



## Article

# COVID-19 Pandemic: Influence of Gender Identity on Stress, Anxiety, and Depression Levels in Canada

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**Abstract: Background:** This cross-sectional study explored variation of the prevalence of perceived stress, depression and anxiety among different self-identified gender identity groups in the Canadian population during the early stages of the COVID-19 pandemic. **Methods:** Anxiety, depression, and stress were assessed using the Generalized Anxiety Disorder 7-item (GAD-7) scale, Patient Health Questionnaire-9 (PHQ-9), and Perceived Stress Scale (PSS) respectively. Data were analyzed using one-way analysis of variance. **Results:** There were 8267 respondents to the online survey; 982 (12.0%) were male-identified, 7120 (86.9%) female-identified, and 92 (1.1%) identified as a diverse gender group. Prevalence rates for clinically meaningful anxiety (333 (41.7%), 2882 (47.6%), 47 (61.0%)), depression (330 (40.2%), 2736 (44.3%), 46 (59.7%)), and stress (702 (79.6%), 5711 (86.4%), 74 (90.2%)) were highest among respondents who self-identified as “other gender” followed by female-identified and then male-identified, respectively. There were statistically significant differences between gender groups for mean scores on GAD-7 ( $F(2, 6929) = 18.02, p < 0.001$ ), PHQ-9 ( $F(2, 191.4) = 11.17, p < 0.001$ ), and PSS ( $F(2, 204.6) = 21.13, p < 0.001$ ). **Conclusions:** Gender identity differences exist in terms of the prevalence and severity of anxiety, depressive, and stress symptoms during the COVID-19 pandemic. This finding highlights the importance of incorporating self-identified gender identity in medical research, clinical practice, and policy.

**Keywords:** COVID-19; Text4Hope; mobile phones; text; anxiety; depression; stress; gender; gender identity; pandemic; e-mental health



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## 1. Introduction

The coronavirus disease (COVID-19) was initially detected in Wuhan China in late 2019. The virus rapidly spread across the globe with detrimental pandemic impacts on human life: its impact is reflected in morbidity and mortality rates, economic losses, and overwhelming changes in ways of living and other usual daily activities [1]. All of these factors, together with the uncertainties associated with the pandemic, have unsettled the world and exposed vulnerabilities in leadership and the effectiveness of different healthcare systems [2]. The spread of COVID-19 in Canada prompted quick enactment of policies and strategies to both contain and limit its impact on the population. To 23 December 2021, there

had been 276,436,619 confirmed cases of COVID-19, including 5,374,744 deaths, while in Canada estimates accounted for 1,907,771 cases of COVID-19 and 30,085 deaths (WHO 2020).

Much remains to be learned about this illness, which presents with a combination of symptoms including cough, difficulty in breathing, fever/chills, fatigue, muscle aches, loss of sense of smell, and gastrointestinal symptoms, among others [3].

Initially, COVID-19 was thought to be transmitted through respiratory droplets, contaminated surfaces, and human contact [4,5]. These preliminary observations informed the first wave of prevention strategies (i.e., regular hand washing/sanitizing, wearing of personal protection equipment, and physical distancing

There are now concerted efforts by governments and pharmaceutical organizations worldwide towards the development of new vaccines and treatment protocols to combat the pandemic. Meanwhile, as the development of vaccines for COVID-19 progresses, various approaches have been adopted by healthcare professionals in treating infected individuals with some degree of success, but the mortality rate remains alarmingly high so far as reflected by the global COVID-19 associated death rate, especially as it pertains to the Delta variant (WHO 2020).

With the course of the COVID-19 pandemic yet to be determined and new waves of infection now occurring, it is important to keep in mind that emotional and behavioral responses influence the course of pandemics [6]. Worth acknowledging also is the fact that pandemics confer associated impacts (e.g., preventive measures which include activity restrictions, unclear or excessive information from the media, uncertainty about the illness, and economic consequences) that lead to disparate and negative psychological effects in the population [7]. Some of these psychological impacts could present as stress, depression, and anxiety [8]. These psychological consequences have been identified during the COVID-19 pandemic in various world populations [9–11]. Like any other mental health difficulties, stress, depression, and anxiety all have the potential to run a chronic course and affect functioning in the social and occupational domains [12–14].

