


Long-Term Mental Health Effects of a Devastating Wildfire Are Amplified by Sociodemographic and Clinical Antecedents in College Students

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ABSTRACT

Objectives: The aim of this study is to assess prevalence of major depressive disorder (MDD), generalized anxiety disorder (GAD), and posttraumatic stress disorder (PTSD) in students of Keyano College 18 months after a wildfire and to determine the predictors of *likely* MDD, GAD, and PTSD in the respondents.

Methods: A quantitative cross-sectional survey was used to collect data through self-administered, paper-based questionnaires to determine likely MDD, GAD, and PTSD using the PHQ 9, GAD-7, and the PTSD Checklist for DSM 5, Part 3, respectively. Data were analyzed with SPSS version 20 (IBM Corp, Armonk, NY) using univariate analysis with chi-square tests.

Results: Eighteen months after the wildfire, the 1-month prevalence rates for MDD, GAD, and PTSD among the college students were 23.4%, 18.7%, and 11.0%, respectively. There were statistically significant associations between multiple sociodemographic variables and the likelihood respondents presented with MDD, GAD, and PTSD 18 months after the wildfire. There were also associations between the likely MDD, GAD, and PTSD and abuse/dependence on alcohol and substances in respondents at 18 months.

Conclusion: Our study has established prevalence rates for MDD, GAD, and PTSD among college students 18 months after the Fort McMurray wildfires. Further studies are needed to explore the impact of college-based mental health interventions on the long-term mental health effects of the wildfires.

Key Words: alcohol Fort McMurray, anxiety, depression, drugs, PTSD, wildfires

Burning for over 15 months, the Fort McMurray wildfire of 2016 burnt nearly 600 000 hectares of land¹ and destroyed 3244 buildings.² This disaster caused the evacuation of over 80 000 residents and has been estimated to have a cost of CAD \$9.9 billion, with that number expected to continue to climb until around 2026.³ It has been named the most expensive natural disaster in Canadian history, with CAD \$3.7 billion paid out by insurance providers.⁴ While there were no deaths directly associated with the wildfire, 2 teenagers were killed in a car crash during the evacuation.³

Exposure to a natural disaster in Canada is common, with 12.4 million Canadians reporting having experienced a disaster in their lifetime, 73% of whom reported that their routine was significantly altered, causing a disruption of work, school, and home life.⁵ Recovery from a traumatic natural disaster can take decades for the survivors and their surrounding community to return to normal.^{6,7} While most of those impacted were able to return to their routines within

2 weeks, it often takes more than a year for those who experience a significant psychological impact to recover fully.⁵ Natural disasters often are the cause of destruction or property, physical injuries, or loss of life. While wildfires are less common, the severity of these disasters have increased in the past 200 years, and it has been estimated that two-thirds of those exposed have feared for their lives, with increased prevalence of depression and posttraumatic stress disorder (PTSD) in later screenings.⁸

However, the impact on mental health is often overlooked in many studies.⁹ Natural disasters frequently have lasting consequences on mental health, including depression, anxiety, PTSD, and alcohol and substance use disorders.¹⁰⁻¹² PTSD and depression are the most commonly assessed and treated mental health complications after a natural disaster.¹³ Early diagnosis and treatment of mental health complications are key to improving prognosis.¹⁴ College students are a subpopulation on their own and subject to vulnerabilities that may or may not be seen within the general

population.¹⁵ However, while the number of studies of the impact of natural disasters on mental health is growing, more research is needed to determine the severity of long-term consequences,¹⁶ the specific impact on college students, and to enhance understanding of the impact of intervention. Consequently, the aim of this study is to assess *likely* prevalence of major depressive disorder (MDD), generalized anxiety disorder (GAD), and PTSD in students of Keyano College 18 months after a wildfire and to determine the predictors of *likely* MDD, GAD, and PTSD in the respondents.

METHODS

Study Setting

Keyano College is the only tertiary institution in Fort McMurray, the urban service area of the Regional Municipality of Wood Buffalo in Northern Alberta. With a student population of over 1500 as of November 2017, the college offered degree programs in nursing, education, social sciences, as well as engineering programs related to the oil and gas industry. On May 3, 2016, a mandatory evacuation order was issued for Regional Municipality of Wood Buffalo due to raging wildfire that threatened lives and property. Overall, about 2400 homes in Fort McMurray were destroyed and over 90 000 residents of the region, including Keyano college students and staff, were evacuated. The evacuation order was lifted with residents returning to the municipality in phases from June 1, 2017.

