers. First, this study enriches the research in related fields by illustrating how consumers' loneliness and boredom impact purchase intention during the COVID-19 period based on media compensation theory. Specifically, the effects of loneliness, boredom, and telepresence on purchase intention are identified. The study explored the mediating role of telepresence between boredom and purchase intention and loneliness and purchase intention. Second, our study reveals that influencer-brand image congruence moderates the effects of loneliness and boredom on purchase intention. The results show that influencer-brand image congruence enhances the positive impact of loneliness and boredom on purchase intention. Our study also provides practical suggestions for live commerce platforms and merchants to promote live commerce's sustainable and healthy development. Therefore, this work is crucial since it will provide new information for future consumer psychology and live commerce during the COVID-19 pandemic. **Figure 1** shows the research model established in this paper.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The Impact of Loneliness on Boredom
The COVID-19 pandemic has made it more difficult for individuals to go outside due to fears of infection, death and other threats from the outbreak. And, as time spent at home increases dramatically, people reduce social and recreational activities, increasing consumer isolation (Bu et al., 2020; Elran-Barak and Mozeikov, 2020; Ausín et al., 2021). When people experience emotions of loneliness, they generally wish to take action to interact *via* online media to compensate for real social interaction (Smith et al., 2021). Therefore, when people feel lonely during

the pandemic, they reduce their loneliness by using smartphones and other methods of entertainment to relieve their negative inner feelings (Kardefelt-Winther, 2014; Killgore et al., 2020a). As an essential factor affecting people's mental health, loneliness is closely related to negative emotions such as boredom and anxiety (Beutel et al., 2017). Some studies show that loneliness leads to higher levels of boredom (Chen, 2020; Li et al., 2021). In the COVID-19 period, boredom increases when people feel lonely at home due to the inability to satisfy their inner social needs. Based on this, the following hypothesis is proposed:

H1: Loneliness during the COVID-19 period has an impact on boredom.

The Impact of Loneliness on Purchase Intention
Loneliness is a subjective state of social isolation, a painful experience of the individual's lack of contact with others (Russell et al., 1978). Loneliness is often described as a negative emotion associated with isolation and dissatisfaction (Rokach, 2004). As a negative emotion, loneliness can make people feel unhappy and even lead to illnesses such as depression because loneliness can make people's perceived social status and socialization inconsistent with reality (Russell, 1996). With the rise of loneliness, people often want to take steps to alleviate this negative feeling and, if necessary, even need intervention therapy (Park et al., 2015; Rajendran and Arun, 2020; Yang et al., 2021). Loneliness increases during COVID-19 pandemic when people cannot engage inadequate social and recreational activities due to social distance restrictions and other reasons (Killgore et al., 2020b; Li and Wang, 2020). In this case, people will alleviate their loneliness by purchasing goods. When people feel lonely, they increase their purchase intention and use shopping consumption as a coping means to relieve loneliness (Mandel et al., 2017; Yang et al., 2021). Therefore, this study hypothesized that:

H2: Loneliness during the COVID-19 period can have an impact on purchase intention.

The Impact of Boredom on Purchase Intention
Boredom can be seen as a state of difficulty in concentrating due to constant fatigue while awake (Mikulas and Vodanovich, 1993). COVID-19 causes many people to stay at home for their protection, making people safer and objectively limiting their social activities. People staying at home every day can reduce individual arousal levels and create boredom (van Tilburg and Igou, 2017). People's reduced social activities and social isolation can increase boredom and reduce people's life satisfaction (Chao et al., 2020). Studies have shown that boredom is closely related to shopping behavior, and people's intention and behaviors increase when they feel bored (Lidholm et al., 2017; Bae et al., 2019; Bozaci, 2020; Pelegrín-Borondo et al., 2020). As a result of the common idea that going shopping may both ease boredom and put importance into otherwise mundane events (Sundström et al., 2019). Therefore, to compensate for the lack of social interaction in real life, people increase their purchase intention and even

FIGURE 1 | Research model.
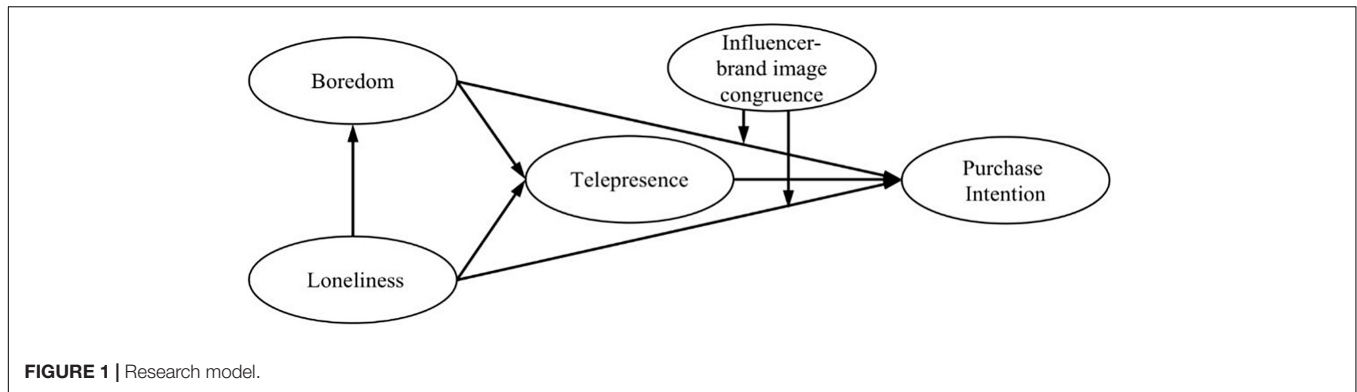
develop an addiction to excessive shopping (El Hedhli et al., 2016; Lidholm et al., 2017; Vinerean et al., 2022). Therefore, this study hypothesized that:

H3: Consumer boredom in the COVID-19 period can have an impact on purchase intention.

The Mediating Effect of Telepresence

Telepresence is an immersive online experience that is a combination of imagined accessibility and immersion, in which consumers are very focused and engaged (Novak et al., 2000; Hopkins et al., 2004; Hyun and O'Keefe, 2012; Beuckels and Hudders, 2016; Cowan and Ketron, 2019). In telepresence, the individual is unaware that they are in a virtual environment created by media such as television or computers at the time (Coyle and Thorson, 2001; Faiola et al., 2013). Telepresence is a standard variable for studying consumer behavior in online environments (Algharabat, 2018). People increase their use of media to compensate for social deficits such as loneliness, boredom, and anxiety (Hollenbaugh and Ferris, 2014; Lim and Kim, 2017). In this process, individuals who feel more lonely may watch media programs and do online shopping to relieve their inner loneliness (Lather and Moyer-Guse, 2011; Minnebo et al., 2014). The emergence of television shopping programs, in particular, has addressed the entertainment and shopping demands of customers (Fritchie and Johnson, 2003). Shopping on television allows consumers to become immersed in the show and engage with the host and other shoppers (Gudelunas, 2002). Consumers can alleviate feelings of loneliness and boredom when shopping on television since they are able to forget about the real world around them (Mollen and Wilson, 2010; Bellman et al., 2014). Through communication and interaction with the hosts of TV shopping programs, individuals can reduce boredom and have a positive psychological experience (Chory-Assad and Yanen, 2005; Derrick et al., 2009; Lim and Kim, 2011). Interacting and shopping with TV hosts help individuals reduce negative emotions, and consumers become immersed in the shopping environment provided by the seller, creating a sense of telepresence. Thus, feelings of loneliness and boredom enhance the telepresence experience. Telepresence could convince customers that they can completely comprehend the goods, allowing them to boost their enjoyment of the occurrence and thus create higher purchase intention (Gao

and Li, 2019; Ongsakul et al., 2020; Ye et al., 2020). During the COVID-19 period, less research has been done on the factors influencing consumer purchase intention in TV buying. Customers can communicate with influencers and others more easily in person than they do on television. Customers who see influencers and other consumers market things are more likely to make a buy themselves (Yu and Kim, 2020; Wang et al., 2021). There are just a few options for customers to connect with the host when buying on TV, such as making phone calls or writing letters rather than using multiple communication channels. But the live commerce environment is real-time communication using cell phones face-to-face, and consumers and participants of other live platforms also form multiple communication fields. Therefore, live commerce is more accessible for consumers to feel telepresence than TV shopping, and the interaction methods are more diverse. Based on the above study, these hypothesis was formulated:

H4: Loneliness in the COVID-19 period influences purchase intention in live commerce through telepresence.

H5: Boredom in the COVID-19 period has an impact on purchase intention in live commerce through telepresence.

Moderating Role of Influencer-Brand Congruence

In live commerce, influencers play the role of merchandise advocates in the sales process. Many social media influencers have enormous followings, and their fans trust the things they advocate, which is regarded to be the marketing value of the influencers to the companies in these social media industries (De Veirman et al., 2017; Kemp et al., 2019; Lou and Yuan, 2019). Influencers significantly impact consumers' shopping decisions as product advocates and opinion leaders (Casaló et al., 2020). In previous studies, spokesperson-brand image congruence is an important influencing factor for consumers' purchase intention. Product spokespersons represent corporate culture and image and are of great significance in the consumer shopping process (Escalas and Bettman, 2005; Shan et al., 2020). When customers believe the spokesperson's image matches the product's image, the product commercial and the brand's image are more positively received by customers, the research revealed (Akbar, 2019; Lee et al., 2019; Haobin Ye et al., 2021). When consumers feel

that the spokesperson's brand image is inconsistent, it decreases the consumer's favorability of the product and can reduce their willingness to purchase the product (Paul and Bhakar, 2018; Deska et al., 2022). Although consumers' feelings of loneliness and boredom can have an impact on purchase intention, when influencer images are less consistent with brand images, it may reduce consumers' trust in the product and decrease the shopping experience. Consumers are less likely to have purchase intention for products with low influencer-brand image congruence. Spokesperson-brand image congruence strengthens consumers' willingness to shop, but research exists primarily in television shopping or in social shopping (Skupski, 2019; Arora et al., 2021). Fewer studies have been conducted in the COVID-19 period on the influencers' brand image congruence in live commerce. Consumers in social media will trust influencers more than traditional celebrities and show more positive attitudes toward products endorsed by influencers (Jin et al., 2018; Kim and Kim, 2021; Li and Peng, 2021; Pop et al., 2022). Whether influencer-brand image congruence enhances the effect of loneliness and boredom on shopping intention is a question worthy of further study. Therefore, this study hypothesized that:

> **H6:** Influencer-brand image congruence enhances the positive effect of loneliness on purchase intention in live commerce.

> **H7:** Influencer-brand image congruence enhances the positive effect of boredom on purchase intention in live commerce.

MATERIALS AND METHODS

Participants

In order to test the research model and related hypotheses, this paper adopts a questionnaire survey method to collect data. 550 Chinese live commerce consumers participated in this study and completed an informed consent form before completing the questionnaire. Using the WENJUANXING data website, a questionnaire was employed to gather information. It was gathered between February 10, 2022 and February 25, 2022.

Variable Measurement

Loneliness

The measure of loneliness was modified from the revised Loneliness Scale by Tian et al. (2012). The scale consists of 20 items (e.g., "Do you feel isolated?"). The response options on the questionnaire ranged from 1 (strongly disagree) to 5 (strongly agree). Higher scores reflect higher levels of individual loneliness. Cronbach's α = 0.835.

Boredom

The boredom scale revised by Lee and Zelman was used in this study (Lee and Zelman, 2019). The scale contains 12 items (e.g., "Usually, I am less able to find things that interest me"). The scale has shown good reliability and validity in previous studies (Elhai et al., 2018). The response options for the questions ranged from 1 (strongly disagree) to 5 (strongly agree). Higher scores reflect higher levels of individual boredom. In our study, the internal

rate of reliability of the questionnaire was high with a Cronbach's α = 0.867.

Telepresence

As revised by Kim and Biocca the telepresence scale was used in this study (Kim and Biocca, 1997). The scale contains nine measures (e.g., when I use live commerce, I forget the reality of my environment). Cronbach a = 0.815.

Influencer-Brand Image Congruence

The study was adapted from a scale developed by Haobin Ye et al. (2021). The scale contains 3 measures (e.g., do you think the influencer's image is consistent with the image of the company). The questionnaire response options range from 1 (strongly disagree) to 5 (strongly agree). Cronbach's α = 0.884.

Purchase Intention

The questionnaire was based on a questionnaire developed by Li et al. (2002). The scale contained four measures (e.g., how likely you think it is to buy the product) (Li et al., 2002). The response options of the questionnaire ranged from 1 (strongly disagree) to 5 (strongly agree). Cronbach's α为0.759.

Procedure

The Academic Research Ethics Committee of Linyi University approved the study (No. LYU20220105). The study questionnaire was answered anonymously, and they were instructed on how to complete the survey. Informed consent was obtained from all participants before the study, and participants could withdraw during the response process.

Data Analyses

Statistical analyses were performed using SPSS 26.0 software. Specifically, first, descriptive statistics and correlation analyses were conducted for the main variables. Second, the effect of loneliness on boredom was analyzed by regression using SPSS. In addition, the mediating and moderating roles of telepresence in loneliness, boredom, and purchase intention were analyzed using model 5 of SPSS PROCESS macro (Preacher and Hayes, 2008). SPSS PROCESS macro can provide several models to perform analysis of processes such as mediation and moderation effects.

RESULTS

Descriptive Statistics

In the 550 valid survey samples, there are a total of 273 females and 277 males. Sample loneliness mean = 3.52, skewness = –6.38, kurtosis = –0.855. sample boredom mean = 3.43, skewness = –8.56, kurtosis = –0.534. More than 65.82% are people aged 18–32, 75.09% of the samples have a junior college degree or above. Most people spent an average of less than 1 h on live commerce every day. The descriptive statistics of our survey samples are shown in **Table 1**.

Table 2 summarizes the descriptive statistical results and correlations between the main variables. Correlation analysis showed that loneliness was positively correlated with boredom,

TABLE 1 | Descriptive characteristics of the sample (N = 550).

Characteristics		Frequency	The percentage
Gender	Male	277	50.36
	Female	273	49.67
Age	18 Years old and below	103	18.73
	18–25 Years old	169	30.73
	26–32 Years old	193	35.09
	33–40 Years old	29	5.27
	40 Years old and above	56	10.18
Education	High school and below	137	24.91
	Junior college degree	208	37.82
	Bachelor's degree	176	32.00
	Master's degree or above	29	5.27
Frequency of use (hours)	Less than 0.5	248	45.09
	0.5–1	260	47.28
	1–3	24	4.36
	Above 5	18	3.27

TABLE 2 | Correlations between variables.

Variables	M	SD	1	2	3	4	5
Loneliness	3.5156	0.96004	1				
Boredom	3.428	0.99126	0.382**	1			
Telepresence	3.4986	1.02513	0.358**	0.321**	1		
PI	3.4232	0.83204	0.290**	0.205**	0.292**	1	
IBC	3.1085	1.32318	0.044	−0.013	0.002	0.103*	1

*p < 0.05; **p < 0.01.
N = 550. M, mean; SD, standard deviation; PI, Purchase Intention; IBC, Influencer-brand image congruence.

TABLE 3 | Standardized parameter estimates for the direct and indirect effects of the hypothesized model.

