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Research paper

The “loneliness epidemic”, intersecting risk factors and relations to mental health help-seeking: A population-based study during COVID-19 lockdown in Canada

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ABSTRACT

Background: Pandemic-induced social distancing and stay-at-home orders, while successful in decreasing the transmission of COVID-19, could exacerbate loneliness. Few studies have examined how pandemic-related social determinants intersect to shape pandemic loneliness and its relations to mental health care in Canada.

Methods: A population-representative sample of 3772 adults from the Canadian Perspective Survey Series (CPSS-6; January 25 to 31, 2021) was analyzed. Gender-specific logistic regression was employed to investigate the association between three-item loneliness scale (UCLA-3) with socio-demographics, job precarity, health behaviours, social isolation indicators, and mental health help-seeking. Classification and Regression Tree (CART) modelling was used to identify intersecting risk factors and the most important predictor of severe loneliness (UCLA-3 score ≥ 7).

Results: The estimated prevalence of severe loneliness was 34.7 % in Canada, with women significantly higher than men (38.1 % vs 31.3 %, $p < 0.001$). Pandemic loneliness were more prevalent in female (OR = 1.53, 99 % CI: 1.26–1.85), those who were younger (OR's range 1.42–3.00), women without college degree (OR = 1.44, 99 % CI: 1.01–2.04), those living alone (OR = 1.56, 99 % CI: 1.09–2.23), immigrant men (OR = 1.79, 99 % CI: 1.23–2.60), those with small network (OR's range: 1.73–3.26), those who were absent from work due to COVID-19 related reasons (OR = 2.11, 99 % CI: 1.04–4.28), past-month binge drinkers (OR's range: 1.39–1.70) and cannabis user (OR = 1.47, 99 % CI: 1.12–1.93). The CART algorithm identifies that immigrants who experienced pandemic-triggered job insecurity were the most-at-risk group of severely loneliness. Pandemic loneliness was positively associated with formal help-seeking from mental health professionals (OR = 1.71, 99 % CI: 1.21–2.41), informal help-seeking from social circle (OR = 1.51, 99 % CI: 1.17–1.95), and unmet mental health needs (OR = 1.78, 99 % CI: 1.29–2.49).

Limitations: Cross-sectional data prohibits causal inferences.

Conclusion: The COVID-19 pandemic converges with loneliness epidemic in Canada. Prevention and intervention programs should target upstream social determinants of mental health, especially the intersection of migration status and COVID-19-related job precarity, to eliminate loneliness during the pandemic.

1. Introduction

The COVID-19 pandemic has been causing disruption, unpredictability, and uncertainty in all aspects of human life (Bavel et al., 2020; Fancourt et al., 2021). Since the World Health Organization (WHO) declared that the new coronavirus (COVID-19) outbreak was a global pandemic on March 11, 2020, health authorities around the world have imposed various public health measures including societal lockdowns, flight restrictions, workplace closures, mandatory quarantine (de Lima

et al., 2020; Shi et al., 2020; Wang et al., 2021), enforced social distancing (Kämpfen et al., 2020; Marroquín et al., 2020; Zhao et al., 2020) and stay-at-home orders (Pierce et al., 2020a; Turna et al., 2021). While necessary in slowing the spread of the virus, there have been widespread concerns that these COVID-19 containment strategies could exacerbate pre-existing “loneliness epidemic” (Di Gessa and Price, 2021; O’Sullivan et al., 2021), since they are, by design, meant to keep individuals apart from person-to-person interactions and to curtail activities organized in community congregate settings, such as indoor

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recreational events, gymnastic exercises, and religious/spiritual coping groups (Bao et al., 2021), which could result in greater levels of social isolation and difficulties in maintaining social connections.

In pre-pandemic times, loneliness has already been recognised as one of the major public health concerns that could affect people of any age (Bao et al., 2021; Bu et al., 2020a; Bu et al., 2020b), considering that loneliness has been associated with a myriad of adverse psychological, physiological, and behavioural consequences (McClelland et al., 2020), including depression, suicidal ideation, cardiovascular diseases, coronary heart disease, metabolic syndrome, and increased all-cause mortality (Bu et al., 2020a; Solmi et al., 2020; Steptoe et al., 2013). This recognition has led to the government’s appointment of the “Minister of Loneliness” to take concrete policy actions in the United Kingdom and Japan (Escalante et al., 2021). A recent systemic review indicates that a considerable proportion of the general population are experiencing problematic levels of loneliness on a global scale (Surkalim et al., 2022). Since the pandemic, a burgeoning body of psychiatry research has found that women, youth, divorced individuals, low-income households, those living alone, students, people without large social networks, and those having intolerance of uncertainty were at elevated risks of loneliness amidst this public health emergency (McQuaid et al., 2021; Rumas et al., 2021).

Although scientists have been exploring the magnitude, trends and mechanisms of this traumatic event’s impact on mental health in Canada, the current landscape of Canadian literature on loneliness prevalence during the early stage of COVID-19 pandemic has been constrained by several methodological or theoretical limitations, such as the use of non-probability sampling (Lowe et al., 2022; McQuaid et al., 2021; Rumas et al., 2021; Wickens et al., 2021), single-item measure of loneliness (McDonald et al., 2022; Savage et al., 2021; Wickens et al., 2021), and the focus of a specific sub-population (Howden et al., 2022; Savage et al., 2021). While these early insights based on rapid approaches are valuable, high-quality population-representative data on loneliness arising from the pandemic are still needed to inform appropriate evidence-based health policies to mitigate mental health sequelae (Holmes et al., 2020; Pierce et al., 2020b). Furthermore, although

gender-specific differences in loneliness have been examined before the pandemic (Ernst et al., 2021), far less is known about the extent to which psychological consequences of the COVID-19 pandemic related to labour force participation and social isolation differ by the role of gender. In fact, a recent commentary from *The Lancet* pointed out that the gendered impact of this public health crisis has not been thoroughly addressed in research and policy response (Wenham et al., 2020).

Emerging studies have linked feeling lonely to reduced odds of COVID-19 preventive behaviours such as mask wearing and hands sanitizing (Kang et al., 2021; Stickley et al., 2021) and increased propensity to health care utilization (Bao et al., 2021; Gerst-Emerson and Jayawardhana, 2015). Studies also revealed that efforts have been made to adapt the provision of mental health services to the pandemic response by modifying access to diagnosis, support, and treatment such as the delivery of tele-mental health and remote therapy (Ashcroft et al., 2021; Moreno et al., 2020); yet many questions remain about whether this rapid transition to virtual care could be responsive to the immediate mental health needs of Canadians so as to address pandemic-induced loneliness symptoms. Given that the COVID-19 pandemic is constantly evolving and that pandemic-related stressors could impose an enduring impact, it is essential to assess the causes and consequences of loneliness symptoms during the second wave of COVID-19 infection in Canada. This timely surveillance could not only inform targeted interventions to address pandemic-related mental health problems but also be conducive to the continuous assessment of mental health care system. Therefore, guided by the pandemic-specific conceptual framework (see Fig. 1), the present study aims to examine the following three research questions:

- (1) What are pandemic-specific risk and resilience factors of loneliness symptoms and how do these factors differ between men and women in the general population?
- (2) How do risk factors intersect to affect loneliness symptoms and which is the most important determinant during the pandemic?
- (3) Is loneliness a robust indicator associated with greater likelihood of mental health help-seeking behaviours after controlling for other mental health conditions?