Study Design and Institutional Review Board Approval

Quantitative data collected through self-administered paper-based questionnaires were used in this cross-sectional survey study design. Total sampling methods were adopted to collect data from all students enrolled in Keyano College in November 2017. Written consent was obtained from all study participants after they had been provided with information leaflets and opportunities to ask questions about the study. The study received institutional review approval from the University of Alberta Review and Ethics Board (Pro00066054).

Data Collection and Analysis

Respondents' demographic and clinical, as well as wildfire exposure and support-related information was collected with a data collection form designed for the purpose. The PHQ 9, GAD-7, and the PTSD Checklist for DSM 5 were used to assess the presence or absence of likely MDD, GAD, and PTSD, respectively, in respondents. The PHQ 9 scoring was done using the standard recommendation with a threshold for likely depression being met if 5 of the 9 items were checked at least "more than half the days" and either item A or B were checked at least "more than half the days."¹⁷ A score of 10 or more on GAD-7 was used to assess GAD symptomatology.¹⁸ The PTSD Checklist for DSM 5 (PCL 5) Part 3¹⁹ was used to assess *likely* PTSD in respondents. Patients with a PCL-5 score of 33 or more were deemed to have a *likely* PTSD.

We used the Drug Use Disorder Identification Test²⁰ to assess for the presence of drug-related problems and the Alcohol Use Disorder Identification Test²¹ to assess the presence of problem drinking among the respondents. Data were collected throughout November 2017 from students of Keyano College. In an effort to achieve total sampling, data collection points were set up in 2 common areas of the college, namely the canteen and the main students lounge. In addition, information leaflets and survey forms were distributed to students in lecture rooms by a staff member and a student representative who worked in collaboration with the research assistant. In this way, all students were offered the opportunity to participate in the survey. Students collecting the survey forms from a staff member or student representative were directed to submit completed forms to a drop box located at the data collection points. The survey forms took 20–30 minutes to complete, and no incentives were offered to students for completing and returning the survey forms.

We analyzed data using SPSS Version 20 (IBM Corp, Armonk, NY). We presented absolute numbers and percentages according to gender for all of the demographic and clinical variables. We used univariate analyses with chi-square tests to ascertain the relationship between each of the predictors and the likelihood that respondents had MDD, GAD, and PTSD. Statistically significant relationships were established where $P \leq 0.05$ (2-tailed exact significance).

RESULTS

Of 1587 students enrolled in Keyano College during the month of November 2017, 329 students consented and completed the paper surveys, giving a response rate of 20.73%. There were 94 (28.6%) male respondents and 235 (71.4%) female respondents. **Table 1** shows the gender distribution of the sociodemographic and background, as well as current clinical characteristics of the respondents, including the prevalence rates for probable addiction and mental health presentation in respondents 18 months after the wildfires.

Table 1 shows that only 11.0%, 14.6%, and 0.0% of respondents self-reported they had histories of a depressive disorder, an anxiety disorder, and PTSD, respectively, prior to the onset of the wildfires. It also shows that 18 months after the wildfire, the 1-month prevalence rate for MDD, GAD, and PTSD among the college students were 23.4%, 18.7%, and 11.0%, respectively. A higher proportion of female students than male students had a likely MDD, GAD, and PTSD with the 1-month prevalence rate of likely PTSD at 18 months in female students being almost twice the rate among male students. Furthermore, **Table 1** suggests that 15.5%, 13.5%, and 4.4% of respondents presented with high risk drinking, problematic drug use, and moderate to high nicotine dependence, respectively. The results in **Table 1** suggest that while a higher proportion of male respondents had high risk drinking and moderate to high nicotine

TABLE 1

Gender Distribution of Sociodemographic and Clinical Characteristics of Respondents