Research has suggested there may be biological sex differences in terms of COVID-19 prevalence and expressions. Preliminary evidence from Wuhan, China, and Italy [15,16] suggests that cisgender males are most infected by COVID-19 and also have increased COVID-related deaths. Similar patterns were seen during the severe acute respiratory syndrome (SARS) pandemic of 2003 [17] and Middle East respiratory syndrome (MERS) of 2012 [18] pandemic, when there were higher fatality rates in cisgender males compared to cisgender females. There is however limited data on the prevalence of anxiety, depression, and stress in diverse gender identity groups during the current COVID-19 pandemic. We already know that the prevalence of anxiety, depression, and stress in the general population is higher in cisgender females [19,20] but how this potentially could vary, particularly in the Canadian population in the era of COVID-19, is largely unknown. Evidence from studies focused on past pandemics might be a guide in understanding COVID-19 and its psychological impacts among diverse gender identity groups. This study was designed to investigate the psychological impact of COVID-19, focusing on anxiety, depression, and stress in different demographics of the Canadian population with particular emphasis on its variation among diverse gender identities.

## 2. Methods

A cross-sectional survey was used to explore the impact of gender identity on the perceived stress, depression, and anxiety symptom scores among the individuals who subscribed to the Text4Hope program.

### 2.1. Recruitment and Sample Size

The recruitment procedures and sample size calculation have been described in our related papers [21–23]. In summary, Text4Hope is a daily supportive texting service provided by Alberta Health Services to Albertans during the COVID-19 crisis. The content was developed and reviewed by a group of psychiatrists, psychologists, and mental health therapists,

including the study authors. Over a period of six weeks, Text4Hope subscribers received an online survey at registration with the program, collecting demographic data including gender, age, ethnicity, education, relationship status, employment, type of employment, and housing status. Subscribers were also asked for other related clinical characteristics, using validated scales for self-reported symptoms, including the Perceived Stress Scale [24] (for moderate to high stress;  $PSS \geq 14$ ), the Generalized Anxiety Disorder-7 (GAD-7) Scale [25] (for likely generalized anxiety disorder;  $GAD-7 \geq 10$ ), and the Patient Health Questionnaire-9 (PHQ-9) [26] (for likely depressive symptoms;  $PHQ-9 \geq 10$ ). Sample size was calculated in reference to the total population in Alberta, which is approximately 4.3 million, and with a confidence level of 99% and a 2% margin of error; it was estimated to be 4200 individuals. The expected response rate was 20% [27]. Participant consent was implied by submission of subscribers' survey responses.

## 2.2. Outcome Measures

Primary outcomes are:

Estimated overall prevalence of anxiety, stress, and depressive symptoms in Alberta, Canada during the time of COVID-19.

Secondary outcomes are:

Relationship of self-identified gender to the proposed symptomatology of anxiety, stress, and depression during the COVID-19 pandemic.

## 2.3. Statistical Methods

The IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA) [28], was used for analysis. Results of the general and demographic data were reported as frequencies and percentages against gender distribution data.

Distribution of prevalence rates and mean scores on the clinical measures, Perceived Stress Scale, the GAD-7, and the PHQ-9 by gender category distribution was studied using the chi-square test and one-way analysis of variance (one-way ANOVA), respectively, with two-tailed significance ( $p$ -value  $< 0.05$ ). Tukey's post hoc test was used to examine the statistical differences in the mean scores of the various clinical measures between the different age groupings. The Welch F test was used instead of one-way ANOVA when the homogeneity of variance assumption was not met, and the Games–Howell post hoc test was run for paired comparisons.