Relationship	β	SE	95% CI		Results
			Lower	Upper	
Direct effect					
Loneliness→boredom	0.382	0.035	0.314	0.474	Supported
Loneliness→PI	0.183	0.037	0.111	0.256	Supported
Boredom→PI	0.106	0.036	0.036	0.176	Supported
Indirect effect					
Loneliness→TP→PI	0.067	0.016	0.038	0.100	Supported
Boredom→TP→PI	0.068	0.016	0.040	0.101	Supported

n = 550, bootstrapping randomly sampled 5,000 times.

telepresence, and the purchase intention process. Boredom was positively correlated with telepresence and purchase intention, and Purchase intention was positively correlated with endorser influencer-image congruence.

Table 3 depicts the relationship between consumer loneliness, boredom, and purchase intention during COVID-19. Specifically, loneliness had an impact on boredom ($\beta = 0.382$, $SE = 0.035$, $t = 9.669$). In addition, loneliness had an impact on purchase intention ($\beta = 0.183$, $SE = 0.037$, $t = 4.961$). Boredom has an impact on purchase intention ($\beta = 0.106$, $SE = 0.036$, $t = 2.964$). Hypothesis 1 and Hypothesis 2 and Hypothesis 3 are supported.

Mediation analysis was performed to test the mediating role of telepresence in the association between loneliness, boredom, and purchase intention. To test the mediating

TABLE 4 | Moderation analysis.

Relationship	β	SE	95% CI		t	Results
			Lower	Upper		
Loneliness × IBC → PI	0.047	0.025	−0.002	0.096	1.868	Not supported
Boredom × IBC → PI	0.049	0.024	0.001	0.098	2.024	Supported

PI, Purchase Intention; IBC, Influencer-brand image congruence.

role of escape motivation between loneliness, boredom and purchase intention, we ran the PROCESS macro, model 5, in SPSS with 5,000 bootstrapping samples (Preacher and Hayes, 2008). All data were standardized. Telepresence exhibited a significant mediating effect (**Table 3**). We suggested that telepresence plays a mediating role between loneliness and purchase intention ($\beta = 0.067$, 95% confidence interval of bootstrapping = 5,000 is [0.038, 0.100], excluding 0). Moreover, telepresence exerts a mediating effect on boredom and purchase intention ($\beta = 0.068$, 95% confidence interval of bootstrapping = 5,000 is [0.040, 0.101], excluding 0). Thus, telepresence partially mediates the relationship between loneliness, boredom and purchase intention.

To test the moderating roles of influencer-brand congruence, we ran the PROCESS macro (PROCESS Model 5; Preacher and Hayes, 2008). Influencer-brand congruence had a significant moderating effect on the relationship between boredom and purchase intention, results shown in **Table 4** ($\beta = 0.049$, $t = 2.024$). To illustrate the moderating effect presented above, we conducted a simple slope test. We divided telepresence into high (M + 1 SD) and low (M −1 SD) groups to better explain telepresence in moderating boredom and purchase intention (**Figure 2**). The results revealed that when the influencer-brand congruence was high (mean + 1 SD), boredom exerted a significant influence on the purchase intention of live commerce consumers ($b = 0.171$, $t = 3.534$, $p < 0.001$). When the influencer-brand congruence was low (mean −1 SD), boredom exerted no significant negative impact on the purchase intention of live commerce consumers ($b = 0.040$, $t = 0.842$, $p = 0.40$). Therefore, We found that influencer-brand congruence exerts a significant moderating effect on boredom and purchase intention ($\beta = 0.049$, 95% confidence interval of bootstrapping = 5,000 is [0.072, 0.157], excluding 0). Hence, Hypothesis 4 and Hypothesis 5 and Hypothesis 6 are supported.

DISCUSSION

This study was constructed to explore the potential mechanisms between loneliness, boredom and consumer shopping intention during COVID-19. Telepresence is a potential mediator of loneliness, boredom and shopping intention, while influencer-brand congruence is a potential moderator to explain the influence of loneliness on purchase intention. Loneliness is a factor in boredom for live commerce customers in particular. To put it another way, loneliness has an effect on boredom. Therefore, the study is consistent with the previous findings (Bu et al., 2020; Elran-Barak and Mozeikov, 2020; Killgore et al., 2020a; Ausín et al., 2021; Li et al., 2021).

FIGURE 2 | Showing moderation.
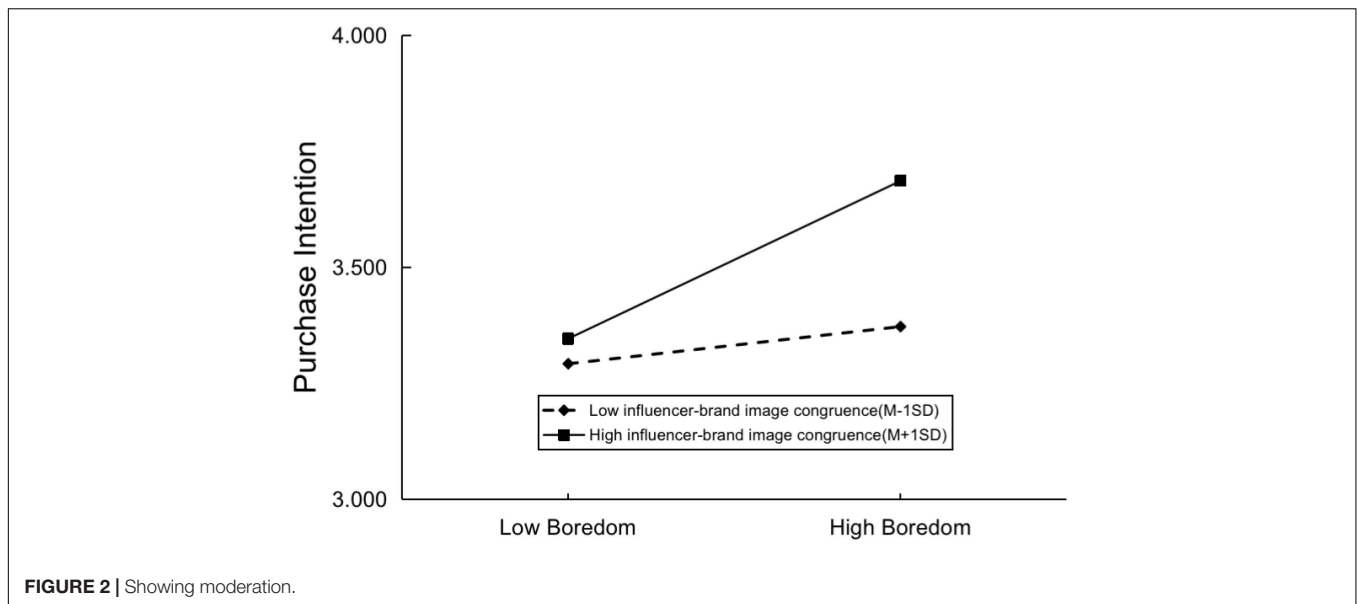
Consumers' loneliness and boredom positively predicted purchase intention in live commerce. When consumers feel loneliness and boredom, they are motivated to shop through live commerce, consistent with previous research findings (Lidholm et al., 2017; Jiang et al., 2018; Lee and Zelman, 2019; Yang et al., 2021; Vinerean et al., 2022). Telepresence mediates consumer loneliness, boredom and purchase intention (Lim and Kim, 2017; Gao and Li, 2019; Ongsakul et al., 2020). Loneliness and boredom affect consumers' willingness to shop through telepresence. When consumers are lonely, if telepresence increases, it makes them more likely to have purchase intention. Consumers have reduced their social behavior during the COVID-19 period for various reasons, so they need to compensate for the lack of interpersonal behavior through the Internet and other means. A high influencer-brand image congruence is more likely to make consumers willing to purchase intent, consistent with previous research findings (Ruiz-Equihua et al., 2020; Kim and Kim, 2021; Pop et al., 2022). In other words, when consumers are bored, interesting live commerce can provide a way to eliminate boredom and make consumers feel interesting, which is inseparable from the influencer's charm. The statistics show that influencer-brand congruence has a moderating effect on the relationship between boredom and purchase intention. However, influencer-brand image congruence did not act as a moderator between loneliness and purchase intention, possibly since, during the pandemic, consumers sought other social outlets to alleviate their loneliness when they felt lonely.

IMPLICATIONS

When it comes to customers' purchase intention, previous research has neglected to take into account COVID-19's results on emotions of loneliness, boredom, telepresence, and influencer-brand congruence. The findings of this study provide important insights for live commerce platforms and merchants. First, given the importance of consumer loneliness and boredom in purchase intention during the COVID-19 period, live commerce platforms and anchors should develop new features that reduce consumer loneliness and boredom to promote consumers' purchase intention. Second, current research has found that consumers' telepresence mediates feelings of loneliness, boredom and purchase intention, so live commerce platforms need to improve picture and sound quality to ensure consumers' telepresence. In addition, influencer-brand image congruence can strengthen the influence of boredom on purchase intention. Especially, retailers using live commerce should focus on enhancing their brand image in order to boost the likelihood that customers will make a purchase during the COVID-19 period. Therefore, when consumers are bored, merchants in live commerce should choose products with high influencer-brand image congruence to sell and promote the sales of products.

CONCLUSION

This research sheds light on the psychological underpinnings of consumer purchasing behavior during the COVID-19 period and sheds light on the elements that influenced consumers' buying intentions. If we want to build the live commerce business, we need to understand the psychology of consumers. This study constructed a moderated mediation model of the relationship between loneliness, boredom, telepresence, influencer-brand congruence and purchase intention during the COVID-19 pandemic and verified the mechanism of loneliness and boredom on the customer purchase intention during the COVID-19 pandemic through empirical methods. Research in the subject of live commerce is enriched by this study, which gives a novel viewpoint on the investigation of customer purchase intention.

Although this study can provide some insight into the factors influencing consumers' purchase intention, this study has some limitations. First, all data in the study were filled in by consumers themselves, which may lead to bias in consumers' recall. Second, COVID-19 is still very severe in some areas of China, but the outbreak is under control in other places, which may affect the data's accuracy. Third, a cross-sectional study cannot determine a causal relationship between loneliness, boredom and purchase intention. This study only examined the regulatory impact of influencer-brand congruence, but it may also be utilized as an antecedent variable to affect purchase intention. Thus future research can further deepen and expand on this. Using a longitudinal survey to evaluate the influence of additional characteristics such as resilience on consumer purchase intention is recommended in future research.

DATA AVAILABILITY STATEMENT

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Academic Research Ethics Committee of Linyi University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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Double jeopardy: How lower levels of support during COVID-19 exacerbated the relationship between loneliness and distress

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While the relationship between loneliness and psychological distress is well documented, the mechanisms underlying this relationship are less clear. One factor known to be related to loneliness as well as psychological distress, is social support, with some studies suggesting that support—both received and provided—can serve as a mechanism to reduce the distress associated with loneliness. In this paper we examine the mediating role of both aspects of support in the relationship between loneliness and psychological distress in the COVID-19 context. We used a multi-country dataset collected at two timepoints during the pandemic; the first during the early stages (N = 6,842, 11 countries) and the second collected for a subset of countries (N = 1,299, 3 countries) 3 months later. Across all eleven countries, results revealed significant positive associations between loneliness and distress. Furthermore, using longitudinal data, we investigated the directionality of this relationship and found that increased loneliness over time was associated with increased psychological distress. The data also showed that both feeling unsupported and feeling unable to provide support to others mediated this relationship. These findings point to the need to facilitate people's ability to draw effective social support and help others—particularly at times when social connectedness is threatened—as a way of alleviating the psychological distress that commonly presents with loneliness.

Introduction

Loneliness is generally described as a negative experience, arising from the feeling that one's social needs are not met by one's social relationships (1–3). While loneliness is not a new phenomenon, it became highly salient during the COVID-19 pandemic; a time when social engagement was tangibly reduced by virtue of people needing to isolate at home to stop the spread of the virus (4). Over a period of approximately 2 years, people across the world worked from home more (5), traveled less (6), and engaged in significantly fewer social activities (7). For many people, feeling cut off from family, friends, and work colleagues resulted in increased levels of social isolation and loneliness (8–12). This was supported by data showing higher rates of loneliness for people living under lockdown orders (reducing social contact opportunities) than those living with no restrictions (8, 9, 13).

The impact of loneliness on a person's quality of life is significant, and is often associated with increased psychological distress, in the form of anxiety and depression (14, 15). These negative wellbeing effects also came to the fore when the COVID-19 pandemic hit, with data showing increased levels of reported distress during the pandemic (16). Furthermore, data collected showed that these effects were greater for vulnerable groups such as people on low incomes, those with pre-existing mental illness, or more generally, people with less social support (11, 13, 17–20).

Previous research has shown how social support can play a role in reducing loneliness, as well as in countering psychological distress (21–23). However, opportunities to both feel supported as well as to provide support for others were also diminished by the social restrictions put in place to manage COVID-19 (8, 9, 13). It is likely that this further exacerbated both loneliness and psychological distress during the pandemic (24–27). In a study which included samples from eleven countries taken during the pandemic, we examined the relationship between loneliness and psychological distress. In particular, we focused on social support–both received and provided–as a hypothesized mechanism through which loneliness influences psychological distress. Before elaborating on why social support provides an explanation for the relationship between loneliness and psychological distress, we will first step back to assess the social underpinnings of loneliness, and why– theoretically speaking–loneliness enhances psychological distress. We propose that the social identity approach provides a theoretical model from which to understand the relationships between social (dis)connection, loneliness, and psychological distress.

Loneliness and psychological distress: A social identity approach

While the relationship between loneliness and psychological distress may seem intuitive–it is emotionally painful to feel lonely due to a sense of being socially disconnected–few theoretical frameworks have examined the question of why loneliness should enhance psychological distress. Here, we propose that the social identity approach–combining Social Identity Theory and Self-categorization Theory principles (28–31)–might help to theorize this relationship. The social identity approach describes how a person's sense of self is informed by their group memberships, and more specifically, the strength of identification with them (32–34). Tajfel [(35). p. 78] defined social identity as the part of a person's self-concept informed by group memberships and from which is derived "value and emotional significance". Self-categorization theory was subsequently developed to provide a socio-cognitive account of the process of social identification. It describes how and when social identities are activated, and how the salience of group memberships affects the self (30, 31, 36, 37).

Research informed by the social identity approach has shown how group memberships (and the social identities that are derived from group memberships) affect people's self-esteem, belonging, meaning, sense of purpose, and efficacy (38–40). Given the central role of group memberships in how people think, feel, and behave (39–42), recently, social identity theorizing has been extended to focus on understanding the social processes that underlie health and wellbeing outcomes [the Social Identity Approach to Health, SIAH, (33, 43–45)].

This sub-discipline of social identity research describes how a sense of positive group membership is key to understanding a range of health outcomes (32, 46, 47). Referred to as the *Social Cure,* this perspective has demonstrated how social connection can improve feelings of personal control (39), satisfy global psychological needs (48), enhance resilience (49), alleviate depression (50), and even reduce post-retirement mortality rates (51). Findings from the social cure perspective suggest that it is both the process and strength of identification with groups that provides a base from which to access health-giving psychological resources. This relationship has been demonstrated empirically with a range of populations, from heart surgery patients (52) to Australian school students (53). Consistent with this perspective, large-scale epidemiological studies have demonstrated that a positive sense of social integration and support strongly predicts health outcomes, including longevity (54–56).