Variables	Male	Female	Overall
Age (years)			
≤ 25	49 (52.1%)	125 (53.2%)	174 (52.9%)
26–40	26 (27.7%)	85 (36.2%)	111 (33.7%)
> 40	19 (20.2%)	25 (10.6%)	44 (13.4%)
Relationship status			
Single/separated/divorced/widowed	53 (57.6%)	113 (56.3%)	184 (57.0%)
Married/cohabiting/partnered	39 (42.4%)	100 (43.3%)	139 (43.0%)
Respondents' score on the ACE questionnaire			
0	39 (59.1%)	75 (40.3%)	114 (45.2%)
1–3	22 (33.3%)	79 (42.5%)	101 (40.1%)
4 or more	5 (7.6%)	32 (17.2%)	37 (14.7%)
Area of residence relative to destroyed properties			
0–1.0 properties destroyed per square kilometer	30 (32.3%)	52 (22.5%)	82 (25.3%)
1.1–50.0 properties destroyed per square kilometer	47 (50.5%)	155 (67.1%)	202 (62.3%)
50.1–300.0 properties destroyed per square kilometer	16 (17.2%)	24 (10.1%)	40 (12.3%)
Respondents witnessed burning of homes by the wildfires.	69 (75.0%)	182 (77.4%)	251 (76.8%)
Respondents were fearful for their lives or the lives of friends/family.	62 (68.1%)	215 (91.9%)	277 (85.2%)
Home was completely destroyed by the wildfire.	15 (17.0%)	16 (6.8%)	31 (9.6%)
Respondents had a history of Depressive Disorder before the wildfire.	6 (6.9%)	29 (12.5%)	35 (11.0%)
Respondents had a history of Anxiety Disorder before the wildfire.	7 (8.0%)	40 (17.2%)	47 (14.6%)
Respondents had a history of PTSD before the wildfire.	0 (0.0%)	0 (0.0%)	0 (0.0%)
Respondents were on antidepressants before the wildfire.	0 (0.0%)	21 (9.1%)	21 (6.5%)
Received sufficient support from family and friends			
High level support	80 (87.0%)	215 (92.3%)	295 (90.8%)
Limited or no support	12 (13.0%)	12 (13.0%)	30 (9.2%)
Received sufficient support from the Red Cross			
High level support	72 (80.0%)	196 (84.6%)	268 (82.3%)
Limited or no support	18 (20.0%)	36 (15.5%)	54 (16.8%)
Received sufficient support from the Government of Alberta			
High level support	73 (79.3%)	174 (64.0%)	247 (76.9%)
Limited or no support	19 (20.7%)	55 (24.0%)	74 (23.1%)
Received counseling after the wildfire	8 (8.8%)	35 (15.1%)	43 (13.3%)
Alcohol Use Identification Test Scores			
≤ 7 (low-risk drinking or abstinence)	54 (76.1%)	165 (87.8%)	219 (84.6%)
≥ 8 (High-risk, harmful, or hazardous drinking or alcohol dependence)	17 (23.9%)	23 (12.2%)	40 (15.5%)
Drug Use Identification Test			
≤ 5 for men and ≤ 1 for women (no drug-related problems)	67 (94.4%)	151 (83.0%)	218 (86.2%)
≥ 6 for men and ≥ 2 for women (drug-related problems)	4 (5.6%)	31 (17.6%)	35 (13.8%)
Respondents had a likely GAD based on GAD 7 scale.	11 (12.8%)	46 (21.0%)	57 (18.7%)
Respondents had a likely MDD based on PHQ 9 scale.	19 (21.1%)	56 (24.9%)	75 (23.4%)
Respondents had a likely PTSD based on the PTSD Checklist for DSM 5 Part 3.	5 (6.8%)	25 (12.6%)	30 (11.0%)

dependence, a higher proportion of female respondents presented with problematic drug use.

Table 2 shows the association between the sociodemographic and clinical antecedents and the likely mental health effects suffered by respondents 18 months after the Fort McMurray wildfires.

According to Table 2, there were statistically significant associations between age, adverse childhood experience (ACE)

score, history of depressive disorder, history of anxiety disorders and being on antidepressants before the wildfires, and the likelihood of having an MDD 18 months after the wildfires. Respondents who were age 25 years or younger, those with an ACE score of 1 or more, had a history of depressive disorder, anxiety disorder, or were on an antidepressant before the wildfire were more likely to present with MDD compared with the following, respectively: those who were ages 26 years and older, had a zero ACE score, had no history of a depressive disorder, anxiety disorder, or being on antidepressants before the wild

TABLE 2

Chi-Square/Fisher's Exact⁺ Test of Association Between Demographic and Clinical Antecedents and the Likelihood That the Students had MDD, GAD, and PTSD