## 3. Results

A total of 44,992 individuals subscribed to Text4Hope in the first 6 weeks, and 8267 of them responded to the online survey invitation, yielding a response rate of 19.4%. Of the 8267 respondents, 982 (12.0%) identified as male, 7120 (86.9%) identified as female, and 92 (1.1%) identified as belonging to "other" gender identities.

Table 1 shows the demographic characteristics of the respondents by gender identity categories. The table depicts that the age group 40–60 y constituted the majority with 3424 (42.6%). Similarly, Caucasian (6685, 82.0%), individuals with post-secondary education (6950, 85.0%), employed (5983, 73.2%), married/cohabiting/partnered (5791, 70.8%), and owning homes (5276, 65.7%) were the most represented groups within our sample.

The data displayed in Table 2 illustrate the prevalence rates for clinically meaningful stress, anxiety, and depression. The data suggest that the prevalence of high/moderate stress, likely GAD and likely MDD, were highest in respondents who identified as other than male or female.

**Table 1.** Gender identity distribution of demographic characteristics of respondents.

Variables	Male	Female	Other Gender	Overall
	N (%)	N (%)	N (%)	N (%)
<b>Age (Years)</b>				
≤25	108 (11.3)	776 (11.1)	23 (29.1)	907 (11.3)
26–40	336 (35.0)	2568 (36.7)	33 (41.8)	2937 (36.6)
41–60	396 (41.3)	3009 (43.0)	19 (24.1)	3424 (42.6)
60	119 (12.4)	638 (9.1)	4 (5.1)	761 (9.5)
<b>Ethnicity</b>				
Caucasian	751 (76.6)	5884 (83.1)	50 (55.6)	6685 (82.0)
Indigenous	32 (3.3)	263 (3.7)	7 (7.8)	302 (3.7)
Asian	93 (9.5)	312 (4.4)	2 (2.2)	407 (5.0)
Other	105 (10.7)	620 (8.8)	31 (34.4)	756 (9.3)
<b>Education</b>				
Less than High School Diploma	56 (5.7)	258 (3.6)	12 (13.0)	326 (4.0)
High School Diploma	125 (12.8)	674 (9.5)	10 (10.9)	809 (9.9)
Post-Secondary Education	792 (80.9)	6100 (85.9)	58 (63.0)	6950 (85.0)
Other Education	6 (0.6)	72 (1.0)	12 (13.0)	90 (1.1)
<b>Employment status</b>				
Employed	713 (72.9)	5219 (73.4)	51 (55.4)	5983 (73.8)
Unemployed	124 (12.7)	818 (11.5)	12 (13.0)	954 (11.7)
Retired	78 (8.0)	475 (6.7)	3 (3.3)	556 (6.8)
Student	52 (5.3)	386 (5.4)	14 (15.2)	452 (5.5)
Other	11 (1.1)	208 (2.9)	12 (13.0)	231 (2.8)
<b>Relationship status</b>				
Married/Cohabiting/Partnered	691 (70.6)	5055 (71.2)	45 (48.9)	5791 (70.8)
Separated/Divorced	52 (5.3)	565 (8.0)	1 (1.1)	618 (7.6)
Widowed	8 (0.8)	125 (1.8)	1 (1.1)	134 (1.6)
Single	222 (22.7)	1287 (18.1)	29 (31.5)	1538 (18.8)
Other	6 (0.6)	72 (1.0)	16 (17.4)	94 (1.1)
<b>Housing status</b>				
Own Home	605 (63.5)	4634 (66.4)	37 (40.2)	5276 (65.7)
Living With Family	101 (10.6)	667 (9.6)	19 (20.7)	787 (9.8)
Renting	243 (25.5)	1615 (23.1)	27 (29.3)	1885 (23.5)
Other	4 (0.4)	66 (0.9)	9 (9.8)	79 (1.0)

Table 3 illustrates the means and standard deviations for the GAD-7, PHQ-9, and PSS by gender identity categories. The mean score for the respondents on the GAD-7 scale ( $n = 6932$ ) was 9.68 (SD = 5.87). For the PHQ-9 scale, the mean score for all respondents ( $n = 7070$ ) was 9.44 (SD = 6.29) and for the Perceived Stress Scale ( $n = 7577$ ) it was 20.79 (SD = 6.83).