As much as social connection is good for health, social disconneciton is a risk to health. To understand just how important social connectedness is for humans, consider situations where opportunities for social interaction are lacking, for instance, conditions of ill-health, old age, or social

restrictions. Considerable evidence suggests that being cut-off from social interaction with groups that matter to people can have a profoundly negative effect on people's resilience, health, and wellbeing, and can even lead to early death [for a review, see (32, 45)]. Social isolation represents a health hazard because people are no longer able to reap the psychological benefits of group membership. Consistent with this reasoning, inadequate social connection is known to lead to an increased sense of being lonely (54), the most common impact of which is increased psychological distress (14, 15, 57, 58). In order to understand the basis of this relationship, social identity research has explored the types of resources unlocked through membership of groups, such as social support (59, 60).

A social identity analysis of social support

Defined as "various forms of aid and assistance supplied by family members, friends, neighbors, and others" [(61). p. 435], social support has long been recognized as an important public health factor (62, 63), with data showing that a perceived lack of social support can be associated with increased loneliness (22, 23) as well as with heightened levels of distress, psychological maladjustment, and physical illness (21, 64, 65). It is still not clear however either why or how social support can reduce loneliness and psychological distress. Traditionally, research into the dynamics of support tends to examine sociological factors (such as age, gender, and social class), and individual-level variables, such as personality (66, 67). However, a meta-analysis showed weak–and at times inconsistent–evidence of the relationship between social support and health (68). Examining support from a social identity perspective provides a means to understand its social underpinnings, and from which to make sense of these contradictory findings.

According to the social identity approach, social connection provides a vehicle for accessing social support–both practically as well as psychologically, with both the receipt and provision of support known to be a resource harnessed through group membership (69–72). Of relevance here is a recent study with retirees (51). Steffens and colleagues' study examined the dual process of both support received and support provided to others. In line with evidence that feeling supported was beneficial for a range of outcomes [such as life satisfaction, subjective wellbeing, and improved physical health; (24, 27, 73, 74)], Steffens and colleagues found that feeling supported predicted wellbeing among retirees. Interestingly though, it was provision of support *to* others that more strongly explained the relationship from social connection to wellbeing. The latter finding is consistent with studies showing how providing help is associated with increased coping mechanisms, elevated feelings of life satisfaction, improved wellbeing (27, 75–79). Further, providing support to others has also been shown to decrease

loneliness (26, 80), and these findings have been replicated across cultures (81).

Of relevance to the current research, the pathway from social connection to wellbeing has been shown to emerge under conditions of collective threat, such as public emergencies or natural disasters. Here we see that the perception of a common fate allows for the establishment of a shared identity, and that this emergent social identity leads to mutual support and subsequently to enhanced individual and collective health (82–84). Furthermore, research into formal support provision has demonstrated that rates of volunteerism are associated with increased feelings of personal self-efficacy and empowerment, as well as improved mental and physical health (85, 86), and that increases in shared identity are associated with higher levels of wellbeing for volunteers (87).

Building on the reasoning that social connectedness and social identification with groups unlocks psychological resources, a lack of social connectedness (i.e., loneliness), would prevent the action that would allow one to draw from those psychological resources. That is, higher levels of social isolation restrict the pathways–both logistical and psychological–that would allow individuals to draw effectively from social support. Consistent with this reasoning, higher loneliness has been found to be associated with lower levels of received social support (22, 23). Likewise, loneliness–and the lack of shared identity and connection with others that lies behind loneliness–limits the extent to which lonely individuals are motivated to provide social support to others. Supporting this, research has demonstrated links between increased loneliness and a reduction in pro-social tendencies, which includes a range of acts that are categorized as beneficial to others, including the enactment of support (88–92).

Receipt and provision of social support during the COVID-19 pandemic

The pandemic provided a unique context for examining the relationships between social disconnection, support, and psychological distress. Under conditions of COVID-19, loneliness rates were elevated whilst the need for support as well as the need to help others was highly salient (13, 76, 93). Data collected during the pandemic demonstrated that, despite restrictions, people still endeavored to support each other (94), with evidence from across the globe of volunteering and the emergence of community-based mutual aid groups (95–97). Despite some acts of support making the headlines [such as the *Clap for our Carers* movement in the UK, (98)], the vast majority occurred at more local levels, and involved shopping, dog-walking, and other forms of emotional, informational or logistical support (99).

Hypothesized model showing the relationship between loneliness and psychological distress as mediated through both support received, and support provided.
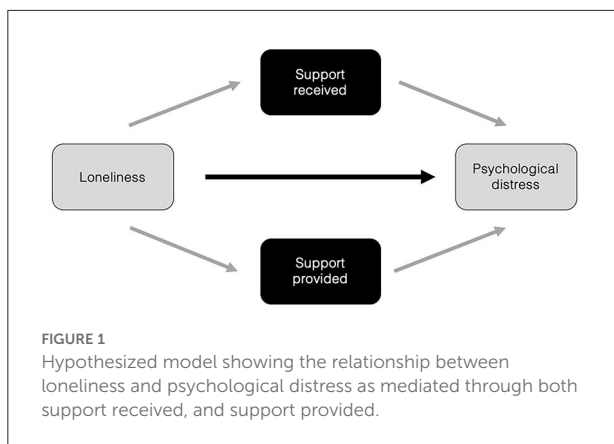
Whilst there are established links between social support and wellbeing, as well as evidence that this relationship emerges more strongly as a result of a shared identity, less is known about this process during a crisis in which social connection (and the establishment of shared identity) was restricted. Within the context of the COVID-19 pandemic, we predict that a lack of social connection–and the risk of increased loneliness that arises from this–inhibited the process of both receiving help from others, as well as being able to provide support to others (32, 52, 71). Research would suggest that this inability to enact support is likely to exacerbate the relationship between loneliness and negative health outcomes, such as psychological distress. These relationships are illustrated in the model below (Figure 1), and which provides the basis for the hypotheses the present research tests.

The present research

The COVID-19 pandemic created the context for a potential double jeopardy: social restrictions put people at risk of increased loneliness *and* reduced their capacity to engage pro-socially with others (to support others and benefit from support provided). We argue that social support, received and given, lies at the heart of this double jeopardy, offering a means to overcome the effect of loneliness on psychological distress. To test this relationship, we used a multi-country dataset to explore relationships between loneliness and psychological distress, with social support as a possible mediator. We first examined the more established route *via* feeling supported by others, and then examined the lesser-known pathway through provision of support *to* others.

Within this study there were two waves of data, both collected during the pandemic (March and June 2020; for a description of the pandemic conditions of each country at the time of data collection, refer to Supplementary material). In the first wave, residents from eleven countries took part in the study, providing a sample of 6,842 participants. Three months

later we collected a second wave of data in three countries– the UK, Australia, and the US–surveying 1,299 of the same participants. Using the first wave of data, we first examined the relationships between loneliness, psychological distress, and social support, focusing particularly on the hypothesized mediating role of social support in the relationship between loneliness and psychological distress. Using the second wave of data, we explored these same relationships longitudinally. We expected to find that at Wave 1 higher levels of loneliness would be related to higher levels of psychological distress (H1a), and that higher levels of support received would be associated with lower levels of both loneliness and psychological distress (H1b). Further, we examined support provision, hypothesizing that this too would be associated with lower levels of both loneliness and psychological distress (H1c). We also expected to find that both forms of social support would mediate the relationship between loneliness and distress. Specifically, we hypothesized that lonelier people would feel less supported by others, which would in turn exacerbate their distress (H2a). We also hypothesized the lesser-known pathway through support provision, predicting that lonelier people would report less provision of support to others, which would in turn exacerbate their distress (H2b).

We also examined the direction of these relationships as they changed during the peak months of the pandemic. Here, we expected to find that increased loneliness (from Wave 1 to Wave 2) would lead to greater psychological distress (H3). Further, we expected receipt of social support from others (H4a) as well as provision of social support to others (H4b) to mediate this relationship over time, such that those reporting greater loneliness would see a decline in both forms of support, which would explain increases in psychological distress.

Method

Participants

A total of 6,842 participants were sampled across eleven countries: Australia, China, France, Germany, Indonesia, Italy, the Netherlands, Spain, Thailand, the UK and the US. Participants were sampled *via* either the Prolific crowd sourcing platform (Germany, Italy, the Netherlands, Spain, the United Kingdom and the United States), recruited through social media (Thailand and Indonesia), or both platforms (France and Australia). Countries were selected to represent as broad a dataset as possible but were also dictated by logistical constraints such as researcher access and funding restrictions. This first wave of data was collected during the pandemic in March 2020. For a description of the pandemic conditions of each country at the time of data collection, refer to Supplementary material.

In this Wave 1 sample, 532 participants (7.78%) were excluded after having failed an attention check ("To ensure you are a real human-being (and not a bot), please select strongly agree for this item"), leaving a final sample of 6,310 (54.90% identified as female; 43.60% male, 1.50% non-binary/other; M_{age} = 30.44, SD = 11.95). Additional sample characteristics for each country are presented in Supplementary Table 1. A Monte Carlo sensitivity power analysis for indirect effects (100) indicated that our final sample size in Wave 1 (N = 6,310) had 99% statistical power (a = 0.05) based on the strength of associations between our predictor, mediator, and outcome variables.

To provide us with longitudinal data, a smaller subset of this Wave 1 sample participated in a second survey undertaken 3 months later. Within this second wave, for reasons of convenience, data were collected from only three of the eleven countries, and comprised responses from 1,299 participants residing in Australia (n = 468), the US (n = 373) and the UK (n = 469). A total of 32 participants were excluded from Wave 2 after having failed an attention check, leaving a final sample of 1,267 (53.40% female; 45.50% male, 1.10% non-binary/other; M_{age} = 35.04, SD = 12.36). Additional sample characteristics for each country are presented in Supplementary Table 1. A Monte Carlo sensitivity power analysis for indirect effects (100) indicated that the final sample had 99% statistical power (a = 0.05) based on the strength of associations between our predictor, mediator, and outcome variables.

Procedure

The study received ethical clearance *via* its university Ethics Committee (clearance number 2020000485). For Wave 1, data was collected between March 17th and April 10th, 2020, and for Wave 2 between June 24th and July 2nd, 2020. Surveys conducted in Chinese, Dutch, French, German, Indonesian, Italian, Thai, and Spanish were translated from English by the authors (all native speakers in their respective languages). Participant data collected on Prolific was advertised as a study looking at the effects of COVID-19 on people's thoughts and behavior,[1] and participants were paid according to the platform's best practice guidelines. Once the participants had read a brief introduction to the study and were informed of their data anonymity and right to withdraw, they were asked for consent to proceed. Upon consent, participants were redirected to the survey which took approximately 15 min to complete.

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1   The data reported in this study formed part of a wider survey looking into a range of other issues related to the experience of living through the COVID-19 pandemic. For information on other variables measured: https://osf.io/6t3y7/.

Measures

Loneliness

Loneliness was measured using four items adapted from Hughes (101); "I feel I lack companionship," "I feel left out," "I feel isolated from others," and "I feel lonely;" α = 0.84. Participants were asked "How often do you feel like this in general?" and provided their responses to each statement using a scale from 1 (*Hardly ever*) to 3 (*Often*).

Social support received

Social support received was measured with three items (52): "I get the emotional support I need from other people," "I get the help I need from other people," "I get the resources I need from other people'; α = 0.87. Participants were asked to indicate their agreement using a scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Social support provided

Provision of support was measured using three items from Haslam and colleagues (52); "I give other people the emotional support they need," "I give other people the help they need," and "I give other people the resources they need;" α = 0.86. Participants were asked "When you think about people who are in your life, how much do you agree or disagree with these statements?" and indicated their agreement using a scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Psychological distress

The Kessler Psychological Distress (K6) scale was used to measure distress over the past 30 days (102, 103). The K6 scale was developed as a screener for serious mental illness and was designed to provide a tool able to bridge between community and clinical epidemiology. Participants responded to the six words presented (e.g., "nervous," "hopeless") and asked to rate their frequency of occurrence from 1 (*None of the time*) to 5 (*All of the time*) (α = 0.87).

Results

Cross sectional analysis

Descriptive data

Table 1 displays the overall means, standard deviations, and bivariate correlations of key variables collapsed across the eleven Wave 1 countries. Results for each of the eleven countries are presented individually in the Supplementary Table 2.

TABLE 1 Mean, standard deviation and bivariate correlations of key variables, wave 1.

Variable	M	SD	Correlations			
			1	2	3	4
1. Loneliness	1.58	0.56	-			
2. Social support provided	5.46	0.99	−0.18**	-		
3. Social support received	5.23	1.19	−0.34**	0.52**	-	
4. Psychological distress	2.02	0.81	0.54**	−0.13**	−0.26**	-

N = 6,310 **p < 0.01.

Multi-level mediation

To test our hypotheses, we conducted multi-level path analysis in MPlus version 8.3 (104) to account for clustering of the data (11 countries, total $N = 6,842$). The key difference between multi-level mediation and standard mediation is the presence of random intercepts (i.e., allowing the intercept within each country to vary) which allowed us to control for country-level differences. Since our hypotheses focused on individual-level variables (i.e., participant perceptions and experiences), we focused on the within-level mediation effects (Level 1) and used group-mean centering of the predictor variables to center the predictors within each country (105). We note that a small amount of the variance in psychological distress (ICC = 0.06) was attributable to country-level differences. All analyses controlled for participants' age and gender.

Using multi-level path analysis, we first tested the association between loneliness and psychological distress (H1a), and then the associations between social support (both receipt and provision) and loneliness and psychological distress (H1b and H1c). We found that loneliness was significantly associated with higher psychological distress [$b = 0.52$ (0.494, 0.544), $SE = 0.01$, $p < 0.001$], providing support for H1a. As expected, we found that receipt of support was significantly negatively associated with psychological distress [$b = -0.28$ (-0.320, −0.248), $SE = 0.02$, $p < 0.001$] and significantly negatively associated with loneliness [$b = -0.34$ (-0.388, −0.292), $SE = 0.03$, $p < 0.001$], providing support for H1b. At the same time, we found that this same relationship was observed for provision of social support, such that it was significantly negatively associated with psychological distress [$b = -0.16$ (-0.187, −0.131), $SE = 0.02$, $p < 0.001$] and significantly negatively associated with loneliness [$b = -0.19$ (-0.244, −0.143), $SE = 0.03$, $p < 0.001$], providing support for H1c.

In a second step, we tested our mediation hypotheses (H2a and H2b) using both types of social support as mediators. Figure 2 shows the findings from multilevel analysis with the relationship between loneliness and psychological distress mediated by social support received. As expected, higher levels of loneliness predicted less social support received [$b = -0.35$

FIGURE 2
Wave 1 mediation model of the effect of loneliness on psychological distress, via social support received (***$p < 0.001$).