Variables	Major Depressive Disorder			Generalized Anxiety Disorder			Posttraumatic Stress Disorder		
	MDD Likely	P-value	Effect Size (Phi/Cramer's V*)	GAD Likely	P-value	Effect Size (Phi/Cramer's V*)	PTSD Likely	P-value	Effect Size (Phi/Cramer's V*)
Sex									
Male	19 (21.1%)	0.56	0.04	11 (12.8%)	0.10	0.10	5 (6.8%)	0.20	0.08
Female	56 (24.9%)			46 (21.0%)			25 (12.6%)		
Age (years)									
≤ 25	43 (36.1%)	0.00	0.28	33 (28.2%)	0.01	0.19	20 (19.4%)	0.00	0.21
≥ 26	13 (12.3%)			13 (12.7%)			5 (5.3%)		
Relationship status									
Single/separated/divorced/widowed	48 (27.7%)	0.11	0.10	34 (20.6%)	0.46	0.05	15 (10.3%)	0.84	0.02
Married/cohabiting/partnered	27 (19.7%)			23 (16.9%)			14 (11.3%)		
Respondents' score on the ACE questionnaire									
0	12 (10.6%)	0.00	0.22*	10 (8.8%)	0.00	0.21*	4 (3.7%)	0.00	0.22*
1–3	27 (26.7%)			24 (23.8%)			12 (12.1%)		
4 or more	12 (32.4%)			10 (27.0%)			8 (22.9%)		
Area of residence relative to destroyed properties									
0–1.0 properties per km ²	22 (28.2%)	0.60	0.06*	9 (12.5%)	0.23	0.10*	4 (6.9%)	0.00	0.24*
1.1–50.0 properties per km ²	43 (22.4%)			36 (19.1%)			15 (8.6%)		
50.1–300.0 properties per km ²	10 (25%)			10 (25.0%)			11 (30.6%)		
Respondents witnessed burning of homes by the wildfires.									
No	18 (24.3%)	0.88	0.01	16 (21.9%)	0.49	0.05	6 (10.5%)	1.0	0.01
Yes	57 (23.8%)			41 (17.8%)			24 (11.3%)		
Respondents were fearful for their lives or the lives of friends/family.									
No	14 (29.2%)	0.36	0.05	6 (13.6%)	0.41	0.06	2 (6.9%)	0.55	0.06
Yes	61 (23.1%)			51 (19.8%)			28 (11.9%)		
Home was completely destroyed by the wildfire.									
No	68 (24.5%)	0.37	0.06	50 (18.6%)	1.0	0.02	24 (10.1%)	0.12	0.10
Yes	5 (16.1%)			5 (16.7%)			6 (20.0%)		
Respondents had a history of depressive disorder before the wildfire.									
No	54 (19.7%)	0.00	0.27	40 (15.0%)	0.00	0.25	16 (6.8%)	0.00	0.34
Yes	19 (55.9%)			15 (46.9%)			12 (40.0%)		
Respondents had a history of anxiety disorder before the wildfire.									
No	54 (20.7%)	0.01	0.17	35 (13.9%)	0.00	0.28	18 (8.1%)	0.01	0.18
Yes	19 (40.4%)			20 (43.5%)			10 (22.7%)		

TABLE 2

Chi-square/Fisher's Exact⁺ Test of Association Between Demographic and Clinical Antecedents and the Likelihood That the Students had MDD, GAD, and PTSD (Continued)

Variables	Major Depressive Disorder			Generalized Anxiety Disorder			Posttraumatic Stress Disorder		
	MDD Likely	P-value	Effect Size (Phi/Cramer's V*)	GAD Likely	P-value	Effect Size (Phi/Cramer's V*)	PTSD Likely	P-value	Effect Size (Phi/Cramer's V*)
Respondents were on antidepressants before the wildfire.									
No	62 (21.3%)	0.00	0.18	49 (17.4%)	0.04	0.13	24 (9.6%)	0.01	0.19
Yes	11 (52.4%)			8 (38.1%)			6 (33.3%)		
Received sufficient support from family and friends									
High level support	69 (24.3%)	0.74	0.02	51 (18.5%)	0.61	0.03	23 (9.4%)	0.00	0.18
Limited or no support	6 (24.1%)			6 (10.5%)			7 (29.2%)		
Received sufficient support from the Red Cross									
High level support	57 (22.1%)	0.29	0.06	40 (16.1%)	0.07	0.11	20 (8.9%)	0.01	0.17
Limited or no support	15 (28.8%)			14 (27.1%)			10 (23.8%)		
Received sufficient support from the Government of Alberta									
High level support	57 (24.1%)	0.87	0.01	40 (17.4%)	0.22	0.08	16 (7.8%)	0.00	0.20
Limited or no support	18 (25.0%)			17 (24.6%)			14 (22.6%)		
Received counseling after the wildfire									
No	60 (22.3%)	0.08	0.10	48 (18.3%)	0.51	0.04	26 (10.8%)	0.76 ⁺	0.02
Yes	15 (34.9%)			9 (23.1%)			4 (12.9%)		

⁺Fisher's exact test was used when the number of counts in any cell was less than 5.

fire. The magnitude of the effect size in each of these associations was small to medium. The corresponding odds ratios for age, history of depressive disorder, history of anxiety disorders, and being on antidepressants before the wildfire were, respectively: 0.25 with 95% CI (0.12–0.49), 5.16 with 95% CI (2.46–10.81), 2.60 with 95% CI (1.35–5.01), and 4.06 with 95% CI (1.65–10.01).

