

# Examining the association between diabetes, depressive symptoms, and suicidal ideation among Aboriginal Canadian peoples living off-reserve: a cross-sectional, population-based study

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**Background:** Diabetes is a prevalent chronic condition that has been linked to depression and suicidal behavior. The Aboriginal peoples of Canada are known to suffer from significant health disparities and higher burden of physical and mental illnesses. The purpose of this study was to assess whether diabetes is associated with higher depressive symptoms and lifetime suicidal ideation among Aboriginal Canadian peoples living off-reserve.

**Methods:** Data were obtained from the Aboriginal Peoples Survey, 2012. Depressive symptoms were evaluated by a modified version of the previously validated K-10 scale, while diabetes and suicidal ideation were self-reported. A secondary analysis was conducted on a weighted sample of 689,860 participants for depressive symptoms (9.25% diabetics) and 694,960 for suicidal ideation (9.39% diabetics). Descriptive statistics and multiple logistic regression analysis were conducted.

**Results :** Our study found that the prevalence of depressive symptoms was higher among diabetics (17.53%) compared with nondiabetics (11.12%; OR =1.70, 95% CI: 1.22–1.61). After adjusting for sociodemographic variables, smoking/alcohol use/drug use, anxiety disorders, and other chronic illnesses, diabetes was still significantly associated with depressive symptoms (aOR =1.46, 95% CI: 1.03–2.07). Additionally, diabetics (23.86%) were more likely to report suicidal ideation compared with nondiabetics (18.71%; OR =1.36, 95% CI: 1.05–1.77). Controlling for the effect of sociodemographics and health-related behaviors, diabetes was still associated with higher risk of reporting suicidal ideation (aOR =1.40, 95% CI: 1.05–1.88).

**Conclusion:** Our results suggest that the Aboriginal Canadian diabetic patients living off-reserve are at higher risk of depressive symptoms and suicidal ideation. Culturally appropriate co-screening strategies need to be implemented in primary health care settings to provide the supports necessary for this vulnerable population. Further research is needed to fully elucidate the nature of these associations in order to develop effective intervention and treatment approaches.

**Keywords:** aboriginal, Canada, diabetes, depression, depressive symptoms, suicidal ideation

## Introduction

Aboriginal peoples constitute diverse groups of the original inhabitants of Canada and their descendants. According to the Canadian constitution, three major groups are recognized: First Nations, Inuit, and Métis.<sup>1</sup> In 2016, there were ~1.7 million Aboriginal peoples, representing 4.9% of the Canadian population. They represent one of the youngest and fastest growing subsegments of the Canadian population.<sup>2</sup> The Aboriginal Canadian peoples have consistently shown high rates of diabetes, depres-

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sion, and suicidal behavior.<sup>3-5</sup> In general, diabetes has been linked to both depression and suicidal behavior.<sup>6,7</sup> However, research that specifically examines the association between diabetes, depression, and suicidal behavior among Aboriginal Canadian peoples is lacking.

The Aboriginal Canadian peoples endure significant health disparities that lead to a higher burden of diseases compared with their non-Aboriginal counterparts.<sup>8,9</sup> These health disparities are a by-product of socioeconomic, cultural, and political factors that negatively impact Aboriginal peoples. The socioeconomic disadvantages stem from lower levels of education and income, higher unemployment rates, and poor housing conditions.<sup>9</sup> The political inequities emerged as a consequence of colonization and resulted in the undermining of indigenous cultures and values, marginalization, and social exclusion.<sup>10</sup> For instance, the historical trauma caused residential schools, which were established by the Canadian government to assimilate Aboriginal children into Euro-Canadian culture, had a wide impact and serious ramifications on the Aboriginal survivors and their descendants.<sup>10</sup> The persistence and growth of these inequities ultimately resulted in health disparities including poor physical and mental health among Aboriginal peoples.<sup>10</sup>