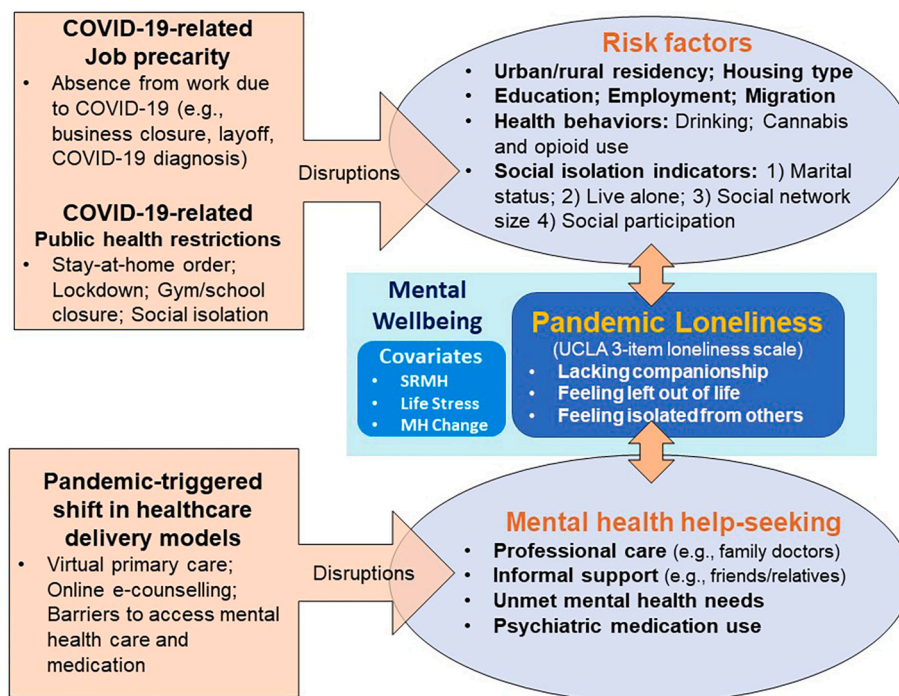


Fig. 1. Conceptual framework: Understanding COVID-19 pandemic’s impact on loneliness symptoms.
Notes: SRMH = self-rated mental health; MH change = changes in mental health status compared to pre-pandemic.

2. Methods

2.1. Data source and study context

The data were drawn from the Canadian Perspective Survey Series – Substance Use and Stigma during the Pandemic (CPSS6-COVID), a sixth online survey, conducted during January 25 to January 31, 2021. This timing was at the larger second wave of the pandemic in Canada (778,972 confirmed cases and 20,032 deaths as of January 31, 2021) and only around 1.5 month after the first COVID-19 vaccine was officially authorized with most Canadians unvaccinated. The purpose of the cross-sectional CPSS survey series is a multi-wave effort to evaluate the health and socioeconomic consequences of the COVID-19 pandemic among Canadians aged 15 years or older in 10 provinces, starting from March 2020 (Lin, 2022a, 2022b). The CPSS6-COVID survey, in particular, aims to evaluate the ongoing impact of COVID-19 on Canadians' mental health and substance use, with a special focus on the social stigma of addiction. The sampling frame of CPSS is a probabilistic panel (i.e., four rotation groups) from the Labour Force Survey (LFS) created by a stratified multi-stage sampling. Participants answering the LFS for the last time in April, May, June and July of 2019 were selected at random to participate in the CPSS and received emailed survey invitations with a link for online self-completion. Details of the survey methodology regarding the sampling frame and data collection are available elsewhere. The CPSS represents 98 % of the national populations and excludes persons living on First Nations reserves; the institutionalized population, and households in remote areas. The collection response rate of the CPSS6 was 54.4 % and may reflect a tight schedule for data collection and COVID-19-related fatigue during the pandemic. Among the total 3941 respondents in the CPSS6, individuals with missing values were excluded in this study ($n = 169$, 4.3 % of the total), yielding an analytic sample of 3772.

2.2. Ethical considerations

The analyses were based on the public-use microdata files (PUMF) available to both Canadian and international researchers via Statistics Canada's Data Liberation Initiative. The public-use data are completely de-identified with necessary suppression methods to protect confidentiality; thus, according to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2 (2018), this study is considered as non-human subject research that does not require institutional ethics review.

2.3. Measurements

Pandemic loneliness symptoms were assessed by the widely used three-item loneliness scale (UCLA-3) (Hughes et al., 2004), a validated short version derived from the 20-item Revised University of California at Los Angeles Loneliness Scale (R-UCLA). Questions were re-designed in the pandemic context: "In general, how often have you felt the following since the start of the COVID-19 pandemic?". The UCLA-3 evaluates three symptoms: feelings of lacking companionship, feeling left out of life, and feeling isolated from others. The response option in the CPSS-6 survey was rated on a five-point Likert scale; and to be consistent with prior literature (Gyasi et al., 2022; Polenick et al., 2019; Varga et al., 2021) and original UCLA-3 scale's coding approach (Hughes et al., 2004), we converted it back into a three-point Likert scale: 1 = never or hardly ever; 2 = some of the time; 3 = often or always. First, ratings were summed to generate a composite measure (ranging: 3–9), with higher scores indicating greater loneliness. Second, to produce a binary measure, we used a cut-off score of 7 or greater (score ≥ 7) on the UCLA-3 to classify respondents: 3–6 (not severely lonely); 7–9 (severely lonely). These cut-off points have been applied in previous studies (Gyasi et al., 2022; Polenick et al., 2019; Varga et al., 2021). In this CPSS-6 data, the UCLA-3 has a Cronbach's alpha of 0.804 ($M = 5.64$, $SD = 1.90$) in the

overall sample. Third, for sensitivity analytical purposes, three loneliness symptom items were coded as three binary variables (0 = never/hardly ever/some of the time; 1 = often/always).

Other mental health conditions. Self-rated mental health (SRMH) (Chiu et al., 2020; Islam et al., 2014), perceived life stress (Ahmad et al., 2014; Villatoro et al., 2018) and mental health change compared to pre-pandemic were ascertained by three single-item questions (as covariates) to predict mental health help-seeking. SRMH was assessed by a question asking, "In general, how would you describe your mental health?" and binary coded (0 = excellent/very good/good; 1 = fair/poor). Perceived life stress was assessed by a question asking, "In general, how would you describe the amount of stress in your life, since the start of the COVID-19 pandemic?" (0 = Not at all stressful/A little stressful; 1 = stressful/very stressful/extremely stressful). Mental health change (vs pre-pandemic) was examined by the item: "Compared to before the COVID-19 pandemic, how would you say your mental health is now?" (0 = about the same; 1 = much/somewhat better; 2 = somewhat worse now; 3 = much worse now).