FIGURE 3
Wave 1 mediation model of the effect of loneliness on psychological distress, via provision of social support (***$p < 0.001$).
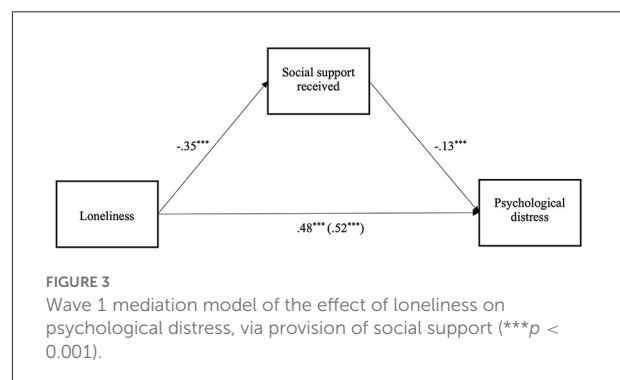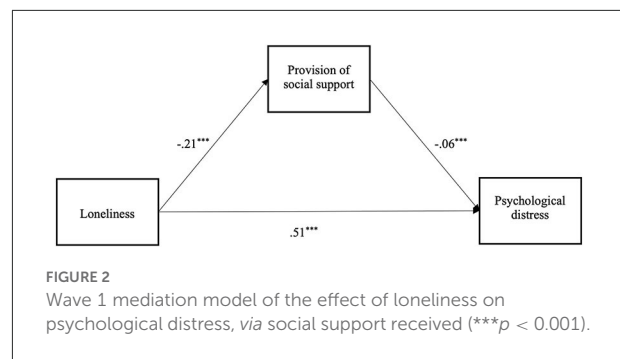
(-0.401, −0.289), $SE = 0.03$, $p < 0.001$], and less received social support in turn predicted higher levels of psychological distress [$b = -0.13$ (-0.162, −0.088), $SE = 0.02$, $p < 0.001$]. The indirect effect between loneliness and psychological distress via social support received was significant [$b = 0.04$ (0.027, 0.059), $SE = 0.01$, $p < 0.001$], providing support for H2a. After accounting for this indirect effect, the direct effect between loneliness and psychological distress remained significant [$b = 0.48$ (0.437, 0.513), $SE = 0.02$, $p < 0.001$].

We then examined the alternative pathway through provision of social support. Figure 3 shows the findings from multilevel analysis with the relationship between loneliness and psychological distress mediated by provision of social support. As hypothesized, higher levels of loneliness predicted less provision of social support [$b = -0.21$ (-0.257, −0.156), $SE = 0.03$, $p < 0.001$], and less provision of social support in turn predicted higher levels of psychological distress [$b = -0.06$ (-0.080, −0.040), $SE = 0.01$, $p < 0.001$]. The indirect effect between loneliness and psychological distress via provision of social support was significant [$b = 0.01$ (0.007, 0.017), $SE = 0.003$, $p < 0.001$], providing preliminary support for H2b. After accounting for this indirect effect, the direct effect between loneliness and psychological distress remained significant [$b = 0.51$ (0.479, 0.535), $SE = 0.01$, $p < 0.001$].

TABLE 2 Means, standard deviations, and bivariate correlations for key variables wave 1 and 2.

Variable	M	SD	Correlations							
			1	2	3	4	5	6	7	8
1. Loneliness (wave 1)	1.62	0.58	-							
2. Social support provided (wave 1)	5.57	1.01	−0.28**	-						
3. Social support received (wave 1)	5.20	1.28	−0.42**	0.54**	-					
4. Psychological distress (wave 1)	2.05	0.84	0.52**	−0.18**	−0.31**	-				
5. Loneliness (wave 2)	1.68	0.62	0.68**	−0.18**	−0.35**	0.47**	-			
6. Social support provided (wave 2)	5.46	1.04	−0.25**	0.65**	0.40**	−0.17**	−0.22**	-		
7. Social support received (wave 2)	5.08	1.32	−0.40**	0.40**	0.66**	−0.30**	−0.47**	0.55**	-	
8. Psychological distress (wave 2)	1.99	0.87	0.45**	−0.17**	−0.29**	0.72**	0.57**	−0.19**	−0.41**	-

$N = 1{,}267.$ **$p < 0.01$.

Longitudinal analysis

Descriptive results and correlations

Table 2 displays the overall means, standard deviations, and bivariate correlations of key variables collapsed across the three Wave 2 countries. Results showed a significant increase in loneliness from Wave 1 ($M = 1.62$) to Wave 2 ($M = 1.68$), $t_{(1,263)} = -5.08$, $p < 0.001$, as the pandemic progressed. Furthermore, and in line with Wave 1 findings, loneliness was positively associated with psychological distress at both timepoints (H1a). On looking at social support–and again in line with Wave 1 findings–support received was significantly negatively associated with both loneliness and psychological distress at both timepoints (H1b), as was support provided (H1c).

Longitudinal relationships

To explore changes in loneliness and distress at Wave 1 and Wave 2, we used SPSS (v28) to conduct a regression between loneliness at Wave 1 and psychological distress at Wave 2, controlling for psychological distress, age and gender at Wave 1. We found that loneliness at Wave 1 significantly predicted psychological distress at Wave 2 ($R^2 = 0.54$, $F_{(4,1,259)} = 364.960$, $p < 0.001$); providing support for H3.

Longitudinal mediation

To test H4a and H4b, we conducted mediation analysis using MPlus version 8.3 (104). The ICC showed that a very small amount of the variance in psychological distress was attributable to national differences (ICC < 0.01), which is consistent with the ICC of psychological distress at Wave 1. Therefore, we conducted the mediation with the collapsed data across three countries, but we note that the conclusions were identical when

the same mediation was conducted through multilevel modeling while controlling for country-level differences.

Starting with support received (H4a), we found a longitudinal result whereby loneliness predicted increased psychological distress over time, and that this was mediated by social support received (see Figure 4). Specifically, greater loneliness at Wave 1, predicted reduced social support received at Wave 2 [$b = -0.16$ (-0.204,−0.106), $SE = 0.03$, $p < 0.001$], over and above Wave 1 social support received [$b = 0.59$ (0.542, 0.641), $SE = 0.03$, $p < 0.001$]. Reduced social support received at Wave 2 in turn predicted increased psychological distress at Wave 2 [$b = -0.21$ (-0.251,−0.160), $SE = 0.02$, $p < 0.001$], over and above Wave 1 distress [$b = 0.64$ (0.597, 0.687), $SE = 0.02$, $p < 0.001$]. The indirect effect between Wave 1 loneliness and Wave 2 psychological distress *via* Wave 2 social support received was significant [$b = 0.03$ (0.020, 0.044), $SE = 0.01$, $p < 0.001$]. After accounting for this indirect effect, the direct effect between Wave 1 loneliness and Wave 2 distress was not significant [$b = 0.02$ (-0.030, 0.065), $SE = 0.02$, $p = 47$], providing support for H4a and aligning with Wave 1 results.

As previously analyzed with the Wave 2 data, we also examined the alternative pathway of providing support to others (H4b). Here, we found a longitudinal link whereby loneliness predicted increased psychological distress over time, and that this was again mediated by the provision of social support (see Figure 5). Specifically, greater loneliness at Wave 1, predicted reduced provision of social support at Wave 2 [$b = -0.07$ (-0.117,−0.027), $SE = 0.02$, $p < 0.01$], over and above Wave 1 provision of social support [$b = 0.63$ (0.579, 0.677), $SE = 0.03$, $p < 0.001$]. Reduced provision of social support at Wave 2 in turn predicted increased psychological distress at Wave 2 [$b = -0.06$ (-0.100,−0.022)], $SE = 0.02$, $p < 0.01$], over and above Wave 1 distress [$b = 0.66$ (0.619, 0.707), $SE = 0.02$, $p < 0.001$]. The indirect effect between Wave 1 loneliness and Wave 2 psychological distress *via* Wave 2 provision of social support was significant [$b = 0.004$ (0.000, 0.008), $SE = 0.002$, $p < 0.05$]; providing support for H4b. After accounting for this indirect

FIGURE 4
Longitudinal mediation model of the effect of loneliness at wave 1 on psychological distress at wave 2, *via* social support received at wave 2, while controlling for wave 1 levels of distress and social support received (* $p < 0.05$. **$p < 0.01$. ***$p < 0.001$).

FIGURE 5
Longitudinal mediation model of the effect of loneliness at wave 1 on psychological distress at wave 2, *via* provision of social support at wave 2, while controlling for wave 1 levels of distress and provision of social (** $p < 0.01$. ***$p < 0.001$).

effect, the direct effect between Wave 1 loneliness and Wave 2 distress was still significant [$b = 0.07$ (0.025, 0.120), $SE = 0.02$, $p < 0.01$].

A final analysis examined the effects of both provided and received support simultaneously as mediators of the relationship between loneliness and distress (see Figure 6). We found that greater loneliness at Wave 1, predicted reduced social support received at Wave 2 [$b = -0.17$ (-0.215,−0.119), $SE = 0.02$, $p < 0.001$], over and above Wave 1 social support received [$b = 0.58$ (0.525, 0.624), $SE = 0.03$, $p < 0.001$]. At the same time, reduced social support received at Wave 2 predicted increased psychological distress at Wave 2 [$b = -0.23$ (-0.284,−0.173), $SE = 0.03$, $p < 0.001$], over and above Wave 1 distress [$b = 0.64$ (0.596, 0.686), $SE = 0.02$, $p < 0.001$]. The indirect effect between Wave 1 loneliness and Wave 2 psychological distress *via* Wave 2

received social support was significant [$b = 0.04$ (0.024, 0.053), $SE = 0.01$, $p < 0.001$]. We also found that greater loneliness at Wave 1 predicted reduced provision of social support at Wave 2 [$b = -0.08$ (-0.125,−0.034), $SE = 0.02$, $p < 0.01$], over and above Wave 1 provision of social support [$b = 0.61$ (0.565, 0.662), $SE = 0.03$, $p < 0.001$]. Reduced provision of social support at Wave 2 predicted reduced Wave 2 psychological distress [$b = 0.05$ (0.002, 0.095), $SE = 0.02$, $p < 0.05$], over and above Wave 1 distress [$b = 0.64$ (0.596, 0.686), $SE = 0.02$, $p < 0.001$]. The indirect effect between Wave 1 loneliness and Wave 2 psychological distress *via* Wave 2 provision of social support was not significant [$b = -0.004$ (-0.008, 0.000), $SE = 0.002$, $p = 0.079$]. After accounting for both indirect effects, the direct effect between Wave 1 loneliness and Wave 2 distress was not significant [$b = 0.02$ (-0.028, 0.067), $SE = 0.02$, $p = 0.43$].

FIGURE 6
Longitudinal mediation model of the effect of loneliness at wave 1 on psychological distress at wave 2, *via* social support received at wave 2 and provision of social support at wave 2, while controlling for wave 1 levels of distress, provision of social support, and social Support Received (* *p* < 0.05. ** *p* < 0.01. ***p* < 0.001).
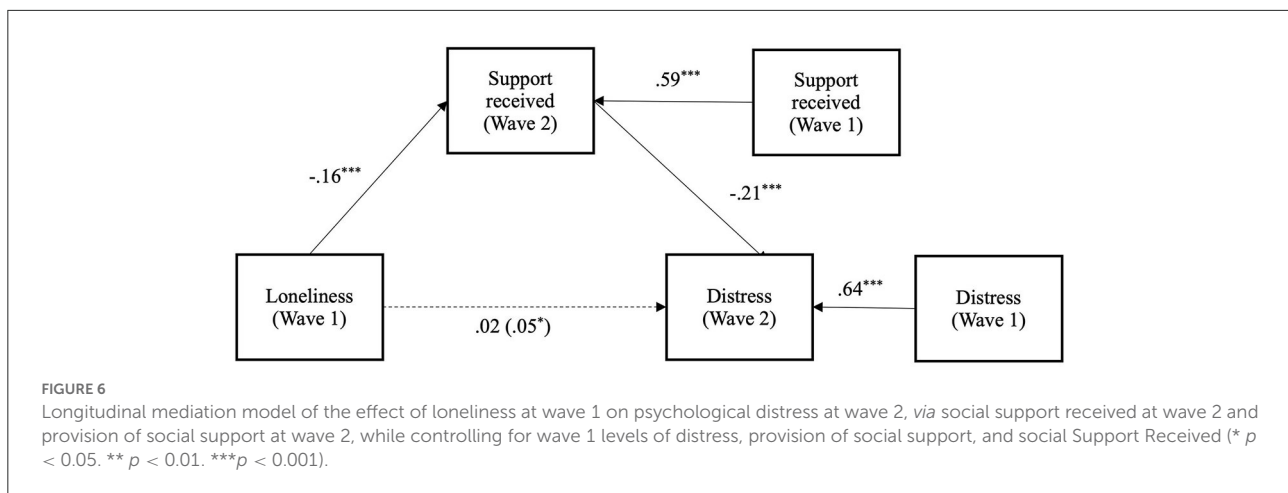
Discussion

During the COVID-19 pandemic levels of loneliness and psychological distress increased across the world (8, 9, 11). There were many contributing factors to these outcomes, not least, a significant reduction in the richness of social interaction that was enforced to curb the spread of the virus (4, 10, 106). Social distancing requirements and the various stay-at-home orders also meant that people's ability to receive support and support others–key hypothesized mechanisms through which to both overcome loneliness and associated psychological distress– was hindered. Enforced social isolation therefore not only reduced people's ability to enact social connection, but this is turn made social support a challenge–both logistically and psychologically, thereby creating a double jeopardy. In our research, we examined the role played by social support in the relationship between loneliness and psychological distress, particularly testing the pathway from loneliness to distress *via* both received and provided social support. The latter pathway *via* support provision is currently under-investigated in the literature but was particularly relevant during the COVID-19 pandemic in which providing support to more vulnerable groups became highly salient (11, 17–20).

We interrogated a large multi-county dataset across eleven countries and found a significant association between loneliness and distress. Using longitudinal data from three countries, we found evidence that this relationship unfolded over time in the hypothesized direction such that increased loneliness predicted increased distress. This extends the loneliness literature by providing evidence for directionality in this relationship from loneliness to distress (12, 107). We also found that increased social support–both received and provided–was associated with lower levels of loneliness and psychological distress. Specifically, across time, we found that a sense of both being supported as well as providing support for others partially explained the relationship between loneliness and psychological distress, such

that lonelier people reported lower levels support receipt and provision, and this in turn caused them more psychological distress. These longitudinal findings confirm the positive role played by support given and received in the relationship between loneliness and distress (21–23, 64, 65).

The more novel demonstration of the importance of support provision provides further evidence of how helping others can mediate the relationship between group connectedness and improved health and wellbeing (51, 52, 71). Of note however, when examining both forms of support together, it appeared that receiving support had more impact on the relationship between loneliness and distress than provision of support. This might be a reflection of the difficulties people had in providing support to others due to enforced social distancing measures. It might also be a reflection of the importance of feeling supported *by others* through a highly stressful event, and which fits with other data collected during the pandemic demonstrating the relationship between lower levels of support received and psychological distress (108).

The current findings have several theoretical implications. Using a large, multi-country dataset, our results provide an empirically tested model of the directional relationship between loneliness and distress during COVID-19. Further, our results highlight a key underlying mechanism–that of social support. Social support has previously been shown to play a key role in unlocking the social cure benefits of group connectedness (52, 71). At the same time, the enactment of support provides a means of structuring and cementing social connection (33, 109). This aligns with previous research that has shown how social support is associated with improved wellbeing and reduced loneliness (26, 27, 75, 78, 79).