**Table 2.** Chi-square test of association between gender identity categories and the prevalence of perceived stress, likely generalized anxiety disorder, and likely major depressive disorder.

	Male N (%)	Female N (%)	Other Gender N (%)	Total Prevalence N (%)
<b>Perceived Stress</b>				
Moderate or High Stress <sup>a</sup>	702 (79.6)	5711 (86.4)	74 (90.2)	
Chi <sup>2</sup>		30.38		6487 (85.6%)
p-value		<0.001		
Effect Size (Phi)		0.06		
<b>Generalized Anxiety Disorder (GAD-7)</b>				
GAD likely <sup>b</sup>	333 (41.7)	2882 (47.6)	47 (61.0)	
Chi <sup>2</sup>		16.01		3262 (47.1)
p-value		<0.001		
Effect Size (Phi)		0.05		
<b>Major Depressive Disorder (MDD)</b>				
MDD likely <sup>c</sup>	330 (40.2)	2736 (44.3)	46 (59.7)	
Chi <sup>2</sup>		12.84		3112 (44.0)
p-value		0.002		
Effect Size (Phi)		0.04		

<sup>a</sup> Moderate or high stress defined as PSS-10 score  $\geq 14$ . <sup>b</sup> Likely GAD defined as GAD-7 scale score  $\geq 10$ . <sup>c</sup> Likely MDD defined as PHQ-9 scale score  $\geq 10$ .

**Table 3.** Mean scores on the GAD-7 Scale, PHQ-9 Scale, and PSS by gender identity.

		N	Mean	SD <sup>a</sup>	SE <sup>b</sup>	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
<b>GAD-7 Total Score</b>	Male	799	8.63	5.982	0.212	8.21	9.04	0	21
	Female	6056	9.80	5.828	0.075	9.65	9.95	0	21
	Other	77	11.52	6.225	0.709	10.11	12.93	0	21
	Total	6932	9.68	5.865	0.070	9.54	9.82	0	21
<b>PHQ-9 Total Score</b>	Male	821	8.75	6.465	0.226	8.31	9.19	0	27
	Female	6172	9.49	6.232	0.079	9.33	9.64	0	27
	Other	77	12.52	7.586	0.864	10.80	14.24	0	27
	Total	7070	9.44	6.288	0.075	9.29	9.58	0	27
<b>PSS Total Score</b>	Male	882	19.46	7.092	0.239	18.99	19.92	0	40
	Female	6613	20.94	6.761	0.083	20.78	21.10	0	40
	Other	82	23.12	7.525	0.831	21.47	24.78	8	40
	Total	7577	20.79	6.829	0.078	20.64	20.95	0	40

<sup>a</sup> Standard deviation. <sup>b</sup> Standard error.

The data displayed in this table indicate that male-identified participants exhibited consistently lower means on the three scales compared to their female-identified and counterparts with other or diverse gender identities.

Table 4 summarizes the one-way ANOVA results comparing sums of squares between and within the groups of gender identity distribution for the GAD-7, PHQ-9, and PSS scales.

Although the Levene statistic did not reflect a violation of the assumption of homogeneity of error variances for the GAD-7 scale data ( $p > 0.05$ ), this was not the case for the PHQ-9 and PSS scale data ( $p < 0.05$ ). The data displayed in Table 4 indicate statistically significant differences between and within the gender identity groups for scores on the GAD-7 scale ( $F(2, 6929) = 18.02, p < 0.001$ ).