Social determinants of mental health. Social demographics, that signify conditions where people are born, grow, live, and work (McQuaid et al., 2021), were collected in the CPSS-6. These included (1) age groups, (2) gender, (3) highest educational attainment, (4) migration status (Canadian-born residents versus migrants), (5) residency (urban or rural), (6) housing type, (7) precarious employment status, and (8) health behaviours. *Precarious employment status (pandemic job precarity)* was a derived variable to investigate the pandemic's impact on labour market participation (worked at least 1 h for pay, including self-employment) in the past 7 days prior to the survey (i.e., January 18 to 22, 2021). Respondents were first asked: "Did you work (at least one hour) at a job or business?" for the designated week and, if so, "Did you have a job or business from which you were absent (for the entire week)?" To measure the direct disruption from the COVID-19 pandemic, respondents who had a casual job with no work available at the week were not considered as absent from work. Those who replied affirmatively were asked: "What was the main reason you were absent from work that week?". The response options were categorized into five levels: 1 = employed and at work for at least part of the week (including work from home); 2 = employed but absent for the entire week due to COVID-19 (e.g., business closure, layoff or personal circumstances including "personal safety, own or household member's diagnosis, self-isolation after recent travel, taking care of children due to school closure"); 3 = employed but absent for the entire week due to other reasons not related to COVID-19, including planned absence (e.g., "vacation, work schedule, maternity or parental leave, seasonal business") and unplanned absence (e.g., "illness other than COVID-19, caring for children or elder relative for non-COVID-19 reasons"); 4 = not employed; 5 = not stated. Health behaviours during the pandemic such as binge drinking (i.e., consuming five or more drinks on one occasion), cannabis use, and opioid use were also ascertained.

Social isolation component was assessed by four separated indicators of social integration collected in the CPSS-6 demographic questions: (1) marital status, (2) living arrangements measured by household size, (3) social network size, and (4) social participation, in consistent with prior research (Steptoe et al., 2013). *Social network size* was measured by the question: "Approximately how many relatives and friends do you have who you feel close to, that is, how you feel at ease with and can talk to about what is on your mind?". The response was coded as: 0 = no person; 1 = one to two persons; 2 = three persons or more. *Social participation* was measured by the question: "In the past 12 months, were you a member or participant in the following groups, organizations, or associations (include groups you are active in online)?" Respondents could choose from a multiple response set of options, such as recreational, cultural, educational, political, religious, or hobby organizations, civic or community (youth/senior) associations, immigrant-serving agencies, or ethnic groups and/or others. These groups could be formally organized or informal groups of people who get together regularly to do an activity or talk about things. The response was aggregated as: 0 = no

group; 1 = at least one group.

Mental health help-seeking during COVID-19. We examined four binary variables (yes/no) to capture the full spectrum of mental health (MH) support and treatment during the pandemic. *Professional MH care* was assessed by the question: “Since the beginning of the COVID-19 pandemic, have you seen, or talked on the telephone to, any of the following people about problems with your emotions, mental health or use of alcohol or drugs?” Options included psychiatrist; family doctor or general practitioner; psychologist; nurse; social worker, counselor, or psychotherapist. *Informal MH support* was an indicator of social support assessed by the same question and was flagged if respondents selected any of the options, including family member, friend, co-worker, supervisor, boss, teacher, school principal, or other persons. Similar to prior literature (Urbanoski et al., 2008), *unmet MH need* was measured by the question: “Since the beginning of the COVID-19 pandemic, was there ever a time when you felt that you needed help for your emotions, mental health or use of alcohol or (prescribed and non-prescribed) drugs, but you didn’t receive it?”. *Psychiatric medication use* was assessed by the question: “Since the beginning of the COVID-19 pandemic, have you taken any prescribed medication to help you with problems with your emotions, mental health or use of alcohol or drugs?”

2.4. Statistical analysis

Statistical analyses and data management were performed using the SPSS software package, Version 26 (IBM Corp., Armonk, N.Y., USA). First, unweighted statistics were used to describe the overall sample characteristics, while a normalized weight was applied to calculate weighted percentages that represent the national estimates. Stratified by gender, cross-tabulation analyses were generated by Chi-square tests (χ^2) using weighted percentages to compare between-group differences by loneliness. Second, binary logistic regression was conducted to examine associations between explanatory variables and the probability of severe loneliness in the general sample as well as gender-specific samples. Due to multiple comparisons, a more stringent criterion was employed for the statistical significance ($p < 0.01$). Third, the Classification and Regression Tree (CART) was performed to identify intersecting risk factors of severe loneliness. Lastly, another series of logistic regression analyses were conducted to evaluate the robustness of the association between loneliness and mental health help-seeking after controlling for all covariates including other mental health conditions.

As a machine learning approach, the CART algorithm is binary decision tree that allows identifying complex interactions between variables across the measurement space (Smits et al., 2008); and the strongest predictor from the root node by splitting the data into child nodes repeatedly (Lemon et al., 2003). Because decision tree modelling could detect meaningful intersections and split branches based on heterogeneity, this approach was considered a promising data-driven explorative tool for quantitative intersectionality research (Bauer and Scheim, 2019; Evans, 2019) and for the identification of at-risk populations in public health science (Lemon et al., 2003). In this study, cases with severe loneliness were assigned a value of ‘1’, and others were assigned a value of ‘0’. The CART model selected variables with close associations with loneliness from all influencing factors and visually displayed their interactions in the form of a tree diagram. Categories of each predictor were merged if they are deemed as homogenous with respect to loneliness. To avoid overfitting (Kreatsoulas and Subramanian, 2018), we set the stopping rules to require each child node with a minimum sample size of $n = 50$ and branching limited to five levels. We used cross-validation with 10 sample folds to calculate misclassification risk (Rhodes et al., 2011).

3. Results

3.1. Sample characteristics and prevalence of severe loneliness

Table 1 summarizes weighted percentages of all variables stratified by severe loneliness. The overall sample ($n = 3772$) mainly consisted of respondents who were Canadian-born (75.6 %), aged >25 years (87.2 %), college degree or above (62.1 %), urban residents (85.6 %), and living in a single-detached house (60.9 %). The sex distribution was even (men: 49.9 %; women: 50.1 %). More than half of respondents were employed and at work (54.2 %) while only 1.7 % were absent from work due to COVID-19 related reasons. Most respondents tended to report moderate-to-good social integration: married (61.8 %), cohabitating (83.9 %), size of social network >2 persons (58.5 %). Most had healthy habits: no past-month binge drinking (70.8 %) and never use cannabis (71 %). Notably, the estimated prevalence of severe loneliness (UCLA-3 score ≥ 7) was 34.7 % since the pandemic (feeling isolated from others: 41.9 %; lacking companionship: 23.4 %; feeling left out of life: 17 %) for the general population in Canada, while the female sample had significantly higher rate of severe loneliness than the male sample (38.1 % vs 31.3 %, $p < 0.001$). In the entire sample, 13.6 % reported seeking professional consultation for mental health, 9.9 % of respondents reported prescribed medication use, 23.9 % of respondents reported seeking informal support, and 13.4 % of respondents reported unmet mental health needs. Chi-square statistics revealed that most variables were significantly linked to loneliness in the overall sample, except for urban-rural residency ($p > 0.05$). There were gender-specific risk factors for loneliness: lower educational attainment was correlated with loneliness only among women while urban residency and living alone were stood out only among men.