Aboriginal peoples are particularly vulnerable and disproportionately affected by diabetes in Canada.<sup>11</sup> Diabetes, once considered rare among Aboriginal communities, is now reported at higher rates among First Nations living off-reserve (10.3%) and among Métis (7.3%) compared with the general Canadian population (5%), and the gap is increasing.<sup>12</sup> Even among Inuit people, who historically have reported very low rates of diabetes, the trends are changing as their rates are becoming comparable to the general population (4.3%). These findings are mainly due to poor dietary choices, limited physical activity, and increased obesity.<sup>13,14</sup> Aboriginal individuals are more likely to be diagnosed with diabetes at a younger age, suffer from serious complications, and experience worse treatment outcomes compared with non-Aboriginals.<sup>15</sup> Moreover, underreporting of the disease and limited access to health care services continue to be growing concerns for the Canadian Aboriginal peoples,<sup>16</sup> suggesting the magnitude of the diabetic epidemic may be larger than estimated.<sup>17</sup>

Depression is a common comorbidity with diabetes.<sup>6,18,19</sup> Diabetic depressed patients are less likely to adhere to medical treatment and lifestyle changes, resulting in poor prognosis for both conditions.<sup>20</sup> This comorbidity has been widely examined in different populations but there is scarcity of research among Aboriginal peoples. It is known that

Aboriginal peoples of Australia face health disparities that are similar to the Aboriginal peoples of Canada.<sup>21</sup> A study in Australia evaluated the prevalence of depression among urban diabetic patients and found it to be two times greater among the Aboriginal compared with the non-Aboriginal population.<sup>23</sup> The authors further reported that among Aboriginal individuals, depression tended to be more severe in nature and in many cases, undiagnosed and left untreated.<sup>22</sup>

Aboriginal Canadian populations have one of the highest rates of suicide worldwide.<sup>23</sup> Among the First Nations, suicide rates are two times the national average and alarmingly, the Inuit suicide rates are among the highest in the world (6–11 times the national average).<sup>4</sup> Suicidal ideation is a crucial component of suicidal behavior, which often precedes suicidal attempts or completed suicide, and is known to be a strong predictor for suicidal death.<sup>24</sup> In 2012, 24% of First Nations living off-reserve, 23.5% of Inuit, and 19.6% of Métis people reported lifetime suicidal ideation compared with 11.1% in the general Canadian population.<sup>25</sup> Similar to depression, suicidal behavior has been linked to diabetes. However, the scientific evidence is limited and at times, contradictory,<sup>7,26</sup> and therefore, more research is needed in this area.

Despite Aboriginal peoples in Canada consistently reporting higher prevalence of diabetes, depression, and suicidality, to the best of our knowledge, no studies explored the associations between these conditions among this vulnerable population. Therefore, the aim of the present study was to use data from the Aboriginal Peoples Survey (APS), 2012, to 1) determine the prevalence of depressive symptoms and suicidal ideation among patients with diabetes; 2) investigate whether diabetes is associated with a higher risk of depression and suicidal ideation; and 3) assess whether these associations vary by different characteristics among the Aboriginal Canadian populations living off-reserve.

## Methods

### Study characteristics

#### Design

Cross-sectional population-based observational study.

#### Participants

The Indian reserve system is governed by the Indian Act (1876) and relates to the First Nations people of Canada. Historically, First Nations people were legally bound by the Canadian government to live on reserve. The ban was lifted in 1951 and First Nations were allowed to live on- or

off-reserve.<sup>27</sup> Presently, the majority (62%) of the First Nations population live off-reserve, while the remaining portion (38%) live on-reserve.<sup>28</sup> Métis and Inuit people traditionally do not live on-reserves. In this study, we are examining the off-reserve Aboriginal population (First Nations, Métis, and Inuit).

### Data source

The present study used data from the APS conducted by Statistics Canada in 2012. It is a national survey on the social and economic conditions of First Nations living off-reserve, Métis, and Inuit. The total weighted number of participants in the APS is 9,63,110 with a participation rate of 76% and used stratification-specific domains for sampling.<sup>29</sup> For this study, the age of participants ranged between 15 and 97 years old. To ensure that statistical estimates would be representative of the Aboriginal Canadian population, sampling weights computed by Statistics Canada were incorporated into the analysis, and the Taylor linearization method was used to estimate the covariance matrix of the regression coefficients (SURVEYLOGISTIC procedure in SAS).

## Measures

### Measuring tool

Evaluation of depressive symptoms in this study was based on the use of a modified version of the previously validated K-10 distress scale.<sup>30,31</sup> The K-10 scale is used to evaluate the distress experienced by individuals during the past 30 days.<sup>32</sup> The K-10 scale and a number of its modified versions (K-5, K-6) have been previously used among Aboriginal peoples.<sup>33,34</sup> While these tools measure distress rather than depression or anxiety, their scores correlate well with depression and anxiety.<sup>30–32</sup> Self-reported suicidal ideation was part of the APS questionnaire.