**Table 4.** One-way ANOVA comparing sums of squares between and within groups.

		Sum of Squares	Df	Mean Square	F	Sig.
GAD-7 Total Score	Between Groups	1233.365	2	616.682	18.018	<0.001
	Within Groups	237,147.154	6929	34.225		
	Total	238,380.519	6931			
PHQ-9 Total Score	Between Groups	1136.291	2	568.145	14.426	<0.001
	Within Groups	278,323.669	7067	39.384		
	Total	279,459.960	7069			
PSS Total Score	Between Groups	2168.300	2	1084.150	23.385	<0.001
	Within Groups	351,144.142	7574	46.362		
	Total	353,312.442	7576			

Table 5 displays the results for post hoc analyses of GAD-7, PHQ-9, and PSS scales results. Regarding the GAD-7 scale, the three gender identity groups surveyed exhibited significant differences in average scores relative to each other. Male-identified participants expressed significantly lower mean scores on the anxiety scale compared to female-identified participants and other participants with diverse gender identities (mean difference = 1.17, 95% CI = (−1.69)–(−0.66), and mean difference = 2.9, 95% CI = (−4.53)–(−1.26)), respectively. In contrast, those who identified with diverse gender identities expressed the highest mean compared to the female-identified group (mean difference = 1.72, 95% CI = 0.15–3.29), respectively.

Consequently, we ran Welch F tests for PHQ-9 and PSS scales. That analysis revealed statistically significant differences between and within the gender groups for scores on the PHQ-9 scale ( $F(2, 191.4) = 11.17, p = 0.00$ ) and the PSS ( $F(2, 204.6) = 21.13, p = 0.00$ ).

Table 5 illustrates how the three gender identity groups expressed significant differences in their PHQ-9 scores in relation to each other. For example, male-identified participants had significantly lower mean scores on the PHQ-9 scale compared to female-identified participants (mean difference = 0.739, 95% CI = (−1.3)–(−0.18),  $p = 0.006$ ) and those who identified as having diverse gender identities (mean difference = 3.77, 95% CI = (−5.9)–(−1.64),  $p < 0.001$ ). On the other hand, the gender diverse group had significantly higher mean scores on the PHQ-9 scale compared to respondents who identified as female (mean difference = 3.03, 95% CI = 0.96–5.11,  $p = 0.002$ ).

As with data from the GAD-7 and PHQ-9 scales, PSS scores yielded significant differences among the three gender identity groups in relation to each other. As illustrated by the data of Table 5 the gender diverse group scored the highest (mean difference = 3.67, 95% CI = 1.61–5.72,  $p < 0.001$ ) and (mean difference = 2.18, 95% CI = 0.19–4.17,  $p = 0.03$ ), compared to the male and female-identified groups respectively. Additionally, male-identified participants scored significantly lower than the female-identified participants (mean difference = 1.49, 95% CI = (−2.08)–(−0.89),  $p < 0.001$ ).

**Table 5.** Tukey HSD and Games–Howell post hoc multiple comparisons.

Dependent Variable	(I) Gender	(J) Gender	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
GAD-7 Total Score <sup>a</sup>	Male	Female	−1.173	0.220	<0.001	−1.69	−0.66
		Other	−2.894	0.698	<0.001	−4.53	−1.26
	Female	Male	1.173	0.220	<0.001	0.66	1.69
		Other	−1.721	0.671	0.028	−3.29	−0.15
	Other	Male	2.894	0.698	<0.001	1.26	4.53
		Female	1.721	0.671	0.028	0.15	3.29
PHQ-9 Total Score <sup>b</sup>	Male	Female	−0.739	0.239	0.006	−1.30	−0.18
		Other	−3.770	0.893	<0.001	−5.90	−1.64
	Female	Male	0.739	0.239	0.006	0.18	1.30
		Other	−3.031	0.868	0.002	−5.11	−0.96
	Other	Male	3.770	0.893	<0.001	1.64	5.90
		Female	3.031	0.868	0.002	0.96	5.11
PSS Total Score <sup>b</sup>	Male	Female	−1.486	0.253	<0.001	−2.08	−0.89
		Other	−3.666	0.865	<0.001	−5.72	−1.61
	Female	Male	1.486	0.253	<0.001	0.89	2.08
		Other	−2.180	0.835	0.029	−4.17	−0.19
	Other	Male	3.666	0.865	<0.001	1.61	5.72
		Female	2.180	0.835	0.029	0.19	4.17

<sup>a</sup> Tukey HSD post hoc multiple comparison. <sup>b</sup> Games–Howell post hoc multiple comparison.