3.2. Logistic regression predicting severe loneliness

Table 2 presents the multivariable-adjusted associations between major risk factors and severe loneliness in the general sample and stratified by gender. For the general sample, logistic regression analysis revealed that young age (15–24 years) (OR = 3.00, 99 % CI: 1.85–4.87), female (OR = 1.53, 99 % CI: 1.26–1.85), absence from work due to COVID-19 reasons (OR = 2.11, 99 % CI: 1.04–4.28), living alone (OR = 1.56, 99 % CI: 1.09–2.23), cannabis use in the past month (OR = 1.47, 99 % CI: 1.12–1.93) were significantly associated with severe loneliness. There were also gradient effects between severe loneliness with diminished size of social circle (OR’s range: 1.73–3.26) and frequency of binge drinking (OR’s range: 1.39–1.70). For the sex-specific analyses, on the one hand, immigrant status (OR = 1.79, 99 % CI: 1.23–2.60), living alone (OR = 2.03, 99 % CI: 1.09–3.75) and opioids use (OR’s range: 1.81–2.85) were uniquely associated with severe loneliness in the male sample, but they did not come through in the female sample; on the other hand, lower educational attainment (OR = 1.44, 99 % CI: 1.01–2.04), absence from work due to COVID-19 reasons (OR = 2.48, 99 % CI: 1.05–5.86) and past-month cannabis use (OR = 1.59, 99 % CI: 1.08–2.33) were three risk factors of severe loneliness mainly driven by the female sample but not by male sample.

3.3. Decision tree model predicting severe loneliness

Fig. 2 provides the dendrogram of how CART algorithm identifies risk factors for severe loneliness (benchmark rate: 34.7 %). The loneliness rate ranged from 19.7 % to 86.2 % across 11 terminal nodes. The performance of the CART tree as a classifier was moderate, with an overall classification agreement of 67.7 %. The cross-validation estimate for risk of misclassification was low at 0.33. As shown in the top parent branch, job precarity due to COVID-19 reasons (including respondents with no answer) was the strongest predictor of severe loneliness (64.1 % vs 33.0 %). Among those experienced pandemic-related job precarity, the immigration status provided the most significant split for loneliness,

Table 1

Sample characteristics: Unweighted sample size and weighted percentages (%) of severe loneliness (UCLA-3 score ≥ 7) among full, male, and female samples, CPSS6-COVID (January 25–31, 2021).

Variables	Full sample (n = 3722)				Male (n = 1744)			Female (n = 2028)		
	Unw. Size	Severely lonely (n=1205)			Severely lonely (n=493)			Severely lonely (n=712)		
		No	Yes	Sig.	No	Yes	Sig.	No	Yes	Sig.
Age				<0.001			<0.001			<0.001
15–24	138	50.5 %	49.5 %		44.9 %	55.1 %		56.4 %	43.6 %	
25–44	1085	61.3 %	38.7 %		68.0 %	32.0 %		54.2 %	45.8 %	
45–64	1521	71.3 %	28.7 %		72.8 %	27.2 %		70.0 %	30.0 %	
≥ 65	1028	71.4 %	28.6 %		79.0 %	21.0 %		64.6 %	35.4 %	
Sex				<0.001						
Male	1744	68.7 %	31.3 %							
Female	2028	61.9 %	38.1 %							
Education				0.001			0.12			0.002
High school grad	884	61.8 %	38.2 %		67.1 %	32.9 %		57.2 %	42.8 %	
College degree	1362	66.2 %	33.8 %		67.3 %	32.7 %		65.0 %	35.0 %	
University	1526	68.6 %	31.4 %		72.2 %	27.8 %		65.1 %	34.9 %	
Immigrant status				0.046			<0.001			0.035
Canadian-born residents	3122	66.2 %	33.8 %		71.6 %	28.4 %		60.6 %	39.4 %	
Immigrants	650	62.6 %	37.4 %		59.1 %	40.9 %		65.8 %	34.2 %	
Pandemic job precarity				<0.001			<0.001			<0.001
Employed; & at work	2095	67.2 %	32.8 %		70.4 %	29.6 %		63.3 %	36.7 %	
Absent; not COVID-19-related	84	63.4 %	36.6 %		83.3 %	16.7 %		51.0 %	49.0 %	
Absent; COVID-19-related	59	42.2 %	57.8 %		50.0 %	50.0 %		38.3 %	61.7 %	
Not employed	1452	66.7 %	33.3 %		70.1 %	29.9 %		64.1 %	35.9 %	
Not stated	82	35.0 %	65.0 %		32.9 %	67.1 %		37.7 %	62.3 %	
Residency				0.403			0.031			0.45
Rural	778	66.9 %	33.1 %		74.8 %	25.2 %		59.9 %	40.1 %	
Urban	2994	65.0 %	35.0 %		67.8 %	32.2 %		62.2 %	37.8 %	
Housing type				<0.001			<0.001			0.001
Single detached house	2517	68.6 %	31.4 %		72.3 %	27.7 %		64.9 %	35.1 %	
Low-rise apartment	413	60.0 %	40.0 %		59.0 %	41.0 %		60.9 %	39.1 %	
High-rise apartment	253	58.5 %	41.5 %		57.5 %	42.5 %		59.3 %	40.7 %	
Others	589	61.0 %	39.0 %		69.5 %	30.5 %		53.7 %	46.3 %	
<i>Social isolation indicators</i>										
Marital status				<0.001			<0.001			0.002
Married	2379	69.2 %	30.8 %		74.4 %	25.6 %		63.4 %	36.6 %	
Widow/separated	635	66.4 %	33.6 %		66.2 %	33.8 %		66.5 %	33.5 %	
Single/never married	758	55.6 %	44.4 %		55.5 %	44.5 %		55.7 %	44.3 %	
Live alone				<0.001			<0.001			0.214
Not alone	2702	66.7 %	33.3 %		70.8 %	29.2 %		62.5 %	37.5 %	
Alone	1070	58.1 %	41.9 %		57.0 %	43.0 %		58.9 %	41.1 %	
Social network size				<0.001			<0.001			<0.001
0 friend/relative	165	39.9 %	60.1 %		37.9 %	62.1 %		42.0 %	58.0 %	
1 to 2 friends/relatives	1370	58.6 %	41.4 %		64.2 %	35.8 %		52.3 %	47.7 %	
≥ 3 friends/relatives	2237	71.3 %	28.7 %		74.1 %	25.9 %		68.8 %	31.2 %	
Social participation				<0.001			<0.001			<0.001
No group	1646	63.5 %	36.5 %		69.7 %	30.3 %		57.3 %	42.7 %	
1 or more social groups	2085	68.5 %	31.5 %		71.7 %	28.3 %		65.3 %	34.7 %	
Not stated	41	55.0 %	45.0 %		40.7 %	59.3 %		68.8 %	31.2 %	
<i>Health behaviours</i>										
Binge drinking				<0.001			<0.001			<0.001
At least once a week	465	56.8 %	43.2 %		58.2 %	41.8 %		54.5 %	45.5 %	
At least once a month	587	61.4 %	38.6 %		68.7 %	31.3 %		50.4 %	49.6 %	
Not in the past month	2720	67.7 %	32.3 %		71.1 %	28.9 %		64.8 %	35.2 %	
Cannabis use				<0.001			<0.001			<0.001
Used; in the past month	594	54.8 %	45.2 %		61.0 %	39.0 %		47.1 %	52.9 %	
Used; not in the past month	496	67.9 %	32.1 %		77.2 %	22.8 %		54.2 %	45.8 %	
Never use	2682	67.0 %	33.0 %		68.6 %	31.4 %		65.7 %	34.3 %	
Opioids use				0.015			<0.001			0.485
Used; in the past month	223	56.5 %	43.5 %		48.7 %	51.3 %		62.1 %	37.9 %	
Used; not in the past month	592	63.7 %	36.3 %		68.0 %	32.0 %		58.5 %	41.5 %	
Never use	2957	66.1 %	33.9 %		69.9 %	30.1 %		62.4 %	37.6 %	
<i>Mental health (MH) help-seeking during pandemic</i>										
Informal MH support				<0.001			<0.001			<0.001
No	2884	70.7 %	29.3 %		73.7 %	26.3 %		67.3 %	32.7 %	
Yes (Sought support)	888	48.0 %	52.0 %		46.4 %	53.6 %		48.9 %	51.1 %	
Professional MH care				<0.001			<0.001			<0.001
No	3279	68.9 %	31.1 %		71.6 %	28.4 %		66.0 %	34.0 %	
Yes (Sought care)	493	42.2 %	57.8 %		44.1 %	55.9 %		40.9 %	59.1 %	