### Outcome measures

The main outcome measures for this study were depressive symptoms and lifetime suicidal ideation.

### Depressive symptoms

The present study used a modified version of the K-10 scale to assess depressive symptoms among Aboriginal participants. Six questions were selected, which addressed components of two domains that included core symptoms (depressed mood and reduced energy) and associated symptoms (unworthiness and hopelessness).<sup>35</sup> These questions were as follow: “In the past 4 weeks, about how often did you feel: 1) tired out for no good reason, 2) hopeless, 3) depressed, 4) everything

was an effort, 5) sad that nothing could cheer you up, and 6) worthless?” Responses were ranked on a Likert scale: 1) all of the time, 2) most of the time, 3) some of the time, 4) a little of the time, and 5) none of the time. To assess the reliability of these questions, Cronbach’s  $\alpha$  was calculated and found to be satisfactory (0.837). A mean score for each respondent was calculated and adjusted for the number of questions answered. Participants were dichotomized on the basis of a recommended cutoff value from the K-10 scale. Those who scored  $\geq 2.5$  were considered “depressed” while those with scores  $< 2.5$  were “not depressed”.<sup>36</sup>

### Suicidal ideation

Lifetime suicidal ideation was assessed by asking the following question: “Have you ever seriously considered committing suicide or taking your own life?” The answer was either “yes” or “no”.

### Exposure variable

The main exposure variable was self-reported diabetes status. Diabetics were those respondents, who answered “yes” to the following question: “We are interested in conditions diagnosed by a health professional and that are expected to last or have already lasted 6-months or more. Do you have diabetes?”

### Control variables (covariates)

In the present study, sociodemographic, health-related behavior, and clinical profile variables were used as controls in our logistic regression models. Selection of these variables was based on the recommendations made in the existing scientific literature.<sup>37</sup>

#### Sociodemographic variables

These included, age ( $\leq 19$ , 20–34, 35–54,  $\geq 55$  years old), sex (male or female), marital status (single, married, widowed/separated/divorced, living in common law), Aboriginal identity (First Nations, Métis, Inuit), highest level of education attained – 1) grade 8 or lower/some secondary education; 2) secondary school diploma/some postsecondary education; 3) postsecondary certificate or diploma below bachelor level; and 4) bachelor’s degree/university certificate or diploma or degree above bachelor level.

#### Health-related behavior variables

These included the smoking status (daily, occasional, non-smoker), alcohol use (regular, occasional, nondrinker), and drug use (yes, no).

## Clinical profile variables

These included chronic illnesses – a derived variable that combined responders who answered “yes” to one of the following questions: “Do you have asthma, fibromyalgia, learning disability, attention deficit disorder, chronic bronchitis, emphysema, chronic obstructive pulmonary disease (COPD), intestinal or stomach ulcers, bowel disorder, hypertension, heart disease and other physical or mental disorders and anxiety disorders (assessed using the following question: ‘Do you have an anxiety disorder such as a phobia, obsessive-compulsive disorder or a panic disorder?’ [yes, no].)” Additionally, for suicidal ideation, mood disorders were included (as a covariate based on the question: “Do you have a mood disorder such as depression, bipolar disorder, mania or dysthymia?” [yes, no]).

## Statistical analysis

Initially, cross tabulations were performed examining the distribution of observations by depressive symptoms, and suicidal ideation status for each variable. Results are reported as rounded weighted frequencies in order to comply with the Statistics Canada requirements for data release and dissemination. The unadjusted association between diabetes and other covariates on depressive symptoms and suicidal ideation were calculated using univariate binary logistic regression models. Covariates with a *P*-value <0.25 were qualified to be included in the multivariable logistic regression models.

For each outcome, four logistic regression models were constructed: Model 1 (crude unadjusted associations between exposure and outcome variable), Model 2 (adjusted for the effect of sociodemographic confounders), Model 3 (additionally adjusted for health-related behavior), and Model 4 (additionally adjusted for clinical profile variables). If the *P*-value for a covariate was <0.05, the variable was retained in the multivariable model. Age and gender were considered important confounders, and therefore, adjusted in the model irrespective of their *P*-values. The Akaike Information Criterion (AIC) comparisons were used to compare the models (lower is better).