The current research extends our understanding of these findings by demonstrating that benefits of support flow two ways–both feeling supported and feeling more able to support others reduces psychological distress. What we also found was that people who felt lonelier were less likely to be

able to activate and engage in support receipt and support provision. Demonstrating this relationship at a time when social connection opportunities were restricted is particularly important as many people–but especially more vulnerable groups–were at a heightened risk of increased levels of loneliness, and thus more vulnerable to increased psychological distress (11, 13, 17–20).

In addition to the theoretical implications noted above, the practical implications of these findings inform our understanding of how to reduce loneliness and psychological distress in the event of future public challenges, particularly ones associated with increased social disconnection. Social support is already recognized as a key factor in the management of public health (62, 63). However, in addition to targeting receipt of social support, governments, organizations, and communities, could benefit from investing in policies and procedures to direct, scaffold, and promote opportunities to create an increased sense of social connection, particularly through providing the means for people to engage in all forms of social support. This may take the form of educational material in which the importance of group connectedness can be promoted (see GROUPS 2 CONNECT; 106), or could be established through financial or structural support for the creation and maintenance of community-based mutual aid groups (95). Enactment of support would thus create a platform for the establishment of social connection and for harnessing the measurable benefits of a social cure. Beyond COVID-19 or similar events, a greater understanding of the power of social support might also benefit the management of what has recently been referred to as the loneliness epidemic (54, 110–112).

Strengths, limitations, and future directions

This study analyzed data from eleven different countries across the globe. Such a large dataset provided us with a significant source of information with which to understand loneliness, psychological distress, and provision of social support. However, a limitation of using crowd sourcing platforms, as well as convenience samples for some countries, was that the sample is unlikely be fully representative. A further limitation was that the measures used were deliberately brief due to the data forming part of a much larger survey. As such, it would have been preferable to have more measures with which to validate the constructs of interest, using clinical measures of other related constructs such as depression or anxiety. Methodological limitations also resulted from the cross-sectional nature of the Wave 1 data. However, being able to test the same analysis longitudinally through inclusion of the Wave 2 data, did strengthen our analysis. It is worth noting however that within the multi-level model, the co-efficient

from social support to psychological distress was small (but significant). Future research using alternative datasets collected during the COVID-19 pandemic in which the same, or similar variables were measured, could shed more light on the extent of these relationships.

Conclusion

Dealing with crisis events such as the COVID-19 pandemic requires the management of both structural issues, and the related psychological fall-out caused by social disconnection and loneliness. The current research contributes to our understanding of factors that might mitigate the negative outcomes associated with these conditions. We showed that increased loneliness led to psychological distress, and that this relationship could be explained by both perceived feelings of being unsupported, as well as feeling unable to support others. In times of crisis, providing a means for people to take more positive social action–to help others–has the advantage of providing support for those in need as well as delivering a social cure for those giving support.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by School of Psychology, The University of Queensland. The participants provided their written informed consent to participate in this study.

Author contributions

SB, TY, BA, JJ, and CH contributed to conception and design of the study. BA organized the database and performed the statistical analysis. SB wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh. 2022.976443/full#supplementary-material

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Check for updates

Early life adverse experiences and loneliness among young adults: The mediating role of social processes

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Loneliness has been described as endemic among young people. Such feelings of social isolation 'even in a crowd' are likely linked to adverse early life experiences that serve to diminish perceptions of social support and intensify negative social interactions. It was suggested in the present series of survey studies that childhood abuse, which compromises a child's sense of safety in relationships, may affect social processes that contribute to loneliness in young adulthood. Study 1 assessed different adverse childhood and adult experiences in relation to loneliness among young adults ($N = 171$). Linear regression analyses indicated that childhood abuse was uniquely associated with greater loneliness, and this relationship was partially mediated by the perceived availability of social support. Study 2 ($N = 289$) assessed different forms of childhood abuse and demonstrated that early life emotional abuse was a unique predictor of loneliness, and this relationship was fully mediated by lower perceived support or value in social connections (social connectedness) and more frequent unsupportive interactions with friends. Study 3 evaluated the implications of the age of occurrence of abuse ($N = 566$). Both emotional and sexual abuse predicted young adult loneliness regardless of age; abuse that was recalled to have occurred at very early ages (0−5 years) was not predictive of loneliness over and above consideration of events that happened in older childhood. These relationships were at least partially mediated by perceived social support, social connectedness, and in the case of emotional abuse, unsupportive interactions with friends. Our results add to mounting evidence pointing to the prevalence of loneliness among young adults and the links to adverse early life experiences that may serve to shape appraisals of safety, value, and personal worth in social relationships.

KEYWORDS

loneliness, early life trauma, emotional abuse, social support, young adult

Introduction

The prevalence of loneliness and its association with adverse health outcomes has become increasingly salient to the general public and among health professionals. Loneliness has been described as an epidemic (Jeste et al., 2020) and pandemic (Palgi et al., 2020). The United Kingdom and Japan each recently appointed a Minister for Loneliness (Basu, 2021). Most recently, the COVID-19 pandemic rendered the consequences of loneliness highly visible, including associations with greater occurrence of anxiety, depression, and elevated substance use (Meade, 2021; Knox et al., 2022). These links were especially marked among younger individuals (Varma et al., 2021), including university students (Bu et al., 2020) who are increasingly being recognized as a group at risk (Diehl et al., 2018; Hysing et al., 2020).

While much attention was paid to these issues through the COVID-19 pandemic, the prevalence of loneliness was not unique to the global social distancing policies that were invoked. Even prior to COVID-19, young adults (18–22 years) were described as the 'loneliest generation of Americans' (Cigna, 2018) with 20–48% reporting severe levels of loneliness (Williams and Braun, 2019). Loneliness at this stage of life poses developmental risks as the young adult years are marked by several transitions, including the expansion of their social world beyond the family, identity exploration, and greater autonomy (Kirwan et al., 2021). Thus, loneliness may be problematic for many adolescents and young adults, being related to cognitive and physical maturation, as well as developmental changes in social autonomy, perspective-taking, and individuation (Laursen and Hartl, 2013; Buecker et al., 2021).

Loneliness does not merely encompass social isolation but includes the psychological torment and pain that comes from a lack of meaningful relationships. Thus, loneliness is both a relational experience and an emotional one (Hawkley and Cacioppo, 2010; Von Soest et al., 2020). The factors that promote or prevent loneliness likely have strong roots in opportunities and safe environments that enable individuals to take full advantage of their social relationships in a manner that ensures well-being. Conversely, encounters that undermine trust, emotional connections to others, or that have been fraught with personal violation or emotional betrayal might diminish the ability to derive socially meaningful relationships. In this regard, early life socio-emotional events may play a significant role in whether individuals experience loneliness as young adults. It was the goal of the present investigation to assess the relations among adverse early life experiences, young adults' social experiences and perceptions, and their reports of loneliness.

Childhood experiences and loneliness

Both childhood and adult trauma experiences were predictive of feelings of loneliness among a range of populations (Kearney et al., 2018; Hyland et al., 2019). The disposition to loneliness and the trajectory toward loneliness among young people is variable over time and across individuals, being related to differences in emotional stability, agreeableness, and extraversion (Vanhalst et al., 2013). Of the many factors that can proactively influence adult well-being, adverse early life experiences may have especially pronounced consequences (Hays-Grudo and Morris, 2020), including links to anxiety and depressive disorders, and suicidal ideation (Anda et al., 2006; Brown et al., 2009; Hays-Grudo and Morris, 2020). It has been reported that childhood abuse was associated with elevated loneliness among young adults (Flett et al., 2016; Arslan and Yıldırım, 2021), and loneliness might represent a mediating factor in the relationship between abuse and psychological disorders (Shevlin et al., 2015). Among other things, traumatic childhood experiences may give rise to feelings of social indifference together with loneliness, which was predictive of suicidal ideation. However, the strength of these relationships diminished when individuals were recognized by others in relevant social groups (Wang et al., 2022).

Adverse childhood experiences may take many forms that can reflect environmental factors (e.g., living in poverty or unsafe neighborhoods) and relational factors, ranging from emotional, physical, or sexual abuse to disturbed parent-child interactions (e.g., neglect, disengagement from children, as well as hostility and coercion) (Rebbe et al., 2017). Some of these experiences may reflect multiple concurrent elements of a particular early life environment (e.g., parental substance use may co-occur with child neglect), and might represent the cumulative occurrence of events over time. While a greater number of adverse childhood events is associated with poorer adult health and wellness outcomes (Hughes et al., 2017; Petruccelli et al., 2019), the nature of these early life experiences may elicit different processes and outcomes (Rebbe et al., 2017; Shin et al., 2018). For example, both childhood physical and emotional abuse were related to suicidal ideation through their links to anxiety, whereas childhood neglect was tied to suicidal ideation through diminished social support (Bahk et al., 2017). Other researchers using latent class analysis of adverse childhood experiences have found commonalities in patterns associated with experiences involving deprivation or violence (Henry, 2020). However, the psychosocial mechanisms linking varying types of adverse experiences with mental health outcomes are less well understood, although multiple biopsychosocial processes are likely implicated (Anisman et al., 2018; Barrero-Castillero et al., 2022).

Young children are typically incapable of making accurate appraisals of situations and may misinterpret parental mistreatment and form inappropriate inferential attributions for their experiences to aspects of themselves, thereby promoting self-blame and diminished self-esteem (Hays-Grudo and Morris, 2020). Coupled with misappraisals, young children may lack effective coping strategies that might otherwise diminish distress (Compas et al., 2017). Cumulative adverse experiences may come to undermine school performance, disturb the ability to form and maintain close relationships, foster mistrust of others, and impair self-regulation, all of which may favor the emergence of psychological disorders in young adulthood (Kisely et al., 2018; Fitzgerald and Gallus, 2020; Karatekin and Ahluwalia, 2020; Colburn et al., 2021). Of course, the impact of early life experiences on the development of loneliness can be influenced by a gamut of psychosocial factors, including age and gender, maladaptive cognitive schemas, epigenetic factors, and socioeconomic status, among many others (Southwick et al., 2014).

Diminished perceptions of social support

Irrespective of age, several social factors, including number of friends, social engagement, and frequency of contact have been tied to feelings of loneliness (Luhmann and Hawkley, 2016). Not surprisingly, such social assets have been identified as critical protective factors that promote resilience in the face of adverse childhood experiences (Sperry and Widom, 2013; Fitzgerald and Gallus, 2020; Leung et al., 2022). Conversely, social ostracism partially mediated the link between adverse childhood experiences and later feelings of loneliness (Arslan and Yıldırım, 2021). Young adults who had experienced more adverse events in their household while growing up perceived less social support (Gayman et al., 2011; Caravaca-Sánchez et al., 2019; Karatekin and Ahluwalia, 2020; Colburn et al., 2021), which predicted greater symptoms of anxiety and depression (Watt et al., 2020). Likewise, childhood physical and emotional abuse were associated with diminished social networks and greater perceived peer rejection in adulthood, which were linked to greater loneliness (Gibson and Hartshorne, 1996; Lev-Wiesel and Sternberg, 2012). It has been suggested that the shame associated with abusive experiences may promote negative perceptions of social support, and hence decreased disclosure of traumatic events (Aakvaag et al., 2019), which might undermine the longer-term capacity to cope effectively with such experiences.

Many adverse childhood experiences are inherently relational, often being committed by an individual who is an important attachment figure and should be a protective influence for the child. This may foster maladaptive cognitive processing of emotionally intense situations and limitations in emotional regulation and social skills (Dvir et al., 2014;

Gama et al., 2021). In addition, the experience of childhood abuse may have important implications for how an individual appraises social support and social connection (Williams and Galliher, 2006; Dodson and Beck, 2017). Specifically, an individual may determine that the risks involved with social connections are not worth the potential benefits and may not actively seek out or appreciate the social support that is available to them (Lee and Robbins, 1995; Lee et al., 2001; Williams and Galliher, 2006), choosing social isolation instead of connection (Arslan and Yıldırım, 2021). The interpersonal foundation of childhood abuse and maltreatment has been proposed as a cogent mechanism by which child abuse promotes later life psychological distress and mental health challenges, including loneliness (Fitzgerald and Gallus, 2020).

The present investigation

Early life adverse experiences can profoundly influence psychosocial functioning among young adults. Yet, little is understood about the socio-emotional wellness of young people with respect to their feelings of loneliness, despite its prevalence and documented connection to mental health. A cluster of early life factors has been linked to loneliness among young adults, including reports of early life trauma, household adversity, psychological maltreatment, and various forms of abuse. There is emerging evidence that different forms of early life adversity trigger varying psychological trajectories. Similarly, diverse social processes have been implicated in the relations between childhood experiences and loneliness, including perceived social support, social isolation, social skills, rejection, and recognition or ostracism from others. Thus, the present multi-study investigation, conducted prior to the COVID-19 pandemic, explored various early life adverse experiences and their relation to loneliness, together with several aspects of social functioning to better understand mechanisms that link the childhood experiences and loneliness in young adulthood. In Study 1, we assessed different forms of trauma experiences in relation to loneliness among young adults, including the mediating role of perceived social support from parents and peers. Study 2 further assessed relations between different forms of childhood abuse and loneliness and expanded on potential social mediators including social connectedness and unsupportive social interactions with parents and peers. Finally, Study 3 assessed whether the age at which specific forms of abuse were experienced had differential implications for social processes and the relationships with loneliness.

Study 1

While adverse childhood experiences have been found to be predictive of loneliness and the emergence of other

psychopathologies in adulthood, what is rarely taken into consideration is the proliferation of stressors that may co-occur with early life adversities. In this regard, adverse childhood experiences have been associated with an elevated risk of subsequent stressor encounters (Widom et al., 2008; Radford et al., 2013). In addition, re-victimization is common among childhood abuse survivors, and it is possible that these later experiences could account for adult wellness (Grasso et al., 2016; Goemans et al., 2021). In Study 1, the relations between exposure to a range of traumatic events (including experiences of adult victimization) and loneliness in young adulthood were assessed. Of particular interest was whether abusive childhood experiences uniquely predicted loneliness relative to other forms of trauma that may be encountered either in adulthood or childhood.

While multiple aspects of social relationships may be affected by early life experiences, a lack of perceived social support is a strong predictor of loneliness (Wang et al., 2018). Social support has been shown to mediate the relationship between experiences of early life trauma and abuse and loneliness in adolescence and adulthood (Runtz and Schallow, 1997; Sperry and Widom, 2013; Watt et al., 2020). The differential effects of such support from friends relative to parents may be especially pertinent during the transition to young adulthood (Riggio et al., 1993; Chen and Feeley, 2014). Adolescence is a developmental stage in which individuals' identity begins to move from parental influences to those provided by peers, and the social-emotional skills that are critical to establishing supportive peer relationships are shaped by individuals' well-being and sense of self (Mitic et al., 2021). It was hypothesized that the relationship between abusive childhood experiences and current loneliness would be mediated by diminished perceptions of social support. As the comparative effects of various sources of perceived support (i.e., parents, friends) in relation to loneliness are not yet well understood (Fitzgerald and Gallus, 2020), the relative contribution of perceived support from friends or parents was also evaluated.