Table 2 also shows a statistically significant association between age, ACE score, history of depressive disorder, history of anxiety disorders and being on antidepressants before the wildfires, and the likelihood of having a GAD 18 months after the wildfire. Respondents who were age 25 years or younger, those with an ACE score of 1 or more, had a history of depressive disorder, anxiety disorder or were on an antidepressant before the wildfire were more likely to present with GAD compared with the following, respectively: those who were 26 years and older, had a zero ACE score, had no history of a depressive disorder, anxiety disorder, or being on antidepressants before the wild fire. The magnitude of the effect size in each of these associations was also small to medium. The corresponding odds ratios for age, history of depressive disorder, history of anxiety disorders, and being on antidepressants before the wildfire were, respectively: 0.37 with 95% CI (0.18–0.75), 4.99 with 95% CI (2.31–10.78), 4.77 with 95% CI (2.41–9.45), and 2.91 with 95% CI (1.15–7.41).

Finally, **Table 2** suggests that there is a significant association between 9 of the sociodemographic variables and the likelihood respondents presented with PTSD 18 months after the wildfire. Respondents who were age 25 years or younger, those with an ACE score of 1 or more, had a history of depressive disorder, anxiety disorder, or were on an antidepressant before the wildfire were more likely to present with PTSD compared with the following, respectively: those who were ages 26 years and older, had a zero ACE score, had no history of a depressive disorder, anxiety disorder, or being on antidepressants before the wildfire. The magnitude of the effect size in each of these associations was either small to medium or medium to high. The corresponding odds ratios for age, history of depressive disorder, history of anxiety disorders, and being on antidepressants before the wildfire were, respectively: 0.23 with 95% CI (0.08–0.64), 9.21 with 95% CI (3.78–22.41), 3.35 with 95% CI (1.43–7.87), and 4.73 with 95% CI (1.63–13.74).

Similarly, respondents who lived in areas of Fort McMurray with 50.1–300.0 properties destroyed per square kilometer and those who perceived that they received low levels of support from family and friends, the Red Cross, and the Government of Alberta were significantly more likely to present with symptoms of PTSD compared with the following, respectively: respondents who lived in areas of Fort McMurray with 0–1.0 properties destroyed per square kilometer and those who perceived that they received high levels of support from family and friends, the Red Cross, and the Government of

Alberta. The magnitude of the effect size in each of these associations was also either small to medium or medium to high. The corresponding odds ratios for the perceived level of support received from family/friends, the Red Cross, and the Government of Alberta were, respectively: 3.97 with 95% CI (1.49–10.58), 3.20 with 95% CI (1.38–7.46), and 3.43 with 95% CI (1.56–7.51).

Table 3 shows the association between the likely MDD, GAD, and PTSD and abuse/dependence on alcohol, nicotine, and substances in respondents 18 months after the Fort McMurray wildfire.

Table 3 suggests that there was a significant association between likely MDD and problem drug use but not high-risk drinking. A higher proportion of respondents with drug-related problems had likely MDD compared with those without drug-related problems. The corresponding odds ratio was 2.77 with 95% CI (1.27–6.00).

Furthermore, the results in **Table 3** suggest that there were significant associations between likely GAD and high-risk drinking, as well as problematic drug use. A higher proportion of respondents with high-risk drinking and drug-related problems had likely GAD compared with those with low-risk drinking and without drug-related problems, respectively. The corresponding odds ratios for high-risk drinking and problematic drug use were, respectively: 3.49 with 95% CI (1.66–7.32) and 3.04 with 95% CI (1.34–6.72).

Finally, **Table 3** indicates that there was a significant relationship between likely PTSD and high-risk drinking but not problematic drug use. A higher proportion of respondents with high-risk drinking had likely PTSD compared with respondents with low-risk drinking. The corresponding odds ratio was 2.88 with 95% CI (1.20–6.91).