(continued on next page)

Table 1 (continued)

Variables	Full sample (n = 3722)				Male (n = 1744)			Female (n = 2028)		
	Unw.	Severely lonely (n=1205)			Severely lonely (n=493)			Severely lonely (n=712)		
	Size	No	Yes	Sig.	No	Yes	Sig.	No	Yes	Sig.
Unmet MH needs				<0.001			<0.001			<0.001
No	3338	70.2 %	29.8 %		72.4 %	27.6 %		67.9 %	32.1 %	
Yes (Had unmet needs)	434	33.5 %	66.5 %		39.5 %	60.5 %		29.1 %	70.9 %	
Psychiatric medication use				<0.001			<0.001			<0.001
No	3352	67.4 %	32.6 %		70.1 %	29.9 %		64.5 %	35.5 %	
Yes (Used medication)	420	46.5 %	53.5 %		53.5 %	46.5 %		41.7 %	58.3 %	
<i>Other mental health conditions</i>										
Self-rated Mental health (SRMH)				<0.001			<0.001			<0.001
Good SRMH	2932	74.4 %	25.6 %		76.0 %	24.0 %		72.7 %	27.3 %	
Poor SRMH	840	39.5 %	60.5 %		44.2 %	55.8 %		36.0 %	64.0 %	
Perceived life stress				<0.001			<0.001			<0.001
Not stressful	3147	71.7 %	28.3 %		74.1 %	25.9 %		69.1 %	30.9 %	
Stressful	625	38.5 %	61.5 %		39.8 %	60.2 %		37.6 %	62.4 %	
Mental health change (vs. pre-pandemic)				<0.001			<0.001			<0.001
Better	251	73.9 %	26.1 %		72.3 %	27.7 %		75.4 %	24.6 %	
About the same	1856	80.3 %	19.7 %		80.0 %	20.0 %		80.5 %	19.5 %	
Somewhat worse	1398	54.5 %	45.5 %		60.4 %	39.6 %		49.7 %	50.3 %	
Much worse	267	27.3 %	72.7 %		34.7 %	65.3 %		19.2 %	80.8 %	

Notes: Sample size was presented as unweighted data while the percentages were based on weighted data to reflect population-based national estimate. CPSS6 = Canadian Perspective Survey Series 6 (online nationwide survey).

with immigrants substantially higher than Canadian-born residents (86.2 % vs. 48.7 %). Besides this crucial interaction, the CART tree elucidates how risk profiles intersect in more complex way to shape loneliness such as four-order intersection (job precarity × social network size × cannabis use × marital status) and five-order intersection (job precarity × social network size × age × binge drinking × education level). Notably, the absence of five risk factors sequentially were the most protective from developing loneliness, that is when respondents did not experience pandemic-related job precarity, have larger social circle (>2 persons), older age (>24 years), no past-month binge drinking and with higher educational attainment (≥college degree).

3.4. Logistic regression predicting mental health help-seeking

Table 3 shows three panels of multiple logistic regression models to test the association between loneliness and mental health help-seeking (full statistics available upon request). After adjusting for covariates and mental health conditions including SRMH, perceived life stress as well as MH change (vs. pre-pandemic), severe loneliness (see Model 1) was positively associated with professional care for MH (OR = 1.71, 99 % CI: 1.21–2.41), informal support for MH (OR = 1.51, 99 % CI: 1.17–1.95), and unmet MH needs (OR = 1.78, 99 % CI: 1.29–2.49), whereas there was no significant correlation between loneliness and psychiatric medication use (OR = 0.76, $p = 0.132$, not shown in Table 3). In addition, loneliness composite scores (range: 3 to 9) and the same covariates were added into statistical models to illustrate the robustness of these associations (all p 's < 0.001, see Model 2 loneliness scale). Lastly, three separate loneliness symptoms were entered into the identical model to provide more nuanced insights (see Model 3): respondents with feeling often left out of life (OR = 1.64, 99 % CI: 1.10–2.43) was more likely to have unmet MH needs; respondents who often felt lacking companionship (OR = 1.59, 99 % CI: 1.09–2.33) and left out of life (OR = 1.69, 99 % CI: 1.09–2.63) were more likely to seek MH professional consultation; respondents who often felt isolated from others had two-fold greater odds of seeking informal MH support for MH (OR = 2.24, 99 % CI: 1.71–2.93).

4. Discussion

To our best knowledge, this is the first large-scale study to estimate the population prevalence of severe loneliness based on the UCLA-3

validated scale, its intersecting risk factors, and health care consequences during the COVID-19 pandemic in Canada. The finding revealed that, in the times of pandemic lockdown, approximately one-in-three Canadians (34.7 %) was at risk of experiencing severe loneliness, with women's prevalence significantly higher than men's (38.1 % vs 31.3 %, $p < 0.001$). This Canadian national estimate of loneliness based on a probabilistic sample was substantially higher than those statistics using an identical measure of loneliness (UCLA-3) reported in other regions during the pandemic, including the prevalence (24.2 %) from China (Bao et al., 2021), the proportion (14 % - 27 %) from UK (Bu et al., 2020b; Groarke et al., 2020), as well as the percentages (7 %–18 %) from other Western and Northern European countries (Varga et al., 2021). In addition, youth and adolescent, women, people with lower educational background, people living alone, and people with limited social circle had an elevated risk of developing severe loneliness during the pandemic. These at-risk groups are consistent with psychiatric literature on loneliness during ordinary times (Lim et al., 2020) as well as the pandemic period (Bao et al., 2021; Bu et al., 2020a, 2020b). The observed gender disparities in loneliness in this study were consistent with other epidemiological studies since the onset of COVID-19, as the intense isolation may impose a greater disruption on women who may be more prone to inflammation under stressful situations (Lin, 2022a, 2022b) and tend to depend more heavily than men on social connections (McQuaid et al., 2021).

The concerning population prevalence implies that, at the second larger wave of COVID-19 infections, severe loneliness was ubiquitous among general Canadian residents (Detsky and Bogoch, 2021), probably due to the pandemic-induced disruption of habitual stress-coping mechanisms caused by the lockdown measures. Since the data collection period (January 25 to 31, 2021) was at the third week following the New Year's Day, being unable to participate in this annual ritual of national celebration with friends and families, for the first time, may exacerbate the feeling of loneliness (Bu et al., 2020a). Also, it is possible that the lockdown-related fatigue as well as the fluctuations in COVID-19 restrictions may have aggravated the sensations of loneliness at the second wave. For example, the Ontario's government paused the 3-stage re-opening plan (since July 17, 2020) by implementing a province-wide shut down on December 26, 2020, further initiated a Stay-at-Home order and Declaration of Emergency on January 14, 2021, and subsequently extended it for another 30 days until February 19, 2021, in light of the emerging COVID-19 variants (Public Health Ontario, 2021).