## Confounders and interaction assessment

To assess whether a covariate had a confounding effect, a change of 20% or more in the coefficient of the main exposure variable (diabetes) was used as a cutoff.<sup>38</sup> Effect modifications were investigated by examining all possible two-way interactions for the main exposure variable (diabetes) with predictors and confounders included in the main effect model.

Interactions were assessed based on their *P*-value and AIC comparisons.

## Model diagnostics

The variance inflation factor (VIF) and tolerance for all variables were calculated to assess whether multicollinearity (if present) would significantly affect reported estimates. We used a cutoff at 2.5 for VIF and 0.4 for tolerance.<sup>39</sup> For model predictability, the receiver operating characteristic curve was generated and the area under the curve was measured and reported. All statistical analyses were performed using SAS V.9.4 (SAS Institute Inc., Cary, NC, USA). To deal with missing values, NOMCAR command was used for data analysis with SURVEYLOGISTIC. NOMCAR (not missing completely at random) suggests that missing data are not randomly missed and computes variance accordingly. This ensures that despite the missing data, the full structure of the complex sample is accurately reflected in the calculated estimates.<sup>40</sup>

## Results

### Depressive symptoms

The total number of Aboriginal participants who responded to the depression questions was 6,89,860. Of these participants, 11.65% (n=80,350) were classified as having depressive symptoms. The prevalence of depressive symptoms among those who reported a physician diagnosis of diabetes was 17.53% (n=11,100), compared to 11.12% (n=69,070) among the nondiabetic participants. Table 1 depicts the characteristics of the study participants, stratified by their depressive symptoms status.

### Univariate analysis

#### Model 1

Diabetics were more likely to report depressive symptoms (OR =1.70, 95% CI: 1.26–2.90, *P*-value <0.0005) compared with non-diabetics. Table 2 lists the crude odds ratios and 95% CIs for the different covariates of depressive symptoms.

### Multiple logistic regression analysis

#### Model 2

Our results indicated that the association between diabetes and depressive symptoms remained significant after adjusting for sociodemographic variables (aOR =1.72, 95% CI: 1.22–2.42, *P*-value =0.0021). There was no significant effect for Aboriginal identity (*P*-value =0.2480), and therefore, this variable was not included in model 3.

**Table 1** Characteristics of study participants based on depression symptoms

Variable	Categories	Depression		Total
		Yes, N (%)	No, N (%)	N (%)
Overall		80,350 (11.65)	609,510 (88.35)	689,860
Diabetes (n=684,360)	Yes	11,100 (17.53)	52,210 (82.47)	63,310 (9.25)
	No	69,070 (11.12)	551,980 (88.88)	621,050 (90.75)
Sociodemographic variables				
Age (n=689,860)	≤19 years	7,290 (9.81)	67,020 (90.19)	74,310 (10.77)
	20–34 years	23,150 (11.89)	171,580 (88.11)	194,730 (28.23)
	35–54 years	35,170 (13.06)	234,210 (86.94)	269,380 (39.05)
	≥55 years	14,740 (9.73)	136,690 (90.26)	151,440 (21.95)
Sex (n=689,860)	Male	24,850 (8.15)	280,010 (94.47)	304,860 (44.19)
	Female	55,500 (14.42)	329,500 (85.58)	385,000 (55.81)
Marital status (n=681,290)	Married	17,440 (7.20)	224,690 (92.80)	242,130 (35.54)
	Common law	11,250 (11.15)	89,580 (88.84)	100,830 (14.79)
	Widowed/ separated/divorced	17,550 (17.92)	80,410 (82.09)	97,950 (14.38)
	Single	33,950 (14.12)	206,440 (85.88)	240,380 (35.28)
Aboriginal identity (n=689,860)	First Nations	44,930 (12.97)	301,420 (87.03)	346,350 (50.21)
	Métis	31,630 (10.17)	279,290 (89.82)	310,910 (45.07)
	Inuit	3,800 (11.66)	28,800 (88.34)	32,600 (4.73)
Level of education (n=636,640)	Grade 8 or lower/ some secondary education	25,340 (17.26)	121,500 (82.74)	146,840 (23.06)
	Secondary school diploma/some postsecondary education	23,300 (11.47)	179,830 (88.53)	203,120 (31.91)
	Postsecondary certificate or diploma below bachelor level	23,030 (10.40)	198,370 (89.60)	221,400 (34.78)
	Bachelor's degree/ university degree above bachelor	4,040 (6.19)	61,250 (93.83)	65,280 (10.25)
Health-related behavior				
Smoking (n=684,540)	Daily	38,980 (18.92)	167,100 (81.09)	206,080 (30.10)
	Occasional	8,260 (12.58)	57,410 (87.42)	65,670 (9.59)
	Nonsmoker	32,970 (7.99)	379,810 (92.01)	412,780 (60.30)
Alcohol use (n=683,850)	Daily	38,380 (10.16)	339,560 (89.84)	377,940 (55.27)
	Occasional	20,840 (13.81)	130,040 (86.19)	150,880 (22.06)
	Nondrinker	20,990 (13.54)	134,040 (86.46)	155,030 (22.67)
Drug use (n=681,310)	Yes	61,000 (14.38)	363,150 (85.61)	424,150 (62.26)
	No	19,150 (7.45)	238,010 (92.55)	257,160 (37.74)
Clinical profile				
Chronic illness (n=689,860)	Yes	69,490 (16.89)	342,010 (83.11)	411,500 (59.65)
	No	10,860 (3.90)	267,500 (96.09)	278,360 (40.35)
Anxiety disorders (n=684,320)	Yes	35,850 (38.49)	57,280 (61.51)	93,130 (13.61)
	No	44,210 (7.48)	546,980 (92.52)	591,190 (86.39)