DISCUSSION

This study is the continued research of the impact of the 2016 Fort McMurray wildfire on the mental health consequences 18 months after the fire. Our study has revealed that the Keyano College students studied had increased rates of MDD, anxiety disorders, and PTSD, as well as comorbid alcohol and substance abuse.

Major Depressive Disorder

Our study revealed that the prevalence rate of MDD of 23.4% post-wildfire was much higher than the self-reported prevalence rate for history of depressive disorder pre-wildfire, which was only 11%. The rates of MDD were 36.1% and 12.3% for those ages 25 and younger and for those ages 26 and older ($P = 0.00$), respectively. This is significantly higher than the prevalence in the general Alberta population of 9.6% for those ages 18–34, and 9.9% for those ages 35–49.²² Reported meta-

TABLE 3

Chi-Square Test of Association Between Likely MDD, GAD, and PTSD and Likely Abuse/Dependence on Alcohol and Substances

Variables	Major Depressive Disorder		P-value	Generalized Anxiety Disorder		P-value	Posttraumatic Stress Disorder		P-value
	MDD Likely	MDD Unlikely		GAD Likely	GAD Unlikely		PTSD Likely	PTSD Unlikely	
Alcohol Use Identification Test Scores									
≤ 7 (low-risk drinking or abstinence)	44 (20.2%)	174 (79.8%)	0.61	32 (14.7%)	187 (85.3%)	0.00	20 (9.4%)	192 (90.6%)	0.03
≥ 8 (High-risk, harmful, or hazardous drinking or alcohol dependence)	14 (35.0%)	26 (65.0%)		15 (37.5%)	25 (62.5%)		9 (23.1%)	30 (76.9%)	
Drug Use Identification Test									
≤ 5 for men and ≤ 1 for women (no drug-related problems)	32 (21.3%)	118 (78.7%)	0.01	27 (18.0%)	123 (82.0%)	0.01	18 (12.2%)	130 (87.8%)	0.27
≥ 6 for men and ≥ 2 for women (drug-related problems)	15 (42.9%)	20 (51.1%)		14 (40.0%)	21 (14.6%)		7 (20.6%)	27 (79.4%)	

analysis of the relevance of MDD post-natural disaster ranges from 5.8% to 54%; however, this study did not include wildfire disasters in the study.²³ Other studies pertaining specifically to wildfire disasters reported rates of depression ranging from 6.3% to 12.9% for low affected to highly affected communities, respectively,²⁴ to 33% in the following 3 to 4 years after the Victoria Black Saturday bushfire.^{24,25} Depression rates among college students revealed the rate of depression between 7% and 9%,²⁶ whereas a systematic review reports numbers as high as 30.6%²⁷; however, neither study included exposure to a traumatic natural disaster, which has limited current research.

Study respondents ages 25 and younger and those scoring 1 or more on the ACE questionnaire were at a higher risk for MDD, totaling 36.1% ($P = 0.00$) and 59.1% ($P = 0.00$), respectively. A higher risk for MDD was found in study respondents with a history of depressive disorder, anxiety disorder, and antidepressant use, with rates of 55.9% ($P = 0.00$), 40.4% ($P = 0.01$), and 52.4% ($P = 0.00$), respectively. While fearing for one's life is a significant risk factor for MDD following a traumatic natural disaster,²⁴ our study did not find a significant correlation. Also, we did not look into the effect of personal injury, as it has been shown to have limited impact on the risk for development of MDD and PTSD.²⁸ Our study showed no correlation at 18 months between depressive symptoms and receiving counseling after the wildfire.

Anxiety Disorders

Our study revealed a 1-month prevalence rate for GAD of 18.7% after the fire. The prevalence rates of GAD were 28.2% and 12.7% for those ages 25 and younger and those ages 26 and older ($P = 0.01$), respectively. This is significantly higher than the general Canadian population, which shows a lifetime prevalence of GAD of 5%.¹⁴ In college students, Pedrelli et al.²⁶ showed a prevalence of anxiety of 11.9%, whereas other studies showed 17%.²⁹ These rates represent all anxiety disorders and not GAD, specifically, which means the rates of GAD alone could be much lower than reported. Unfortunately, these numbers are on the rise according to recent literature,^{26,29,30} are highly detrimental to academic performance,³¹ and do not include exposure to a natural disaster. Limited research is available on the impact of a traumatic natural disaster on college students.