Table 2

Multivariable logistic regression predicting loneliness (UCLA-3 score ≥ 7) by risk factors (e.g., employment, social isolation and health behaviours) among full, male, and female samples, CPSS6-COVID (January 25–31, 2021).

Variables	Full sample (n = 3772)				Male sample (n = 1744)				Female sample (n = 2028)			
	Nagelkerke R ² = 13.0 %				Nagelkerke R ² = 20.3 %				Nagelkerke R ² = 13.4 %			
	OR	99 %CI		Sig.	OR	99 %CI		Sig.	OR	99 %CI		Sig.
Age (ref. 45–64)												
15–24	3.00	1.85	4.87	<0.001	3.63	1.68	7.86	<0.001	2.22	1.15	4.27	0.002
25–44	1.42	1.11	1.81	<0.001	1.19	0.81	1.74	0.252	1.67	1.20	2.32	<0.001
≥ 65	0.97	0.72	1.31	0.822	0.62	0.38	1.00	0.011	1.37	0.92	2.03	0.041
Female (ref. male)	1.53	1.26	1.85	<0.001	–	–	–	–	–	–	–	–
Education (ref. university)												
High school grad or below	1.13	0.87	1.48	0.226	0.99	0.64	1.52	0.932	1.44	1.01	2.04	0.008
College degree	1.06	0.83	1.36	0.557	1.42	0.97	2.10	0.019	0.94	0.67	1.32	0.620
Immigrants (ref. Canada-born)	1.08	0.85	1.37	0.424	1.79	1.23	2.60	<0.001	0.79	0.57	1.11	0.072
Pandemic job precarity (ref. at work)												
Absent; not COVID-19-related	1.04	0.53	2.06	0.870	0.43	0.10	1.94	0.151	1.36	0.60	3.07	0.327
Absent; COVID-19-related	2.11	1.04	4.28	0.007	1.79	0.49	6.57	0.250	2.48	1.05	5.86	0.007
Not employed	1.11	0.88	1.40	0.234	1.40	0.97	2.01	0.019	1.04	0.76	1.42	0.763
Not stated	3.47	2.09	5.77	<0.001	3.04	1.37	6.73	<0.001	2.32	1.12	4.79	0.003
Urban residency (ref. rural)	1.04	0.78	1.37	0.735	1.30	0.81	2.07	0.150	0.95	0.66	1.36	0.698
Housing type (ref. detached house)												
Low-rise apartment	1.14	0.83	1.55	0.291	1.18	0.73	1.90	0.380	0.88	0.57	1.35	0.432
High-rise apartment	1.40	0.99	1.98	0.012	1.60	0.95	2.71	0.021	1.25	0.76	2.05	0.254
Others	1.26	0.97	1.64	0.025	1.10	0.72	1.67	0.572	1.35	0.94	1.92	0.032
<i>Social isolation indicators</i>												
Relationship (ref. married)												
Widow/separated	0.73	0.50	1.06	0.031	0.78	0.39	1.57	0.366	0.73	0.46	1.17	0.084
Single/never married	0.98	0.70	1.36	0.854	0.84	0.48	1.49	0.445	1.13	0.74	1.74	0.447
Live alone (ref. not live alone)	1.56	1.09	2.23	0.001	2.03	1.09	3.75	0.003	1.20	0.77	1.89	0.289
Social network size (ref. ≥ 3 persons)												
0 person	3.26	2.03	5.24	<0.001	3.63	1.71	7.69	<0.001	2.85	1.51	5.38	<0.001
1 to 2 persons	1.73	1.42	2.10	<0.001	1.41	1.04	1.92	0.004	1.96	1.50	2.55	<0.001
Social participation (ref. no group)												
1 or more social groups	1.10	0.90	1.34	0.222	1.00	0.73	1.36	0.973	1.20	0.92	1.57	0.074
Not stated	0.83	0.50	1.40	0.362	2.15	0.97	4.76	0.013	0.43	0.20	0.89	0.003
<i>Health behaviours</i>												
Binge drinking (ref. not in past month)												
At least once a week	1.70	1.27	2.27	<0.001	2.34	1.54	3.56	<0.001	1.32	0.85	2.04	0.103
At least once a month	1.39	1.08	1.80	0.001	1.32	0.90	1.93	0.060	1.45	1.00	2.09	0.009
Cannabis use (ref. never)												
Ever used; not in the past month	0.95	0.71	1.27	0.651	0.67	0.43	1.05	0.022	1.39	0.92	2.09	0.041
Ever used; in the past month	1.47	1.12	1.93	<0.001	1.33	0.88	2.00	0.079	1.59	1.08	2.33	0.002
Opioids use (ref. never)												
Ever used; in the past month	1.51	1.00	2.28	0.010	2.85	1.46	5.58	<0.001	0.97	0.57	1.67	0.886
Ever used; not in the past month	1.25	0.95	1.64	0.040	1.61	1.05	2.44	0.004	1.00	0.68	1.46	0.999

Notes: To account for multiple testing, a more stringent criterion for statistical significance ($p < 0.01$) was applied (bolded) and 99 % confidence intervals (99 % CI) were used. Sig. = significance level. OR = odds ratio. CPSS6 = Canadian Perspective Survey Series 6 (Online nationwide survey). The reference time frame of the employment status: January 18 to 22, 2021.

According to the Canadian Medical Association, constant changes in public health restrictive measures across the country had led to confusion and frustration in the public (The Canadian Press, 2021). As such, it may speak to why “feeling isolated from others” became the major source of the “loneliness epidemic”, as its prevalence (41.9 %) was considerably higher than the other two symptoms (lacking companionship: 23.4 %; left out of life: 17 %), reflecting the repercussion of enforced social distancing, lockdowns and self-isolation. These preventative measures also entailed daily adjustments and multiple waves of losses in many areas of life (i.e., economic security, personal freedom), leading to feelings of loss to grief. Therefore, this abnormal phenomenon has been termed as the “lockdown loneliness” across the globe (Shah et al., 2020).