**Note:** \*Rounded weighted frequency.

**Table 2** Crude odds ratios for depressive symptoms

Variable	Category	Odds ratio	95% CI		P-value
			Lower	Upper	
Sociodemographic variables					
Age (Ref: $\geq 55$ years)	$\leq 19$ years	1.01	0.76	1.34	0.9549
	20–34 years	1.25	0.95	1.64	0.1073
	35–54 years	1.39	1.06	1.83	0.0173
Sex (Ref: Male)	Female	1.898	1.58	2.29	<0.0001
Marital status (Ref: Married)	Single	2.12	1.68	2.67	<0.0001
	Widowed/separated/ divorced	2.81	2.09	3.78	<0.0001
	Common law	1.62	1.21	2.16	0.0011
Aboriginal identity (Ref: Métis)	First Nations	1.32	1.09	1.58	0.0296
	Inuit	1.16	0.91	1.48	0.2185
Level of education (Ref: Bachelor's degree/university degree above bachelor)	Grade 8 or lower/some secondary education	3.17	2.19	4.58	<0.0001
	Secondary school diploma/ some postsecondary education	1.97	1.36	2.85	0.0004
	Postsecondary certificate or diploma below bachelor level	1.76	1.21	2.57	0.0033
Health behavior					
Smoking (Ref: Nonsmoker)	Daily	2.69	2.22	3.25	<0.0001
	Occasional	1.66	1.24	2.22	0.0008
Alcohol use (Ref: Nondrinker)	Occasional	1.02	0.79	1.312	0.8576
	Regular	0.72	0.58	0.89	0.0036
Drug use (Ref: No)	Yes	2.09	1.69	2.57	<0.0001
Clinical profile					
Chronic illnesses (Ref: No)	Yes	5.00	4.04	6.19	<0.0001
Anxiety disorders (Ref: No)	Yes	7.74	6.34	9.46	<0.0001

### Model 3

After adjusting for both sociodemographics and health-related behaviors, diabetes remained significantly associated with depressive symptoms (aOR = 1.71, 95% CI: 1.22–2.39,  $P$ -value = 0.0018). Interestingly, regular alcohol use, especially among Aboriginal participants, had a significant protective effect against depressive symptoms (aOR = 0.72, 95% CI, 0.56–0.93,  $P$ -value < 0.0110).

### Model 4

Our results remained significant after further adjusting for clinical profile variables. The odds of having depressive symptoms for patients with diabetes were 46% higher than those reported for nondiabetics (aOR = 1.46, 95% CI: 1.03–2.07,  $P$ -value = 0.0168). Sociodemographic variables showed that the odds for females were 1.5 times greater than those for males (aOR = 1.51, 95% CI: 1.21–1.89,  $P$ -value = 0.0003), while married participants had a lower risk of reporting depressive symptoms. Health-related behaviors showed that the odds of depression among daily smokers

(aOR = 1.68, 95% CI: 1.33–2.11,  $P$ -value < 0.0001) and drug users (aOR = 1.62, 95% CI: 1.24–3.79,  $P$ -value = 0.0005) were significantly greater. Focusing on the clinical profile, being diagnosed with anxiety disorders was the strongest predictor of depression (aOR = 4.21, 95% CI: 3.32–5.33,  $P$  < 0.0001). The results of the multivariable analysis are shown in Table 3.