Materials and methods

Participants and procedures

Participants were first-year undergraduate students aged 25 years or less recruited online through a computer registry (SONA system), and comprised primarily white/Caucasian females (see Table 1). Upon provision of informed consent, participants completed a series of measures, after which they were fully debriefed, and provided with course credit for their participation and contact information should they experience any distress. The study protocol was approved by the Research Ethics Board at Carleton University (REB#: 03-006).

Measures

Demographics

Participants were asked to identify their gender, age, and ethnoracial background using an open-ended question format.

Loneliness

The UCLA Loneliness Scale Version 3 (Russell, 1996) includes 20 items that assess perceived loneliness (e.g., "How often do you feel alone?"), social behaviors (e.g., "How often do you feel shy?"), and quality of relationships (e.g., How often do you feel that your relationships with others are not meaningful?"). Respondents rated the frequency of such feelings from 1 (never) to 4 (always) and ratings across the items were summed (Cronbach's $\alpha = 0.89$) to provide scores with a possible range of 20–80.

Social support provisions

Perceptions of social support provided by parents and friends were assessed using Cutrona and Russell's (1987) Social Provisions Scale comprising 12 items in relation to each of the sources of support. Participants indicated whether a range of supportive behaviors was provided by each of the sources on a 3-point rating scale: no (1), not sure (2), and yes (3). Mean scores were calculated for the social support provided by parents (Cronbach's $\alpha = 0.89$) and friends (Cronbach's $\alpha = 0.89$). Perceptions of support from these sources was moderately correlated, $r = 0.40$, $p < 0.001$.

Trauma experiences

The Traumatic Life Events Questionnaire (TLEQ) (Kubany et al., 2000) identifies significant traumatic life events at various points across the participant's life. This measure comprises a broad spectrum of potentially traumatic events, ranging from natural disasters, accidents, and assaults, to childhood abuse. Events are described in behaviorally descriptive terms. The frequency of occurrence of each event is assessed using a 7-point scale on which participants indicate whether each event has occurred from never (0) to more than five times (6). For the present study, our interest in various trauma exposures resulted in consideration of five experiences, including (1) non-social experiences of shock (e.g., being in a car accident), social experiences of (2) loss (i.e., the death of a loved one) or (3) having something bad happen to a loved one (e.g., witnessing assault), (4) traumas that involved social threats to the participant directly as an adult (e.g., physically hurt by an intimate partner or threatened by a stranger), and (5) abuse 'while growing up' (i.e., physical punishment and inappropriate sexual interactions) (based on Breslau et al., 1999).

Trauma exposure was calculated in two ways. To assess whether different types of trauma were differentially associated with loneliness, for each of the five trauma types, the average occurrence of the respective events was calculated irrespective of the age at which they were experienced. Second, early life trauma

TABLE 1 Demographic description and prevalence of loneliness for participants of all three studies.

		Study 1 (N = 171)		Study 2 (N = 289)		Study 3 (N = 566)	
		n	%	*n*	%	*n*	%
Gender	Male	54	31.6	75	26.0	147	26.1
	Female	117	68.4	214	74.0	416	73.9
Ethnoracial identity	White/Caucasian	111	72.5	185	64.0	319	56.6
	Asian	26	17.1	66	22.9	146	25.9
	Black	9	5.9	24	8.3	62	11.0
	Indigenous	2	1.3	5	1.7	5	0.9
	Mixed/Other	5	3.3	9	3.1	32	5.7
Age (years)	Mean/*SD*	19.10	1.52	18.76	1.59	19.11	1.69
Loneliness	Score < 34	59	34.5	75	26.0	140	24.7
	Score 35 – 49	68	39.8	137	47.4	247	43.6
	Score ≥ 50	44	25.7	77	26.6	179	31.6

Missing not included in calculations; missing < 1% except for ethnoracial identity in Study 1 (missing *n* = 18, 10.5%).

exposure was calculated by counting the number of events participants reported as having occurred 10 or more years ago (given the mean age of the participants, events that happened 10 or more years ago likely constituted childhood experiences) collapsed across the trauma types (with the exception of abuse while growing up).

Statistical analyses

Frequencies of traumatic events were reported, and gender differences were assessed using independent t-tests. Zero-order relationships among variables were explored using Pearson correlations. To determine whether different forms of trauma were uniquely predictive of loneliness, two linear regression analyses were conducted wherein the five trauma types (at any age; or those experienced 10 or more years ago) were entered simultaneously as predictors. A mediation analysis assessed whether the relations between childhood abuse and loneliness could be accounted for by the diminished levels of perceived social support from friends and parents. The PROCESS macro applying model 4 (Hayes, 2022) was used with bootstrapping procedures using 5,000 resamples to establish the 95% confidence intervals (CI) to assess significance. A follow-up analysis was conducted to determine whether gender moderated the mediated model (PROCESS model 8). For each analysis, the power to detect a medium effect size of partial $R^2 = 0.05$ at $p = 0.05$ with the sample size of the present study was β = 0.85.

Results

The most common form of traumatic event reported by participants was the death of a loved one ($n = 94$, 55.0%). However, other events were not uncommon, including those constituting a severe shock ($n = 54$, 31.6%), witnessing negative experiences among loved ones ($n = 75$, 43.9%), or even personal

assault as an adult ($n = 44$, 25.7%). While the majority of participants did not report experiencing any of these forms of trauma as children (i.e., more than 10 years ago), 19.3% ($n = 33$) reported at least one early life general trauma experience. In addition, 25.7% ($n = 44$) indicated some form of childhood physical or sexual abuse. There was a significant relationship between experiencing abuse as a child and assault in adulthood, $r = 0.37$, $p < 0.001$. There were no gender differences in trauma experiences, nor in feelings of loneliness ($M = 42.35$, $SD = 12.67$). As seen in Table 1, about a third of participants reported relatively low levels of loneliness (scores of 34 or less), but a quarter had moderately high to high scores (50 or greater).

A multiple linear regression analysis conducted with the five trauma types entered together as predictors indicated that, as a whole, traumatic events were not associated with greater loneliness, $R^2 = 0.054$, $F(5,164) = 1.86$, $p = 0.104$. However, examination of the regression coefficients indicated that reports of childhood abuse were uniquely associated with greater loneliness, $b = 2.82$, $SE = 1.16$, $p = 0.016$, $r = 0.22$, $p = 0.002$. Assault as an adult was correlated with greater loneliness, $r = 0.13$, $p = 0.052$, whereas other trauma types were not significantly related to loneliness ($ps > 0.17$).

The multiple regression analysis with traumas experienced early in life trauma (more than 10 years ago) as predictors showed that early life experiences were associated with greater loneliness, $R^2 = 0.064$, $F(2,168) = 5.07$, $p = 0.004$. Examination of the regression coefficients indicated that, once again, only reports of childhood abuse were associated with greater loneliness, $b = 6.10$, $SE = 1.84$, $p = 0.001$, whereas other early life traumas were not, $r = 0.05$, $b = 1.23$, $SE = 2.10$, $p = 0.559$.

As childhood abuse was the only trauma type that was uniquely associated with loneliness, the extent to which this relation was mediated by diminished levels of perceived social support from parents or friends was assessed. As seen in Figure 1, the relationship between childhood abuse and

FIGURE 1
Mediated relationship between experiences of childhood abuse and loneliness through perceived social support from friends and parents in Study 1. Path coefficients indicate that childhood abuse was associated with perceived support and such perceptions were, in turn, related to loneliness. Perceived support partially accounted for the relationship between experiences of child abuse and loneliness among young adults. c represents the total effect, whereas c' represents the direct effect. $^+p < 0.10$; $^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$. $N = 171$.

loneliness was partially accounted for by lower perceived social support, Effect = 1.60, $CI_{0.95}[0.02, 3.65]$, but not uniquely from friends, $a_1b_1 = 1.21$, $CI_{0.95}[-0.18, 3.04]$, or parents, $a_2b_2 = 0.40$, $CI_{0.95}[-0.03, 1.07]$. Gender did not significantly moderate the mediated relationships.

Discussion

As identified in previous research (Cigna, 2018; Williams and Braun, 2019), high levels of loneliness were prevalent in over a quarter of this population of young adults. In addition, a sizable proportion had experienced some form of traumatic event, and in particular, childhood abuse in the form of excessive physical punishment or inappropriate non-consensual sexual interactions was reported by more than 1 in 4 young adults. Although other types of childhood or adult traumatic experiences were common, they were not predictive of loneliness, whereas childhood abuse was related to increased loneliness as a young adult. It seems the social threat emanating from childhood abuse may be an important mechanism associated with later life well-being, whereas experiences reflecting more general adverse childhood experiences or the effects of a broad range of stressors encountered as young adults were less prominent. Childhood abuse was associated with a higher likelihood of revictimization in the form of assault in young adult years. Although adult assault experiences were related to loneliness, they did not account for unique variation when childhood abuse was controlled. This would suggest that the early life experiences play a greater role than those that might be reflective of adult revictimization in shaping feelings of loneliness among young adults.

The relation between childhood abuse and loneliness was partially mediated by lower perceptions of social support, which aligns with research demonstrating the mediating role of social

support in the relationship between childhood abuse and well-being more generally (Runtz and Schallow, 1997; Fitzgerald and Gallus, 2020; Watt et al., 2020). As in earlier research, individuals who experienced childhood abuse were more likely to perceive lower social support from both parents and peers (friends) (Gayman et al., 2011; Caravaca-Sánchez et al., 2019; Karatekin and Ahluwalia, 2020; Colburn et al., 2021). Thus, the experience of childhood abuse may have important implications for how an individual appraises the availability of social support across sources, and may have significant implications for their ability to fill social needs (Gayman et al., 2011; Flett et al., 2016; Von Soest et al., 2020).

An important limitation of Study 1 was the assessment only of childhood sexual or physical abuse. Notably absent were experiences of emotional abuse. This is particularly relevant given that various forms of childhood abuse (i.e., sexual abuse, physical abuse, or emotional abuse) can have differential implications for later life mental health (Kisely et al., 2018; Poole et al., 2018; Colburn et al., 2021; Gama et al., 2021), as well as for social support resources.

Study 2

The numerous socio-emotional outcomes of childhood abuse, including shame and poor views of the self (Wright et al., 2009), a belief that one does not matter to others (Flett et al., 2016), lack of trust in others (Dodson and Beck, 2017), and low social skills (Li et al., 2022) can result in an individual feeling low social connectedness (Lee et al., 2001). Social connectedness is a relational schema that goes beyond perceptions of social support to encompass the value an individual places on their relationships with others and their sense of belonging (Lee and Robbins, 1998; Lee et al., 2001). Importantly, because the cognitive schemas that shape social connectedness begin to form in early life, they may be particularly prone to adverse childhood

experiences that shape one's view of the self in social situations (Lee et al., 2001; Wright et al., 2009). Low social connectedness has been proposed to be a coping mechanism designed to protect an individual from further harm to the self that others may inflict (i.e., rejection), and hence limits perceptions of social support (Lee et al., 2001) and may exacerbate feelings of loneliness.

Possibly due to trust and communication issues, an individual may not only be less likely to perceive that support is available, but might encounter more unsupportive responses from friends or parents when help is sought (Poole et al., 2018; Alink et al., 2019). Childhood abuse may influence choices in adult relationships that compound the likelihood of negative social interactions (Fergusson and Horwood, 1999; Aakvaag et al., 2019), either because they have been exposed to predominantly unsupportive relationships as children (Gayman et al., 2011; Von Soest et al., 2020) or because poor social functioning limits their friendship options (Lev-Wiesel and Sternberg, 2012; Li et al., 2022).

Study 2 broadened our assessment of childhood abuse and considered the mediating role of multiple aspects of social relationships. As Study 1 did not demonstrate that perceptions of support from friends relative to parents were differentially associated with reported child abuse or loneliness, Study 2 assessed perceived support in general, together with an overall sense of social connectedness. However, cognizant of the importance of establishing positive peer relationships through the transition to adulthood and the potentially powerful implications of not acquiring support from friends though this period, we evaluated the mediating role of unsupportive interactions with each of friends and parents in the relationship between trauma and loneliness in young adults.

Materials and methods

Participants and procedure

As in Study 1, participants (N = 289) were first-year undergraduate students aged 25 years or less, recruited online through a computer registry (SONA system), and comprised a primarily female and White/Caucasian sample (see **Table 1**). Upon provision of informed consent, as in Study 1, participants provided demographic information and completed the Traumatic Life Events Questionnaire and the UCLA Loneliness Scale (Cronbach's α = 0.89), along with additional measures of early life abuse and indices of social support. The study protocol was approved by the Research Ethics Board at Carleton University (REB#105169).

Additional measures
Early Life Trauma Inventory (ELTI)

This measure of trauma assessed the self-reported occurrence of traumatic events occurring before the age

of 18 years (Bremner et al., 2007). Respondents rated the frequency of 27 events from 0 (never) to 5 (more than 10 times). The events reflected four types of trauma exposure, namely (1) general trauma (e.g., natural disaster, death, serious accidents, violence) (Cronbach's α = 0.94); (2) physical punishment (i.e., physical contact or restraint with the purpose of causing physical injury to the victim) (Cronbach's α = 0.89); (3) emotional abuse (i.e., verbal harm in the form of shameful and demeaning communication targeted to the victim) (Cronbach's α = 0.94); and (4) sexual events (i.e., unwanted sexual contact that satisfies the perpetrator and/or humiliates the victim) (Cronbach's α = 0.86).

Social support perceptions

As a distinction between support from parents and peers was not evident in Study 1, Study 2 employed a more comprehensive measure of perceived support from others in general (Cutrona and Russell, 1987). This version of the Social Provisions Scale comprised 24-items that assessed the degree of support participants perceived in their current relationships, rated on a scale from 1 (strongly agree) to 4 (strongly disagree) and averaged across all items (Cronbach's α = 0.92).

Social connectedness

This measure comprised 20 items that assessed individuals' sense of belonging and connection within their social world (e.g., "I find myself actively involved in people's lives"; "Even around people I know, I don't feel that I really belong" – reverse-scored) (Lee et al., 2001). Respondents rated each statement from 1 (strongly disagree) to 6 (strongly agree), and ratings were averaged to reflect greater social connectedness (Cronbach's α = 0.93).

Unsupportive social interactions inventory

Unsupportive interactions with friends and parents were assessed in terms of 24 items that assessed various unsupportive responses, including distancing (e.g., "Would change the subject before I wanted to"), bumbling (e.g., "Would not seem to know what to say, or would seem afraid of saying or doing the "wrong" thing"), minimizing (e.g., "Would try to cheer me up when I was not ready to"), and blaming (e.g., "Would ask "why" questions about my role in the event.") (Ingram et al., 2001). Respondents were first asked to think about times they turned to their friends for support before rating their experiences from 0 (none) to 4 (a lot) (Cronbach's α = 0.93) followed by responding to their interactions with their parents (Cronbach's α = 0.93). In both instances, average scores across the items were calculated to reflect greater unsupportive interactions.