#### 4. Discussion

Previous studies that investigated psychological consequences of past respiratory pandemics and even COVID-19 have focused mainly on stress, anxiety, and depression prevalence but not potential differences in relation to self-reported gender identity. This study is one of the first to investigate gender identity differences among clinical psychological consequences of COVID-19. The levels of the psychological impacts of interest in this study with regard to gender identity may help in determining appropriate services in relation to reducing the mental health burden of COVID-19 and developing more targeting and effective interventions. This is especially important given the unique vulnerabilities of sexual and gender minorities, who have received minimal attention in COVID-19 related research, despite well-documented mental health and healthcare disparities relative to their heterosexual and cisgender counterparts [29]. These concerns may be significantly amplified for sexual and gender minority youth who are forced to isolate in unsafe family environments and are cut off from important social support networks in schools and communities. Many K-12 schools and post-secondary institutions are important access points for inclusive mental health services and identity-related support. Sexual and gender minority seniors may also face increased vulnerability as they are more likely to be single and living alone. They may also experience estrangement from their biological families due to experiences of prejudice and discrimination. COVID-19 pandemic restrictions, such as stay in place orders or mandatory isolation requirements, may enhance vulnerability, isolation, alienation, and depressive symptoms.

The rating scales used for our study (i.e., Perceived Stress Scale, GAD-7, and PHQ-9), are all standardized scales. It is important to highlight that the variation of scales used for measuring these psychological consequences in previous studies [30,31] potentially could make formal comparison of the findings difficult. Regardless of the use of different

scales for measuring stress, there seems to be consensus that pandemics are linked to psychological problems in the different populations studied [32–35].

About a quarter of all Text4Hope subscribers participated in the study, but there was overrepresentation of female-identified participants who accounted for 87% of our study population. Within the three gender identity categories included in our study, male-identified participants demonstrated consistently lowest prevalence rates for clinically meaningful symptoms and mean scores on all three rating scales used. These findings are further statistically significant between and within the gender identity groups by one-way ANOVA. Tukey's post hoc analysis test for GAD-7 also confirmed a variation in anxiety levels among the three gender identity groups, with male-identified participants expressing significantly lower mean scores than the other two gender identity groups. The diverse gender identity group consistently had the highest mean scores for all the scales, possibly due to type 1 errors resulting from the small number of participants that fell into this grouping [35]. However, in our study, female-identified participants were more likely to develop or experience the three psychological consequences of COVID-19 compared to male-identified participants. A similar pattern of gender variation was observed in Wuhan and its surrounding cities with greater post-traumatic stress symptoms prevalent in the female-identified population [34]. It is worth highlighting at this point that intrusive memories linked to stress are experienced more in the female-identified population [36], which may contribute to this pattern. Furthermore, in a study that used the COVID-19 Peritraumatic Distress Index (CPDI), which includes anxiety and depression subscales among others, female-identified participants apparently experienced more psychological distress [31]. Another study which investigated gender-perception and psychological distress during the COVID-19 pandemic in a group of healthcare students reported similar findings to our study, as students who identified as female were more likely to meet the criteria for anxiety and depression. The study however found male students to be more at risk of developing stress. This finding among the students who identified as males might be due to chance, given the small number of male participants in the study [37]. The lower likelihood of anxiety and depression among male-identified participants found in our study also aligns with a previous study which further associated the finding to older cisgender males [38]. The latter study also found younger cisgender females to be at increased risk of anxiety and depression during the COVID-19 pandemic. However, in a United Kingdom study focused on an adult population exposed to a traumatic incident, there were no gender differences in terms of stress [39]. By contrast, a study involving a combined population of sufferers of PTSD and complex PTSD reported a higher prevalence of stress in cisgender males [40]. It is unclear what led to this finding, which is considered an outlier, but it may possibly be attributable to exposure to information concerning COVID-19 related increased mortality in the cisgender male populations in Italy and China [15,16,41].