### Suicidal ideation

The weighted total number of Aboriginal participants who responded to the suicidal ideation questions was 6,94,960. The overall prevalence of suicidal ideation was 19.08%. The prevalence of suicidal ideation among diabetics was 23.86% compared with 18.71% among the nondiabetic respondents. Table 4 depicts the characteristics of the study participants, stratified by their suicidal ideation status.

### Univariate analysis

#### Model 1

Diabetics were more likely to report suicidal ideation (OR = 1.36, 95% CI: 1.05–1.77,  $P$ -value = 0.0193) compared with

**Table 3** Adjusted odds ratios of depressive symptoms

		Model 1	Model 2 N=635,640	Model 3 N=633,080	Model 4 N=632,720
Diabetes (Ref: No)	Yes	1.70*** (1.26–2.90)	1.72** (1.22–2.42)	1.71** (1.22–2.39)	1.46* (1.03–2.07)
Age (Ref: ≥55 years)	≤19 years		1.03 (0.66–1.61)	0.89 (0.57–1.39)	1.02 (0.63–1.64)
	20–34 years		1.42 (0.97–2.07)	1.10 (0.75–1.61)	1.16 (0.78–1.72)
	35–54 years		1.80*** (1.29–2.49)	1.40 (0.99–1.96)	1.33 (0.93–1.89)
Sex (Ref: Male)	Female		1.85*** (1.52–2.25)	1.88*** (1.53–2.31)	1.51*** (1.21–1.89)
Marital status (Ref: Married)	Common law		1.53** (1.13–2.09)	1.29 (0.96–1.74)	1.33 (0.96–1.84)
	Widowed/ separated/ divorced		2.48*** (1.82–3.39)	2.2*** (1.60–3.02)	1.97*** (1.43–2.73)
	Single		2.19*** (1.66–2.89)	1.94*** (1.47–2.56)	1.80*** (1.34–2.41)
Aboriginal identity (Ref: Métis)	First Nations		1.16 (0.96–1.41)		
	Inuit		0.99 (0.76–1.29)		
Education level (Ref: Bachelor's degree/ university degree above bachelor)	Grade 8 or lower/ some secondary education		3.53*** (2.39–5.21)	2.67*** (1.79–3.99)	2.34*** (1.55–3.52)
	Secondary school diploma/some postsecondary education		2.09*** (1.42–3.05)	1.72** (1.17–2.51)	1.55* (1.05–2.29)
	Postsecondary certificate or diploma below bachelor level		1.84** (1.25–2.70)	1.56* (1.06–2.29)	1.36 (0.92–2.01)
Smoking (Ref: No)	Daily			1.94*** (1.56–2.42)	1.68*** (1.33–2.11)
	Occasional			1.32 (0.94–1.86)	1.21 (0.82–1.78)
Alcohol use (Ref: No)	Regular			0.72* (0.56–0.93)	0.93 (0.72–1.22)
	Occasional			0.94 (0.71–1.23)	1.05 (0.78–1.39)
Drug use (Ref: No)	Yes			1.94*** (1.51–2.51)	1.62*** (1.24–2.12)
Chronic illnesses (Ref: No)	Yes				2.91*** (2.24–3.79)
Anxiety disorders (Ref: No)	Yes				4.21*** (3.32–5.33)
AUC			0.659	0.688	0.776

**Notes:** \**P*-value <0.05, \*\**P*-value <0.01, \*\*\**P*-value <0.001. Empty cells represent variables not included in the model either due to *P*-value >0.05 in the previous model or not the focus of the model. Model 1: Unadjusted. Model 2: Adjusted for age, sex, marital status, aboriginal identity, and level of education. Model 3: Adjusted for age, sex, marital status, level of education, smoking, alcohol use, and drug use. Model 4: Adjusted for age, sex, marital status, smoking, alcohol use, drug use, chronic illnesses, and anxiety disorders.