Our research is novel because the decision tree analysis highlights that COVID-19-related job insecurity was the strongest determinant for severe loneliness among many other social factors and that immigrants who experienced job insecurity because of a business closure/layoff or personal circumstances related to COVID-19 were the most-at-risk group of developing severely loneliness during the pandemic in Canada. A

recent Canadian study supports that precarious employment during the pandemic is associated with compromised mental health conditions including generalized anxiety disorders (Lin, 2022a, 2022b). Moreover, the pandemic-triggered job insecurity and its intersecting impact with immigration status on severe loneliness have not, to our knowledge, been reported elsewhere. This intersection may reflect the fact that immigrants to Canada are over-represented in low-paid, low-skilled precarious work such as retail positions, cleaners, or cashiers that require extensive interaction with the public (Hira-Friesen, 2018); and thus, at greater occupational risk of COVID-19 infections and consequential employment insecurity (McNamara et al., 2021). Immigrants are especially vulnerable to isolation and loneliness, in pre-pandemic times, because of their resettlement in a new environment where they may face a variety of post-migration stressors such as language obstacles, reduced social networks, a diminished sense of community belonging, racial discrimination, and poverty (Lin, 2021; Lin et al., 2020). The COVID-19 pandemic has amplified immigrants’ susceptibility to loneliness as one third of them were fear of being stigmatized as risky others in Canada (Lin, 2022a, 2022b). This may be due to the

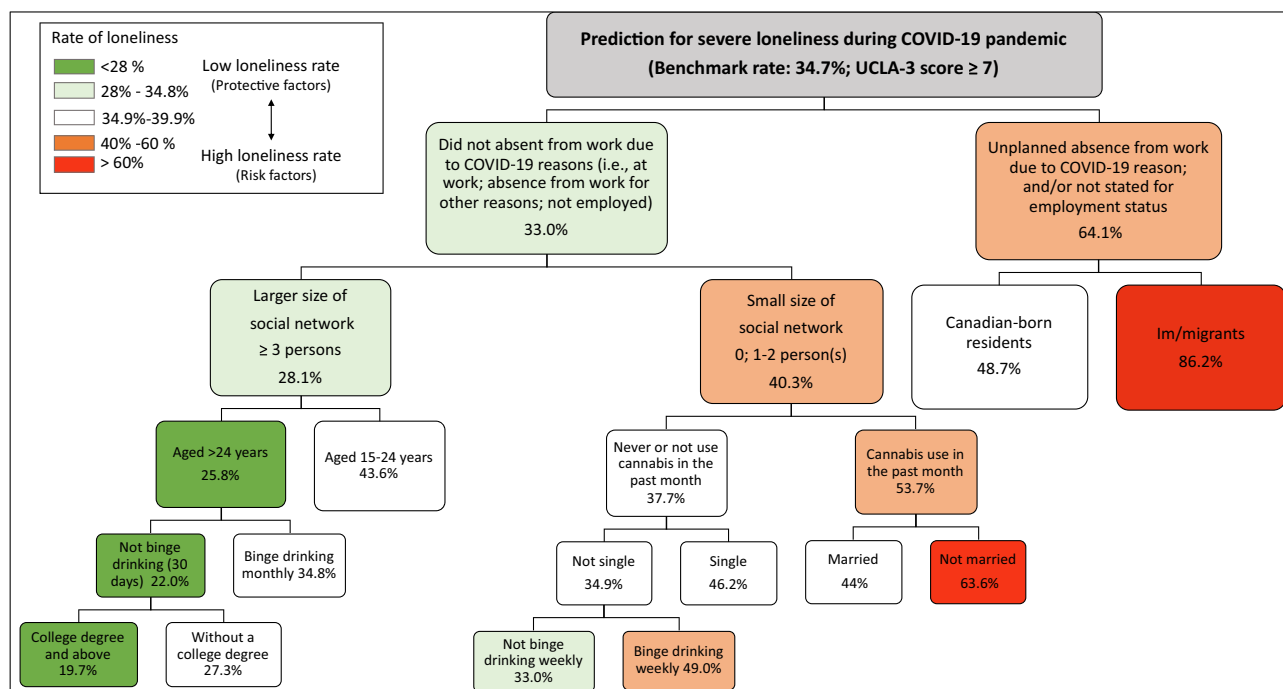


Fig. 2. Machine learning prediction (classification and regression tree) for severe loneliness and its intersecting risk factors during COVID-19 pandemic in Canada ($n = 3722$), CPSS6-COVID (January 25–31, 2021).

Notes: Decision tree is based on the CART growing method to maximize within-node homogeneity (overall classification: 67.7 %; sensitivity of 11.3 % and specificity of 97.8 %). Growing criteria: minimum sample size: child node ($n = 50$); parent node ($n = 100$), branching depth was limited to five levels. Nine variables were inputted into CART analysis software to identify intersecting risk factors of loneliness. At each binary split, the parental node branches off into two directions: the right-hand side (proportion at risk is more prevalent) whereas the left-hand side (less prevalent). Each node displays the splitting variable and the percent of those participants with the outcome of interest (severe loneliness). 10-fold cross-validation was applied to generate misclassification risk.

framing of COVID-19 as “foreign virus” that fuels otherness, xenophobia, and anti-immigrant sentiment. Longitudinal research has found the relationship between job loss and loneliness may be bi-directional and self-reinforcing (Morrish and Medina-Lara, 2021), suggesting that interventions addressing both job precarity and loneliness are crucial for immigrants in the public health crisis. As some racialized immigrant communities may have a culture of mental illness stigma, the 3-item UCLA loneliness scale could be used as a brief community screening tool for depressive symptoms to enable early detection of mental health problems that may be under-recognised among marginalized populations (Liu et al., 2020).

More importantly, severely lonely individuals in Canada were 1.7-fold more likely to seek treatment from mental health professionals, 1.5-fold more likely to seek informal support for mental health concerns and 1.8-fold more likely to have unmet mental health needs. The present study finds that these robust associations between loneliness and mental health help-seeking were independent and not attenuated by other mental health conditions including self-rated mental health, perceived life stress and mental health change. A similar pattern was observed in China (Bao et al., 2021). This suggests that severe loneliness should be considered an important mental health concern and determinant of mental health service use during the COVID-19 pandemic. Although Canada’s mental health care have been transitioned to telehealth services since the outbreak (Ashcroft et al., 2021), vulnerable populations, such as homeless people, low-income households, people with low technological literacy and asylum seekers, who find remote communication more challenging than face-to-face interactions might disengage from remote psychotherapies, and their loneliness could be exacerbated in the absence of in-person contact (Moreno et al., 2020). This may partly explain why severe loneliness was positively correlated with unmet MH needs even after MH care-seeking was taken into account. Against this backdrop of “digital health inequity”, the Canadian

government has implemented the Connecting Families Initiative 2.0 to provide affordable high-speed Internet (\$20/monthly) for low-income individuals and seniors, which could potentially mitigate barriers to digital health care. Another critical initiative is to provide free refurbished smartphones for low-income and homeless individuals (i.e., Homelessness Community Action program in British Columbia, PHONECONNECT program in Ontario) to increase their smartphone ownership and to narrow the gap in access to telemedicine (Kazvman et al., 2021).

5. Strength and limitations

This study has a number of strengths including its use of a nationally representative sample for the general population across all age groups, its validated measurement tool of loneliness adapted for pandemic times as well as its application of machine learning to detect high-order interactions among risk factors. However, several methodological flaws and biases limited the generalisability. First, this study relied on self-reported survey data and therefore is susceptible to recall bias, misreporting and misclassification. Second, the cross-sectional nature of the data prohibits the examination of causality. Without longitudinal data, it is difficult to determine the direction of the association and it may be bidirectional. For example, unhealthy behaviours (e.g., binge drinking, cannabis use, and opioid use) could be consequences of severe loneliness as well as its risk factors. Third, the statistical models will always have the risk of ‘residual confounding’, resulting from unobserved characteristics that are not included in the analyses. For example, the CPSS-6 survey did not capture pre-existing mental health conditions or history of psychiatric diagnoses. Yet, change of mental health status was controlled in the model. We were unable to control for financial resources (e.g., household income) due to a lack of relevant information in the CPSS-6, and alternatively, housing type was treated as a rough proxy. In addition, because CPSS adopts a complex sample design, a

Table 3

Multivariable logistic regression predicting mental health help-seeking by loneliness after controlling for mental health conditions and other covariates in the full sample (N = 3772), CPSS6-COVID (January 25–31, 2021).