Statistical analyses

The same approach to statistical analyses followed in Study 1 was applied in Study 2. The power to detect a medium effect size of partial R^2 = 0.05 at p = 0.05 with the number of variables

Results

Based on responses to the Early Life Trauma Inventory, males were more likely to report early life experiences of physical punishment ($M = 1.99$, $SD = 1.86$) than females ($M = 1.19$, $SD = 1.47$), $F_{(1,286)} = 14.05$, $p < 0.001$, whereas females were more likely to report inappropriate sexual encounters ($M = 0.75$, $SD = 1.45$) than males ($M = 0.27$, $SD = 0.76$), $F_{(1,286)} = 7.50$, $p = 0.007$. There were no gender differences in reports of emotional abuse ($M = 1.35$, $SD = 1.71$) or general trauma exposure ($M = 1.90$, $SD = 1.66$). Correlations among adverse experiences were all moderately positive, ranging from $r = 0.20$ (physical punishment and sexual events) to $r = 0.46$ (between physical punishment and emotional abuse). Notably, general trauma exposure reported in responses to the TLEQ was not associated with any of the dimensions of early life trauma assessed using the ELTI, whereas childhood abuse reported on the TLEQ was associated with higher reports of physical punishment, $r = 0.34$, $p < 0.001$, sexual events, $r = 0.48$, $p < 0.001$, and emotional abuse, $r = 0.30$, $p < 0.001$, along with traumas in general, $r = 0.27$, $p < 0.001$.

There was no gender difference in feelings of loneliness ($M = 43.01$, $SD = 11.40$). As in Study 1, about a quarter of the sample expressed moderately high to high loneliness scores (50 or greater) (Table 1).

The multiple regression analysis assessing the relations between experiences of early life trauma (from the ELTI) and current loneliness was significant, $R^2 = 0.165$, $F_{(4,282)} = 13.98$, $p < 0.001$. Examination of the regression coefficients in Table 2 indicated that only reports of emotional abuse were uniquely associated with greater loneliness. While the other forms of trauma were mildly correlated with loneliness, none accounted for unique variance.

A mediation analysis assessed whether the relation between emotional abuse and loneliness could be accounted for by the diminished levels of social support experienced (lower perceived support, social connection and more unsupportive interactions with friends and parents). As seen in Figure 2, the relation between early life emotional abuse and loneliness was

fully accounted for by social processes, including diminished perceptions of social support, $a_1b_1 = 0.70$, $CI_{0.95}[0.43, 1.01]$, lower social connectedness, $a_2b_2 = 1.66$, $CI_{0.95}[1.24, 2.12]$, and more unsupportive interactions with friends, $a_3b_3 = 0.30$, $CI_{0.95}[0.08, 0.54]$. While emotional abuse was related to reports of more unsupportive interactions with parents, these reports were not associated with loneliness, and did not contribute to mediating the relationship between emotional abuse and loneliness, $a_4b_4 = 0.00$, $CI_{0.95}[-0.29, 0.30]$. A follow-up analysis to determine whether gender moderated the mediated model indicated that gender did not significantly moderate any of the mediated relationships.
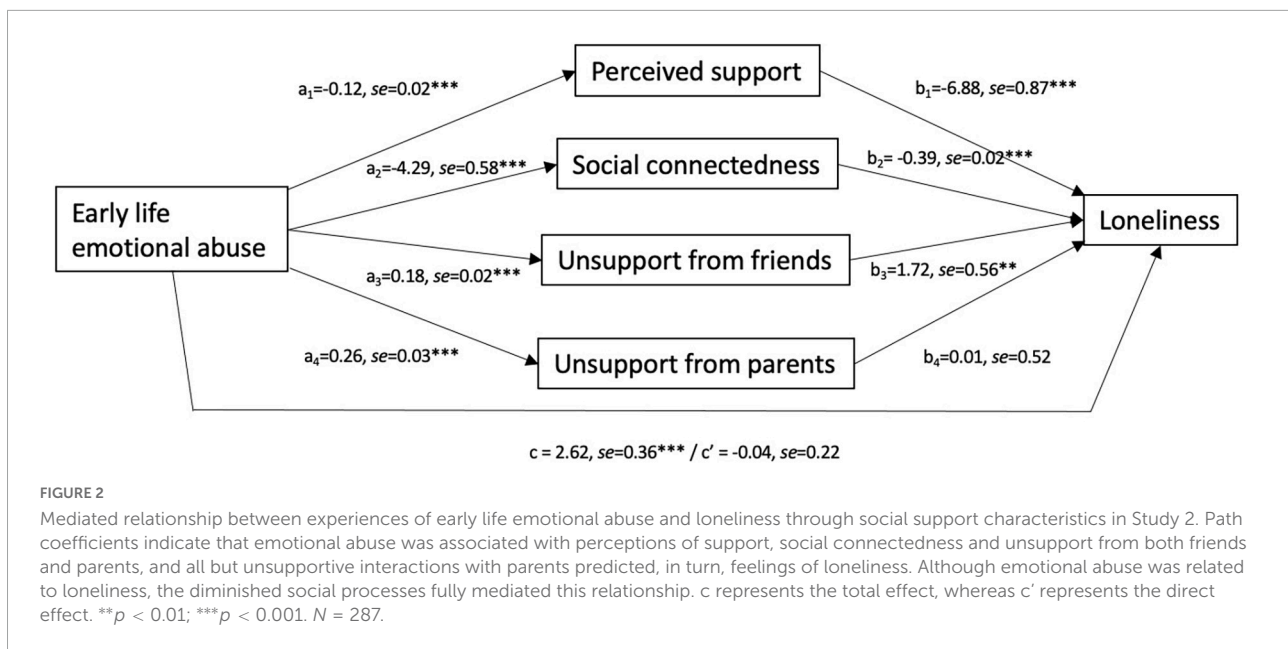
Discussion

As in Study 1, early life adverse experiences were associated with feelings of loneliness in young adults. Although the range of experiences was related to adult loneliness, only emotional abuse was a unique predictor. This aligns with previous research suggesting that loneliness in adolescents and emerging adults is not simply a relational issue but may be indicative of socio-emotional disturbances (Flett et al., 2016; Arslan and Yıldırım, 2021). In this regard, emotional abuse was further associated with diminished support perceptions no matter which index of support was considered. In turn, the link between emotional abuse and loneliness was fully mediated by diminished support perceptions and social connectedness and more unsupportive encounters with friends. Emotional abuse may play a role in shaping cognitive appraisals of safety, value, and personal worth in relationships (Lee et al., 2001; Wright et al., 2009; Flett et al., 2016). In addition, such abuse might decrease the capacity to elicit effective social support from peers (Poole et al., 2018), or may render the individual more likely to seek friendships with deviant or abusive peers (Lev-Wiesel and Sternberg, 2012; Gama et al., 2021). Any of these factors may place young adults at risk for loneliness as they navigate through new social contexts outside of the familial home. In contrast, unsupportive interactions with parents did not appear to be associated with loneliness. It is possible that if parents were perpetrators of emotional abuse, such encounters are anticipated, and may be less directly influential in relation to other social experiences.

All of the types of abuse evaluated by the measure of early life trauma (ELTI) used in Study 2 were related to recollections of childhood abuse while growing up based on the Traumatic Life Events Questionnaire. These relations suggest that the TLEQ and ELTI tapped into common recollections of early life abuse. However, as ELTI responses reflected any events prior to the age of 18, for university-aged young people such reports conflate recent experiences with those that occurred in childhood. The age at which trauma experiences occur is an important variable influencing the mental health implications

TABLE 2 Linear regression coefficients predicting loneliness from early life experiences of trauma assessed using the ELTI in Study 2.

	b	SE	B	r
Physical punishment	−0.81	0.44	−0.11	0.10*
Sexual events	0.37	0.50	0.04	0.16**
Emotional abuse	2.81	0.44	0.42***	0.39***
General trauma	0.20	0.41	0.03	0.17**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. $N = 287$.

FIGURE 2
Mediated relationship between experiences of early life emotional abuse and loneliness through social support characteristics in Study 2. Path coefficients indicate that emotional abuse was associated with perceptions of support, social connectedness and unsupport from both friends and parents, and all but unsupportive interactions with parents predicted, in turn, feelings of loneliness. Although emotional abuse was related to loneliness, the diminished social processes fully mediated this relationship. c represents the total effect, whereas c' represents the direct effect. **$p < 0.01$; ***$p < 0.001$. $N = 287$.

among young adults (Khan et al., 2015; Grasso et al., 2016; Schalinski et al., 2016). Thus, a limitation of this measure is the inability to differentiate early life events from the recent experiences of young adults.

Study 3

While prospective studies are ideal for assessing developmental trajectories and causal relations, prospective analyses of childhood abuse are fundamentally difficult, to say nothing of being ethically challenging to conduct. Studies using retrospective recall have inherent limitations, including biases stemming from more recent experiences. Despite recall biases, recollections of early trauma can play a meaningful role in predicting trauma in later childhood and adolescence (Grasso et al., 2016), as well as providing an understanding of how those experiences are appraised and how individuals cope (Wright et al., 2009). Moreover, it may be when the individual reaches adulthood that they are able to reflect clearly on the impact of such early experiences (Baker, 2009). In this regard, a child may not have the capacity to understand that certain behavior emanating from their caregiver constitutes abuse or have the ability to articulate this. Thus, while recent experiences may bias recall of early life traumas, emerging adulthood may provide the first opportunity for the victim of childhood abuse to evaluate their experiences away from the home environment and reflect on the self-impact of such experiences (Banyard and Cantor, 2004; Wright et al., 2009), and has been proposed as an important developmental task at this stage of life (Wright et al., 2009). Thus, in Study 3, based on retrospective recall, we assessed whether the age range during which adverse

events occurred differentially predicted loneliness, and whether different social mechanisms linked trauma experiences with loneliness among young adults.

Materials and methods

Participants ($N = 566$) were recruited through a university online research recruitment portal. Once again, participants were primarily female and white/Caucasian (see Table 1). Paper surveys were completed in person and participants were compensated with partial course credit. The same measures as in Study 2 were completed, including demographic information, loneliness (Cronbach's $\alpha = 0.94$) perceived social support (Cronbach's $\alpha = 0.91$), social connectedness (Cronbach's $\alpha = 0.95$), and unsupportive interactions with friends (Cronbach's $\alpha = 0.93$) and parents (Cronbach's $\alpha = 0.93$). When completing the Early Life Trauma Inventory (ELTI) (Bremner et al., 2007), participants indicated whether the events occurred during specified age ranges (0–5 years of age; 6–12 years of age; and 13–18 years of age). For each age range, participants indicated experiences of general trauma (Cronbach's $\alpha = 0.94$), physical punishment (Cronbach's $\alpha = 0.89$), emotional abuse (Cronbach's $\alpha = 0.94$), and sexual events (Cronbach's $\alpha = 0.86$). This study was approved by the Carleton University Research Ethics Board (#106215).

The statistical analyses followed the same approach as in the previous studies. The power to detect a medium effect size of partial $R^2 = 0.05$ at $p = 0.05$ with the number of variables and sample size of the present study was $\beta = 0.99$. For none of the variables did the rate of missing responses exceed 1%.

Results

As in Study 2, males reported significantly more experiences of physical punishment ($M = 2.38$, $SD = 1.58$) than females ($M = 1.68$, $SD = 1.51$), $F(1,557) = 22.81$, $p < 0.001$. Conversely, females reported significantly more experiences of unwanted sexual events ($M = 1.20$, $SD = 1.62$) than males ($M = 0.49$, $SD = 0.88$), $F(1,556) = 25.34$, $p < 0.001$. There were no significant gender differences in reported emotional abuse ($M = 2.87$, $SD = 1.73$) or general trauma ($M = 3.58$, $SD = 1.99$). Correlations among adverse experiences were all moderately positive, ranging from $r = 0.19$ (physical punishment and sexual events) to $r = 0.39$ (between physical punishment and emotional abuse). There was no gender difference in feelings of loneliness ($M = 43.87$, $SD = 11.99$). As seen in **Table 1**, almost a third of (31.6%) of the sample reported moderately high to high loneliness scores (50 or greater).

As seen in **Figure 3**, reports all types of abuse increased in average frequency as age increased. Emotional abuse was the most frequently reported type of abuse at all ages, nearly double the frequency of reported physical punishment between ages 13 and 18.

A multiple linear regression analysis conducted to assess the relations between the experiences of early life trauma (collapsed across age of occurrence) and current loneliness indicated that taken together, early life traumas were associated with greater loneliness, $R^2 = 0.142$, $F(4,560) = 23.23$ $p < 0.001$. Examination of the regression coefficients in **Table 3** suggest that all forms of early life trauma and abuse were correlated with greater loneliness, but only emotional abuse and to a lesser degree unwanted sexual events contributed unique variance to loneliness.

Impact of the age during which abuse occurred

Multiple regression analyses assessed whether loneliness was differentially predicted by experiences of sexual events or emotional abuse (separate analyses; these were the only two dimensions of abuse related to loneliness) depending on the age at which the experiences were reported (0–5 years of age, 6–12 years of age, and 13–18 years of age). Encountering unwanted sexual events was mildly associated with loneliness, $R^2 = 0.025$, $F(3,559) = 4.84$, $p = 0.002$, particularly when they were recalled to have occurred in middle to late childhood (**Table 4**). Experiences of emotional abuse across the age ranges were a strong predictor of loneliness, $R^2 = 0.157$, $F(3,559) = 34.59$, $p < 0.001$, but as with sexual events, examination of the regression coefficients suggested that loneliness was increasingly predicted by abuse that occurred in more recent years.

To assess the mediating role of social processes on the link between early life sexual events and emotional abuse at various ages and loneliness, mediation analyses were conducted separately at each age range. As seen in **Table 5**, the patterns were relatively consistent across the age ranges and abuse types.

However, the relations between childhood sexual events and loneliness were fully accounted for by social processes, and in particular perceptions of the availability of social support and feelings of social connection (but not unsupportive interactions with friends or parents). In contrast, with the exception of memories of emotional abuse at very early ages (0–5 years), emotional abuse continued to have implications for loneliness among young adults, beyond the role of social processes. This said, as in Study 2, at all three age ranges, the diminished feelings of social support and social connectedness along with unsupportive interactions with friends (but not parents) were significant mediators in the relations between childhood emotional abuse and loneliness.

Discussion

The results of Study 3 replicated those of Study 2, in that emotional abuse predicted young adult loneliness, and this relationship was mediated by perceived social support, social connectedness and unsupportive interactions with friends, but not unsupportive interactions with parents. However, the age at which emotional abuse occurred had slightly different implications for the mediation model. Specifically, emotional abuse occurring between ages 0–5 did not uniquely predict young adult loneliness, whereas both emotional abuse between ages 6–12 and between ages 13–18 did. Retrospective recall may have had an impact on these results, particularly concerning the accuracy of memories occurring between ages 0–5. Nonetheless, our results are in line with previous research (Khan et al., 2015) suggesting that emotional abuse in later childhood and adolescence had stronger links with psychological distress. Similarly, it had been reported that childhood maltreatment that only occurred between ages 0–5 did not predict later symptoms of mental health problems (Russotti et al., 2021). These authors noted, however, that 12% of participants only experienced maltreatment between ages 0–5, whereas most children reported it throughout childhood and adolescence, and children who experienced maltreatment in both early childhood and in adolescence were at a higher risk for adverse mental health outcomes.