**Abbreviation:** AUC, area under the curve.

nondiabetics. Table 5 lists the crude odds ratios and 95% CIs for the different covariates of suicidal ideation.

## Multiple logistic regression analysis

### Model 2

After adjusting for sociodemographic variables, the association between diabetes and suicidal ideation remained significant (aOR =1.44, 95% CI: 1.09–1.92, *P*-value =0.0117).

### Model 3

The strength of association between diabetes and suicidal ideation was maintained after adjusting for both sociodemographics and health-related behavior variables (aOR =1.40, 95% CI: 1.05–1.88, *P*-value =0.0231). Once again, regular alcohol users were 41% less likely (OR =0.59, 95% CI:

0.49–0.72, *P*-value <0.0001) to self-report suicidal ideation compared with nonusers.

### Model 4

Our results found that the risk of suicidal ideation among diabetics was no longer significant after additionally controlling for the effects of health-related variables (aOR =1.17, 95% CI: 0.87–1.56, *P*-value =0.3012). Sociodemographic variables showed that individuals aged 35–54 years old had significantly higher risk of reporting suicidal ideation (aOR=1.23, 95% CI: 1.01–1.64, *P*-value =0.0385). Consistent with our depression findings, being male, married, or living in common-law relationship was associated with significant lower risk of reporting suicidal ideation. Health-related behaviors showed that drug users (aOR=2.82, 95% CI: 2.33–3.42, *P*-value <0.0001) and daily smokers (aOR =1.39,

**Table 4** Characteristics of study participants based on suicidal ideation status

Variable	Categories	Suicidal ideation		Total
		Yes, N (%)	No, N (%)	N (%)
Overall		132,570 (19.08)	562,390 (80.92)	694,960
Diabetes (n=689,590)	Yes	15,450 (23.86)	49,290 (76.14)	64,740 (9.39)
	No	116,890 (18.71)	507,960 (81.29)	624,850 (90.61)
Sociodemographic variables				
Age (n=694,960)	≤19 years	9,810 (13.15)	64,780 (86.85)	74,580 (10.73)
	20–34 years	38,930 (19.92)	156,440 (80.07)	195,360 (28.11)
	35–54 years	61,330 (22.63)	209,630 (77.37)	270,960 (38.98)
	≥55 years	22,510 (14.61)	131,540 (85.38)	154,060 (22.17)
Sex (n=694,960)	Male	48,730 (12.53)	257,570 (84.09)	306,300 (44.07)
	Female	83,840 (21.57)	304,820 (78.43)	388,660 (55.92)
Marital status (n=686,560)	Married	33,800 (13.85)	210,260 (86.15)	244,060 (35.54)
	Common law	20,060 (19.79)	81,310 (80.21)	101,360 (14.76)
	Widowed/separated/divorced	26,650 (26.75)	72,980 (73.25)	99,630 (14.51)
	Single	51,590 (21.36)	189,930 (78.64)	241,520 (35.18)
Aboriginal identity (N=641,090)	First Nations	71,780 (20.58)	276,970 (79.41)	276,970 (50.18)
	Métis	53,470 (17.11)	259,030 (82.89)	312,500 (44.96)
	Inuit	7,330 (21.74)	26,380 (78.25)	33,710 (4.85)
Level of education (n=641,090)	Grade 8 or lower/some secondary education	30,120 (20.15)	119,340 (79.84)	149,460 (23.31)
	Secondary school diploma/some postsecondary education	40,300 (19.8)	163,200 (80.19)	203,510 (31.74)
	Postsecondary certificate or diploma below bachelor level	44,380 (19.96)	177,960 (80.04)	222,340 (34.68)
	Bachelor's degree/ university degree above bachelor	10,690 (16.25)	55,100 (83.75)	65,790 (10.26)
Health-related behavior				
Smoking (n=689,640)	Daily	58,160 (27.99)	149,620 (72.01)	207,770 (30.13)
	Occasional	12,980 (19.69)	52,930 (80.31)	65,900 (9.56)
	Nonsmoker	61,310 (14.73)	354,660 (85.26)	415,970 (60.32)
Alcohol use (n=688,930)	Daily	66,040 (17.38)	313,860 (82.62)	379,900 (55.14)
	Occasional	31,850 (20.99)	119,840 (79.00)	151,690 (22.02)
	Nondrinker	34,490 (21.92)	122,850 (78.08)	157,340 (22.83)
Drug use (n=686,310)	Yes	108,150 (25.36)	318,300 (74.64)	426,450 (62.13)
	No	23,860 (9.18)	236,010 (90.82)	259,860 (37.86)
Clinical profile				
Chronic illness (n=694,960)	Yes	106,520 (25.64)	308,780 (74.34)	415,310 (59.76)
	No	26,050 (9.32)	253,610 (90.69)	279,650 (40.23)
Anxiety disorders (n=689,340)	Yes	43,100 (46.21)	50,160 (53.78)	93,260 (13.53)
	No	88,960 (14.92)	507,120 (85.08)	596,080 (86.47)
Mood disorders (n=689,400)	Yes	53,970 (57.61)	39,710 (42.39)	93,680 (13.59)
	No	78,220 (13.13)	517,500 (86.87)	595,720 (86.41)