	Panel A			Panel B				Panel C				
	Unmet MH needs			Professional MH care				Informal MH support				
	OR	99 %CI	Sig.	OR	99 %CI	Sig.	OR	99 %CI	Sig.			
Model 1 Loneliness (binary)												
Severely lonely (ref. not lonely)	1.78	1.29	2.46	<0.001	1.71	1.21	2.41	<0.001	1.51	1.17	1.95	<0.001
Poor/fair SRMH (ref. good)	2.94	2.06	4.18	<0.001	1.64	1.12	2.41	0.001	2.05	1.53	2.75	<0.001
High stress (ref. low)	1.59	1.11	2.26	0.001	1.17	0.79	1.73	0.298	1.58	1.17	2.12	<0.001
MH vs. pre-pandemic (ref. same)												
MH better	1.94	1.07	3.51	0.004	4.86	2.79	8.44	<0.001	1.39	0.91	2.14	0.048
MH somewhat worse	1.57	1.03	2.39	0.006	1.96	1.28	2.99	<0.001	1.23	0.92	1.64	0.064
MH much worse	2.27	1.27	4.06	<0.001	1.51	0.78	2.92	0.108	1.39	0.85	2.28	0.084
Nagelkerke R2	R ² = 39.4 %			R ² = 44.4 %				R ² = 30.7 %				
Model 2 Loneliness (scale)												
Loneliness scale (range: 3–9)	1.22	1.13	1.31	<0.001	1.13	1.05	1.21	<0.001	1.14	1.08	1.20	<0.001
Poor/fair SRMH (ref. good)	2.80	1.96	3.99	<0.001	1.62	1.11	2.37	0.001	1.96	1.46	2.62	<0.001
High stress (ref. low)	1.42	0.99	2.04	0.012	1.12	0.76	1.65	0.468	1.45	1.08	1.96	0.001
MH vs. pre-pandemic (ref. same)												
MH better	2.02	1.11	3.69	0.003	5.08	2.92	8.85	<0.001	1.46	0.95	2.25	0.025
MH somewhat worse	1.43	0.93	2.18	0.031	1.92	1.26	2.93	<0.001	1.16	0.87	1.54	0.198
MH much worse	1.87	1.03	3.39	0.007	1.41	0.73	2.75	0.180	1.25	0.76	2.06	0.248
Nagelkerke R2	R ² = 40.5 %			R ² = 44.4 %				R ² = 31.4 %				
Model 3 Loneliness (by symptoms)												
Isolated from others (ref. no)	1.23	0.85	1.78	0.160	0.83	0.56	1.23	0.216	2.24	1.71	2.93	<0.001
Lacking companionship (ref. no)	1.29	0.91	1.84	0.063	1.59	1.09	2.33	0.002	0.86	0.64	1.16	0.196
Feeling left out (ref. no)	1.64	1.10	2.43	0.001	1.69	1.09	2.63	0.002	0.90	0.65	1.27	0.443
Poor/fair SRMH (ref. good)	2.93	2.06	4.18	<0.001	1.63	1.11	2.39	0.001	2.07	1.54	2.77	<0.001
High stress (ref. low)	1.51	1.06	2.17	0.003	1.15	0.78	1.70	0.363	1.50	1.11	2.02	0.001
MH vs. pre-pandemic (ref. same)												
MH better	1.93	1.06	3.49	0.004	4.84	2.78	8.43	<0.001	1.43	0.92	2.20	0.035
MH somewhat worse	1.54	1.01	2.35	0.009	2.00	1.31	3.05	<0.001	1.20	0.90	1.61	0.099
MH much worse	2.09	1.16	3.76	0.001	1.45	0.74	2.81	0.153	1.36	0.82	2.24	0.117
Nagelkerke R2	R ² = 39.2 %			R ² = 44.7 %				R ² = 32.1 %				

Notes: To account for multiple testing, a more stringent criterion for statistical significance ($p < 0.01$) was applied (bolded) and 99 % confidence intervals (99 % CI) were used. Sig. = significance level. OR = odds ratio. CPSS6 = Canadian Perspective Survey Series 6 (Online nationwide survey). Panel A: Models were controlled for all covariates including professional MH care, informal MH support and psychiatric medication use. Panel B: Models were controlled for all covariates including unmet MH needs, informal MH support and psychiatric medication use. Panel C: Models were controlled for all covariates including unmet MH needs, professional MH care and psychiatric medication use. Models predicting psychiatric medication use were not shown as the variable of primary interest (loneliness) was not significant.

bootstrap variance estimation would have been preferable. Unfortunately, given the public use data set without bootstrap weights and the limitation of SPSS, the estimated variability measures produced by the normalized weight approach in the current study may differ from a full design-based approach, normally an underestimation of true variance of the estimates (Statistics Canada, 2014). Lastly, the online survey method of CPSS-6 is subjective to high nonresponse bias, resulting in an overrepresentation of individuals with post-secondary education, Canadian-born residents and two-person households.

6. Conclusion

The COVID-19 pandemic converges with “loneliness epidemic” in Canada, given that one-in-three Canadians (34.7 %) experienced severe loneliness in the general population. This nationwide study not only evaluates how risk factors of loneliness stratify by genders and intersect with each other, but also examines the association between loneliness with mental health care-seeking behaviours during the unprecedented public health crisis. As the pandemic continues to evolve with the spread of more transmissible COVID-19 variants, there is an urgent need for health authorities to address the concurrent loneliness epidemic while balancing public health measures. To combat the pervasive lockdown loneliness, a national multi-level multi-agency strategy could be adopted: at the clinical settings, primary care providers and mental health clinicians should assess loneliness symptoms in their routine patient examinations. At the community level, social care organizations should

develop early prevention and intervention programs (e.g., digital literacy training, accessible digital technology tools, and psychoeducation) targeting high-risk groups with greater burden of loneliness, including those who experience employment uncertainty caused by the pandemic, immigrant men, women with lower educational level, persons living alone, individuals with a limited social network (<3 persons), past-month binge drinkers, past-month cannabis users and men who had ever used opioids in Canada. These equity-driven efforts are crucial to foster social connectedness in a digital era, considering that severe loneliness could exacerbate psychological impact from the COVID-19 pandemic and lead to increased health care expenditure.

CRedit authorship contribution statement

This is a solo-authored paper. Shen (Lamson) Lin: Conceptualization, Methodology, Writing – original draft, Formal analysis, Visualization, Software, Writing – review & editing.

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Ethical approval and data availability statement

The public use microdata file of the Canadian Perspectives Survey

Series is available to Canadian researchers via Statistics Canada's Data Liberation Initiative and to international researchers by request at dl-i-idd@statcan.gc.ca from Statistics Canada. The public-use data are completely de-identified and publicly available with necessary suppression methods to protect confidentiality; thus, according to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2 (2018), this study could be deemed as non-human subjects research exempt from institutional ethics review.

Disclaimer

The opinions expressed in this manuscript are the author's own and do not reflect the views of Statistics Canada.

Declaration of competing interest

The author declared no potential conflict with respect to the research, authorship, and/or publication of this article.

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