Our results suggest that young adults may be victims of emotional abuse more frequently than other forms of early life abuse or trauma, which aligns with previous research findings (Raissian et al., 2014; Grasso et al., 2016). However, emotional abuse was associated with more frequent physical punishment (in both Studies 2 and 3), which may account for why physical punishment was not a unique predictor of loneliness. In addition, the magnitude of the correlation between sexual events and loneliness was the same across the two studies, and thus may have emerged in Study 3 as a result of the increased power due to sample size differences. Indeed, the variance accounted for in such feelings was small, and the relationship
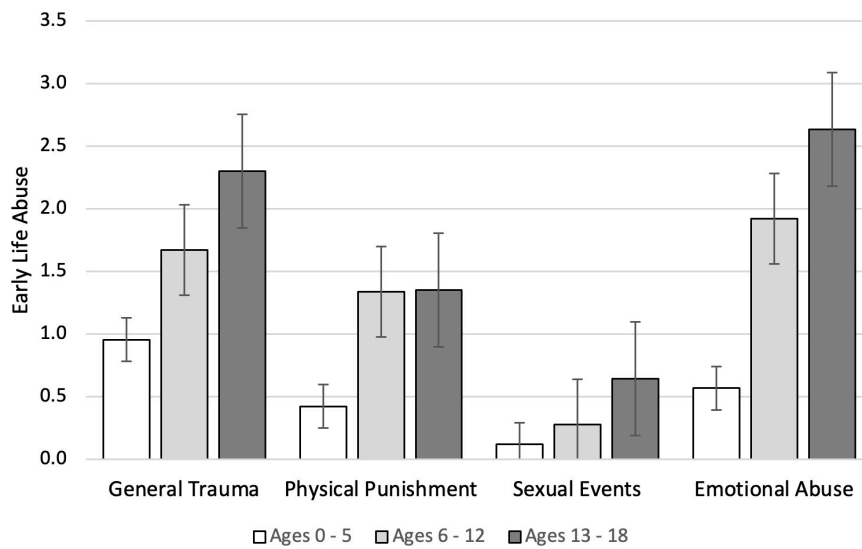
FIGURE 3

Mean frequency of early life abuse (±SE) as a function of type of abuse and the age range at which they were reported to have been experienced in Study 3. $N = 566$. Missing data < 1%.

was fully accounted for by diminished perceptions of social support and connection.

While perceived support, social connectedness and unsupportive interactions mediated the relationship between emotional abuse at all ages and subsequent loneliness in young adulthood, emotional abuse at the older ages contributed unique variance to loneliness levels after accounting for social processes. It appears that the mid and older childhood years represent a particularly vulnerable age for emotional abuse and its impacts on later loneliness, which is consistent with reports suggesting that emotional neglect that begins during the ages of 6–11 renders individuals especially vulnerable to poor outcomes (Khan et al., 2015; Schalinski et al., 2016).

General discussion

Across three studies, it was apparent that loneliness is endemic among young people, with a quarter to a third of each sample reporting moderately high to severe levels

of loneliness. While fundamental social processes, including perceptions of social support, social connectedness, and unsupportive interactions with friends were implicated in feelings of loneliness, so too were early life experiences of abuse, and in particular emotional abuse.

The relationship between adverse childhood experiences and mental health outcomes, including feelings of loneliness has previously been documented. However, given the retrospective correlational nature of most research, including the present study, the mechanisms by which childhood trauma promotes psychological distress and feelings of loneliness in young adulthood are poorly understood (Colburn et al., 2021). Study 1 confirmed that childhood abuse was uniquely associated with greater loneliness among young adults. Although other traumatic stressors were reported, including the loss of a loved

TABLE 3 Linear regression coefficients predicting young adult loneliness based on early life adverse events prior to the age of 18 years in Study 3.

	b	*SE*	*B*	*r*
Physical punishment	0.03	0.33	0.004	0.14***
Sexual events	0.67	0.33	0.09*	0.17***
Emotional abuse	2.54	0.32	0.36***	0.37***
General trauma	−0.37	0.26	−0.06	0.10*

*$p < 0.05$; ***$p < 0.001$. $N = 566$.

TABLE 4 Linear regression coefficients predicting loneliness from reported childhood experiences of sexual events and emotional abuse at different age ranges in Study 3.

	b	*SE*	*B*	*r*
Sexual events				
Ages 0 – 5	0.50	0.92	0.03	0.08*
Ages 6 – 12	1.34	0.68	0.10*	0.13***
Ages 13 – 18	0.84	0.41	0.09*	0.12**
Emotional abuse				
Ages 0 – 5	0.82	0.46	0.08	0.26***
Ages 6 – 12	0.95	0.42	0.14*	0.35***
Ages 13 – 18	1.59	0.38	0.23***	0.37***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. $N = 566$.

TABLE 5 Mediation models of the relations between early life events and loneliness mediated by social factors across the three age ranges in Study 3.

	Total effect (c)	Direct effect (c')	Indirect effects ($a_i b_i$)			
			Perceived social support	Social connectedness	Unsupportive interactions with friends	Unsupportive interactions with parents
Sexual events						
Ages 0 – 5	1.64*	−0.23	0.41, $SE = 0.23$	1.28, $SE = 0.60$	0.13, $SE = 0.12$	0.05, $SE = 0.05$
	$SE = 0.80$	$SE = 0.38$	$CI_{0.95}$ [0.01, 0.91]	$CI_{0.95}$ [0.15, 2.55]	$CI_{0.95}$ [−0.10, 0.38]	$CI_{0.95}$ [−0.04, 0.18]
Ages 6 – 12	1.85**	−0.06	0.31, $SE = 0.16$	1.43, SE = 0.42	0.10, $SE = 0.08$	0.06, $SE = 0.06$
	$SE = 0.59$	$SE = 0.28$	$CI_{0.95}$ [0.02, 0.64]	$CI_{0.95}$ [0.65, 2.29]	$CI_{0.95}$ [−0.04, 0.28]	$CI_{0.95}$ [−0.04, 0.19]
Ages 13 – 18	1.11**	0.27	0.15, $SE = 0.10$	0.58, $SE = 0.23$	0.07, $SE = 0.05$	0.04, $SE = 0.04$
	$SE = 0.39$	$SE = 0.19$	$CI_{0.95}$ [−0.03, 0.35]	$CI_{0.95}$ [0.14, 1.02]	$CI_{0.95}$ [−0.01, 0.18]	$CI_{0.95}$ [−0.04, 0.13]
Emotional abuse						
Ages 0 – 5	2.53***	−0.07	0.59, $SE = 0.14$	1.61, $SE = 0.32$	0.25, $SE = 0.09$	0.14, $SE = 0.11$
	$SE = 0.40$	$SE = 0.21$	$CI_{0.95}$ [0.34, 0.90]	$CI_{0.95}$ [1.00, 2.25]	$CI_{0.95}$ [0.11, 0.44]	$CI_{0.95}$ [−0.07, 0.35]
Ages 6 – 12	2.38***	0.34*	0.43, $SE = 0.09$	1.36, $SE = 0.20$	0.23, $SE = 0.07$	0.03, $SE = 0.09$
	$SE = 0.27$	$SE = 0.16$	$CI_{0.95}$ [0.27, 0.61]	$CI_{0.95}$ [0.98, 1.75]	$CI_{0.95}$ [0.10, 0.39]	$CI_{0.95}$ [−0.16, 0.19]
Ages 13 – 18	2.55***	0.30+	0.45, $SE = 0.08$	1.50, $SE = 0.18$	0.26, $SE = 0.08$	0.04, $SE = 0.09$
	$SE = 0.27$	$SE = 0.16$	$CI_{0.95}$ [0.29, 0.61]	$CI_{0.95}$ [1.16, 1.85]	$CI_{0.95}$ [0.12, 0.43]	$CI_{0.95}$ [−0.14, 0.22]

+$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. $N = 566$.

one, witnessing something negative happening to someone else, or their own experiences of assault as adults, none accounted for unique variance in loneliness over and above experiences of physical or sexual abuse while growing up. This may suggest that the relationship between childhood experiences and outcomes in young adults is not simply a function of revictimization or the proliferation of stressor experiences.

Much of the current research into the effects of childhood abuse is dominated by studies investigating physical and sexual abuse (Stoltenborgh et al., 2015; Poole et al., 2018). Yet, Studies 2 and 3, which included consideration of early life emotional abuse, revealed this to be a powerful predictor of loneliness among young adults. Although other forms of child abuse tended to co-occur with emotional abuse, the latter was reported nearly twice as frequently as physical abuse and four times more frequently than sexual abuse. Our results add to the mounting evidence pointing to the alarming frequency and detrimental impacts of early life emotional abuse. One reason for the comparative lack of research into emotional abuse is the difficulty in defining it and capturing the experience (Baker, 2009; Tonmyr et al., 2011). Retrospective recall is likely biased by more recent experiences, although it did not seem in Study 3 that reports of emotional abuse in early childhood predominated, despite recollections of such abuse in mid to late childhood. Rather than resulting in a bias of over-reporting, it may be that later memories of these experiences are more vivid, and are

more easily understood and interpreted as having constituted emotional abuse (Baker, 2009; Wright et al., 2009).

Childhood abuse has been associated with loneliness, which might, in part, stem from negative perceptions of social support, diminished social connectedness, and unsupportive peer interactions (Gibson and Hartshorne, 1996; Dodson and Beck, 2017; Aakvaag et al., 2019). It had been suggested that childhood abuse may promote a sense that social relationships are too risky and hence a disinclination to seek support or a propensity to communicate with others in a manner that elicits unsupportive reactions (Lee and Robbins, 1995; Lee et al., 2001; Williams and Galliher, 2006). While social support is an important factor in promoting resilience after experiences of childhood abuse (Leung et al., 2022) and protecting against feelings of loneliness (Riggio et al., 1993; Chen and Feeley, 2014), gaps remain in the understanding of critical elements of social support implicated in loneliness among young adults (Leung et al., 2022).

In Study 1, the relationship between experiences of childhood abuse and loneliness was partially accounted for by perceptions that peers and parents were not available as sources of support (although neither accounted for unique variance over the other). This relationship to lower perceived social support (across sources) was replicated in regard to sexual abuse (Study 3) and emotional abuse (Studies 2 and 3). However, a cogent aspect of young people's social experiences that was

disrupted by childhood abuse (at any age) was a sense of social connection. This finding was congruent with research suggesting that the broader cognitive schemas related to social connectedness may play an important role in loneliness (Gibson and Hartshorne, 1996; Dodson and Beck, 2017), and has been proposed as a fundamental mechanism linking emotional abuse and psychological distress and mental illness later in life (Wright et al., 2009). Low social connectedness may be tied to maladaptive social cognitions that were shaped by experiences of early life emotional abuse, contributing to the development of schemas of vulnerability to harm, personal shame, and a lack of mattering to others (Wright et al., 2009; Flett et al., 2016). How children appraise emotional abuse and integrate it into their sense of self and view of social relationships may be especially important in predicting psychological outcomes (Wright et al., 2009).

Early life emotional abuse was associated with reports of frequent unsupportive interactions with friends and parents, although only the interactions with friends were associated with greater loneliness. Social support from friends in the adolescent and young adult stage of life may have a greater impact on mental health and well-being than family support (Secor et al., 2017; Von Soest et al., 2020). It is possible that childhood emotional abuse, which is most often inflicted by family, limits the social skills of children to form healthy peer relationships (Fergusson and Horwood, 1999; Gayman et al., 2011; Aakvaag et al., 2019) and they are more likely to experience social rejection (Lev-Wiesel and Sternberg, 2012; Li et al., 2022). Much like the experience of rejection, unsupportive reactions from parents may lead to the development of relationships with deviant peer groups (Fergusson and Horwood, 1999; Li et al., 2022) who may be less likely to provide positive social support. Moreover, early life emotional abuse has been strongly linked to revictimization later in life (Lev-Wiesel and Sternberg, 2012; Gama et al., 2021), and this may be in the form of unsupportive interactions with emotionally abusive friends. Finally, childhood emotional abuse may influence how an individual perceives not only the availability of social support, but also its quality (Williams and Galliher, 2006). In essence, they may perceive friends as unsupportive regardless of their actual behavior.

Limitations and conclusion

Meaningful and supportive relationships based on secure attachment and mutual reciprocity of support have been described as critical human needs, much like food and water are essential biological needs (Tomova et al., 2020, 2021). In line with this, it has been suggested that feelings of loneliness may have evolutionary significance, in that they motivate an individual to seek connection, which promotes the survival of the individual and the group (Baumeister and Leary, 1995). It may be that early life emotional abuse that is associated with

diminished need for social connection similarly serves in an adaptive capacity, protecting harmed individuals from further exposure to destructive relationships. Indeed, while trauma is often considered as a cogent factor that fosters psychopathology, depending on the psychosocial context and biopsychosocial factors, these experiences can promote resilience (Ungar, 2021). Such protective outcomes were not evaluated in the present study and would likely take some time to emerge. Indeed, before drawing conclusions from the retrospective self-reports and the correlational design of the present study for interventions to alleviate loneliness (and other mental health outcomes), it is important to understand the significance of the social mechanisms that appear to be implicated. While they may be dysfunctional among some populations, for others they may be protective. A limitation of the present studies was that the samples all comprised self-selected university students, who arguably given their immersion in a highly peer-involved social environment, may represent a more socially functional population. At the same time, students are being increasingly recognized as a population at high risk for loneliness and the associated mental health concerns (Diehl et al., 2018; Hysing et al., 2020). Indeed, while the present investigation was not conducted during the COVID-19 pandemic, it became apparent that university students were substantially affected by the social isolation that occurred due to pandemic restrictions, and understanding the mechanisms associated with loneliness among student populations is meaningful (Bu et al., 2020).

Given the limited social connectedness and interpersonal schemas regarding shame and personal safety that arises in relation to experiences of emotional abuse, social surrogates (e.g., fictional characters, pets, or video games) may better serve to meet relational needs, at least temporarily (McConnell et al., 2011; Gabriel et al., 2017; Vella et al., 2019; Paravati et al., 2021). Targeted efforts to enhance social connections and recognition from others may be another fruitful strategy (Haslam et al., 2016; Wang et al., 2022). For example, an intervention that builds on the important role that meaningful social groups play in people's lives (Groups4Health) may serve as an effective strategy for reducing loneliness and promoting wellness (Cruwys et al., 2022). Bringing people together to form a common identity can help furnish them with the confidence and skills they need to engage in ways that are self-affirming. Such strategies might well be more sustainable than individualized clinical interventions, as they fortify social connections in individuals' day-to-day lives (Haslam et al., 2016; Cruwys et al., 2022). While an understanding was gained of the cluster of social processes that emerge from childhood abuse that appear to create links to diminished well-being of young adults, assessments of causal and functional relations are still much needed. Such studies may require multi-method prospective designs that further take gender, socioeconomic status and ethnocultural factors into consideration. Nonetheless, across three studies, the present investigation provides consistent evidence that early life abusive

experiences are associated with loneliness among young adults, and these relations are likely determined by psychosocial processes that may develop in response to such abuse.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Carleton University Research Ethics Board. The patients/participants provided their written informed consent to participate in this study.

Author contributions

JL and KM wrote the initial drafts of the manuscript and were involved in the conception and analyses of the studies. AA and CC were involved in the conception and conduct of the studies. HA contributed to the conception of the research and writing of the manuscript. KM and HA acquired the funding to

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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