Consistent with Karatekin,³² students scoring 1 or more on the ACE questionnaire had a likely diagnosis of GAD of 50.8% ($P = 0.00$). A pre-wildfire history of a depressive disorder, anxiety disorder, and use of antidepressants was associated with an increased prevalence of likely GAD, with rates of 46.9% ($P = 0.00$), 43.5% ($P = 0.00$), and 38.1% ($P = 0.04$), respectively. Dai et al.³³ found that a significant number of flood survivors 17 years after the disaster had comorbid anxiety disorder and GAD.

Posttraumatic Stress Disorder

PTSD had the highest increase in prevalence in our study, rising from 0.0% prior to the wildfire, to 11.0% after the wildfire (12.6% in females and 6.8% in males). These prevalence rates are consistent with literature, which shows a significant increase in PTSD after a natural disaster.³⁴⁻³⁶ Study respondents ages 25 years and less had a rate of likely PTSD of 19.4%, compared with those ages 26 years and older, with a rate of 5.3% ($P = 0.00$). Due to the limited research currently available, it is difficult to determine the rate of PTSD in the general population who are neither military personnel nor first responders; the study by Van Ameringen et al. showed a lifetime prevalence in Canada of 9.2%.³⁷ However, respondents in this particular study reported traumatic experiences, such as unexpected death of a loved one, witnessing severe injury or death, or sexual assault, and did not include rates of exposure to traumatic natural disaster.³⁷ A meta-analysis compiled by Bromet et al. showed a prevalence of 20%–40% following natural or man-made disasters, compared with rates of 3%–5% in the general populations studied by World Mental Health surveys.³⁸ Post-disaster PTSD was significantly related to forced displacement from home and pre-existing exposures to trauma and mental health disorders.³⁸⁻⁴⁰ In the general college student population, 6%–17% of students met criteria for PTSD from various causes⁴¹; however, limited research has been completed to determine rates of PTSD after exposure to a natural disaster, which elucidates the need for further study into this area.

In our study, a higher prevalence of PTSD was found in female students, consistent with previous literature.⁴¹⁻⁴³ Study respondents who scored 1 or more on the ACE questionnaire were more likely to be diagnosed with PTSD, with a rate of 35% ($P = 0.00$). Significantly, likely PTSD was associated with students who lived in areas where the area of residence relative to destroyed properties was 50.1–300.0 properties per km² ($P = 0.00$), which is consistent with literature stating more significant mental health impact in areas that were more heavily affected.^{24,44} We found that the risk of PTSD was increased in our study respondents with a history of depressive disorder, anxiety disorder, and antidepressant use, with rates of 40.0% ($P = 0.00$), 22.7% ($P = 0.01$), and 33.3% ($P = 0.01$), respectively.

Of note, perceived lack of support received from family and friends, the Red Cross, and the Government of Alberta was significantly associated with likely PTSD, but not with likely MDD or GAD. Limited or no support from family and friends was found in 29.2% of study respondents with likely PTSD ($P = 0.00$). Limited or no support received from larger agencies, such as the Red Cross and the Government of Alberta, was associated with the likely diagnosis of PTSD of 23.8% ($P = 0.01$) and 22.6% ($P = 0.00$), respectively. There is mixed literature regarding the potential harm or benefit of early counseling or debriefing post natural disaster.^{45,46} Interestingly, there was no correlation found within our study regarding

the likelihood of PTSD and having received counseling in the months after the fire.

The likely recovery time frame for PTSD is approximately 3 years, according to recent meta-analysis,⁴⁷ with remission estimated at 60% for those affected. However, a prolonged progression of illness with PTSD is observed in those who take longer than a few years to achieve remission.^{48,49} The rebuilding of communities that have been decimated by natural disaster is challenging and is even more challenging with the comorbidity of mental health challenges, which may be aggravated by the lack of access to health care services.⁴⁸ Alberta Health Services pledged CAD \$18.65 million for assistance in psychosocial recovery for the first year after the fire²; however, long-term assistance will be required. With college students already showing climbing rates of MDD and anxiety disorders,^{26,29,30} it is possible that this population will struggle to cope with a natural disaster longer than the general population.

Problematic Alcohol and Drug Use

In general, there is a peak of substance use in young adulthood, which gradually declines over time.²⁶ Reports have shown that 20% of college students meet criteria for alcohol use disorder, with 12.5 showing dependence and 7.8 showing alcohol abuse,²⁶ although this study did not include exposure to a natural disaster. Research has shown a well-documented association between mental health complications associated with trauma, and alcohol and drug abuse.⁵⁰⁻⁵² Alcohol abuse and substance abuse are the most common comorbidities associated with likely PTSD in men, and is the third most common in women, following depression and anxiety disorders.^{49,53,54} Our study reveals that the problematic alcohol use rate was 15.5%, which is lower in comparison to the findings of Pedrelli et al.²⁶ Of the 15.5% affected in our study, 23.9% were male, and 12.2% were female. Problematic alcohol use was highly correlated with GAD, with a rate of 37.5% ($P = 0.00$), and PTSD, with a rate of 23.1% ($P = 0.03$).