Other studies have highlighted how gender diverse populations have increased rates of adverse mental health when compared to cisgender individuals. In the context of the COVID-19 pandemic, these health inequities may be amplified as access to gender-affirmative care has been reduced or limited as a "non-essential" medical service, coupled with increased experiences of isolation and seclusion and higher rates of discrimination [42].

Specific reasons underlying the causes for these reported gender identity differences remain to be determined, although various explanations have been offered. For example, cisgender women may overestimate pain from undesirable stimuli by adopting self-perspective theory when interpreting behavior [43]. Cisgender women may be more likely to seek professional help in the face of physical and psychological stress in comparison to cisgender men [44], who are likely to resort to maladaptive coping methods [45]. The latter could be responsible for the increase in the fatality rate among cisgender men in previous respiratory pandemics [17,18], as they may be presenting too late with the disease. Biological explanations have also been offered, such as that cisgender men may show less reactivity in neural networks linked to fear and excitement responses [46], which plays a role in stress.



Social explanations have also been offered. Cisgender women may experience more role strain due to adopting multiple roles [47]. For example, they may focus on their own health-related concerns as well as those of family members. As a result of multiple roles, the perceived economic consequences of the pandemic are higher [48,49]. As with other disasters or pandemics, COVID-19 restrictions have resulted in significant increases in interpersonal violence with cisgender women being at increased risk [50–52]. Decreased social support could further complicate the psychological impact of the pandemic. As has been highlighted in previous studies, most of the frontline workers in healthcare are female-identified [48], which implies they are more predisposed to contracting the infection and also witness the extent of problems associated with the pandemic, which could be more unsettling.

Our study raises concerns about potential gender-related health inequities and the need to have gender-identify specific health intervention strategies going forward. This must be reflected in policy development and implementation. By way of precedent evidence, consideration of gender-related needs has proven effective in improving care for individuals suffering cardiovascular disease and other health conditions when incorporated into research and clinical care [53].

## 5. Limitations

There are several limitations of our study. First, our sample is not representative of Alberta's population in terms of age and gender [54], which reduces the generalizability of our findings. Second, there is a possibility of information bias as a result of the self-reporting nature of the scales used, and the overrepresentation of female-identified gender could impact the external validity of the study [35]. This indicates the need for a larger study with randomization to make the outcome of the study generalizable to the target population. Additionally, although the ANOVA analysis allowed for comparison of stress, anxiety, and depression levels between all three gender identity groups as a strength, it did not take into account potential confounding factors such as age, ethnicity, sexual orientation, relationship, employment and education status, which is a limitation as gender identity is likely to be one of several key factors upon which vulnerability to mental health effects of COVID-19 would be based. Finally, the data used for the study did not include medical diagnoses or hospitalization status of participants. We understand that these could be useful in further exploring the impact of medical health conditions on the outcome obtained in our analysis. This will have to be considered in a future study.

## 6. Conclusions

This study's results demonstrate variation among gender identity for the prevalence of anxiety, depression, and stress during the COVID-19 pandemic, which aligns with findings from previous studies on past pandemics. This difference in the psychological impact of the pandemic in relation to different gender identity groups highlights the need for the careful consideration of potential factors that could be responsible for cisnormativity and related gender-bias while developing health policies and interventions for pandemics in order to address gender-identity related inequities more effectively in the future. Specifically, planning for and implementing more gender-inclusive virtual care programs such as supportive text message interventions which are relatively low-cost and easily scalable could be a means of supporting individuals with additional risk factors during public health crises [55–61]. Though our study population was large, a larger study with randomization could address potential selection bias, with resultant improvement in the generalizability of study findings. It would also be useful to include more gender identity options to account for a wider array of diverse gender identities and expressions, which may be important to ensure mental health interventions are more inclusive, responsive, and effective.

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