Substance abuse within the college community is 5%, with many students not only abusing illicit drugs, but also abusing prescription drugs,²⁶ although this study was not completed following exposure to a natural disaster. Our study shows that the rate of problematic drug use among college students after exposure to the fire was 13.8%, with 5.6% and 17.6% of males and females affected, respectively. Problematic drug use was highly correlated with a likely diagnosis of MDD, with a rate of 42.9% ($P = 0.01$), and GAD, with a rate of 40% ($P = 0.01$).

However, our study did not have baseline data regarding alcohol use disorder and problematic drug use prior to exposure to the wildfire. Therefore, we are unable to conclusively determine whether the rates described previously are directly related to the natural disaster or were related to a previously existing condition.⁵⁵ Also, different drug abuse types were not taken

into account, and data may not be accurate, as many students misusing prescription drugs do not believe their drug use is problematic.²⁶

Relevance of Support

Support during a natural disaster has been shown to have a protective effect against serious mental health complications.^{44,56} Most common forms of social support during a disaster have often been average citizens, including family, friends, and neighbors, with government and large organization-provided services less utilized.⁵ Interestingly, in our study, the perceived support received from community members, such as family and friends, the Government of Alberta, and the Red Cross, had no impact for or against the development of MDD or GAD. However, consistent with Dai et al.,⁵⁷ PTSD was associated with perceived lack of support from the community (29.2%, $P = 0.00$), Government of Alberta (23.8%, $P = 0.01$), and the Red Cross (22.6%, $P = 0.00$).

Interestingly, also found to be protective against the potential long-term mental health consequences was a history of exposure to hardship in the formative years.⁵⁸⁻⁶⁰ Studies emerging show that healthy development following the experience of a natural disaster as a child enables the ability to rebound faster from disaster in the future.⁵⁸⁻⁶⁰ While it does not preclude the potential of mental health complications, individuals who were found to be resilient had shorter periods of difficulty coping before adapting and returning to predisaster functioning ability.^{43,58,59,61}

Limitations

First, although we adopted the total sampling methods, we only achieved a response rate of 20.73%, which means there was a margin of error of +/- 4.8% in our prevalence rate estimates. Second, the sample of respondents was not fully representative of the student population (eg, over 71% of our respondents were female even though they comprised < 44% of the student population in the data collection month). Third, likely MDD, GAD, and PTSD were identified via screening measured self-reports as opposed to formal diagnostic interviews. Notwithstanding these limitations, our study being 1 of the few studies to examine the long-term mental health effects of college students in the costliest natural disaster in Canadian history adds to the literature by documenting potential predictive factors for MDD, GAD, and PTSD symptomatology in college students after a wildfire. Knowledge of these factors would be helpful for policy-makers when formulating social and clinical programs to mitigate the mental health effects of natural disasters in college students.

CONCLUSIONS

Minimal research is currently available on the impact of a natural disaster on college students, especially in regard to wildfire disasters. This suggests that further study is needed

to determine the association between rates of MDD, anxiety disorder, and PTSD and exposure to a natural disaster, versus rates currently seen in the college student population, which are already climbing irrespective of exposure to a traumatic natural disaster. Further study could determine the impact of these mental health consequences and enhance an understanding of how best to provide assistance for this specific population.

Our study did not look into the impact of a traumatic natural disaster and domestic violence. Studies have shown a marked increase in the prevalence of domestic violence following exposure to natural disaster, which is not commonly studied at this time.^{11,62,63} In Canada, 26% of all violent crime victims are victims of members of their family; however, these numbers are potentially lower than reality, as many victims choose not to file a complaint.⁶⁴

Further study is indicated in the college student population in response to traumatic natural disasters, as limited studies are available within this specific population. The availability of mental health support is a key factor to the recovery.¹⁰ Continued assessment of the students attending Keyano College and provision of low cost, high impact interventions, such as daily supportive text messaging,⁶⁵⁻⁶⁷ will enhance the available literature and can help guide policy-makers to develop tailored strategies to assist this population in the future.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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