95% CI: 1.17–1.64,  $P$ -value = 0.0001) are at higher risk of suicidal ideation, while regular alcohol use maintained its protective effect. Clinical profile variables showed that mood disorders were the strongest predictor of suicidal ideation (aOR = 4.64, 95% CI: 3.77–5.72). Participants diagnosed with anxiety disorders (aOR = 1.52, 95% CI: 1.22–1.88) or chronic illnesses (aOR = 1.73, 95% CI: 1.44–2.07) were more likely to report suicidal ideation. Table 6 illustrates the

results of the multivariable analysis with suicidal ideation as the outcome of interest.

## Discussion

In the present study, we examined the association between diabetes, depression, and lifetime suicidal ideation in a national sample of the Aboriginal Canadian peoples living off-reserve. Our data show that diabetics are at significantly



**Table 5** Crude odds ratios for suicidal ideation

Variable	Category	Odds ratio	95% CI		P-value
			Lower	Upper	
<b>Sociodemographic variables</b>					
Age (Ref: $\geq 55$ years)	$\leq 19$ years	0.89	0.69	1.12	<0.0001
	20–34 years	1.45	1.17	1.81	0.0019
	35–54 years	1.71	1.38	2.12	<0.0001
Sex (Ref: Male)	Female	1.45	1.26	1.68	<0.0001
Marital status (Ref: single)	Married	0.592	0.495	0.707	<0.0001
	Widowed/separated/or divorced	1.345	1.083	1.670	<0.0001
	Common law	0.908	0.745	1.107	0.8312
Aboriginal identity (Ref: Métis)	First Nations	1.26	1.08	1.46	0.2554
	Inuit	1.35	1.13	1.59	0.0220
Level of education (Ref: Bachelor's degree/university degree above bachelor)	Grade 8 or lower/some secondary education	1.30	1.01	1.68	0.2596
	Secondary school diploma/some postsecondary education	1.27	0.98	1.64	0.4023
	Postsecondary certificate or diploma below bachelor level	1.29	0.99	1.66	0.3250
<b>Health behavior</b>					
Smoking (Ref: No)	Daily	2.25	1.93	2.62	<0.0001
	Occasional	1.42	1.11	1.81	0.6388
Alcohol use (Ref: No)	Occasional	0.95	0.77	1.17	0.3114
	Regular	0.75	0.63	0.89	0.0003
Drug use (Ref: No)	Yes	3.36	2.82	4.01	<0.0001
<b>Clinical profile</b>					
Chronic illnesses (Ref: No)	Yes	3.36	2.88	3.91	<0.0001
Anxiety disorders (Ref: No)	Yes	4.89	4.09	5.87	<0.0001
Mood disorders (Ref: No)	Yes	8.993	7.537	10.729	<0.0001

higher risk of experiencing depressive symptoms compared with their nondiabetic counterparts. That effect maintained its strength after adjusting for sociodemographics, health-related behaviors and clinical profile factors. Furthermore, our results indicated that diabetes was associated with higher risk of suicidal ideation, when considering sociodemographic and health-related behavioral factors.

The crude prevalence of depressive symptoms among Aboriginal diabetic participants was 17.53% compared to 11.12% among nondiabetics. Our study findings corroborate those reported by Davis et al, who examined depression among Aboriginal Type 2 diabetic patients in Australia. They found prevalence rates to be higher than those reported among the general Australian population.<sup>22</sup> However, other studies contradict our findings. One of these studies assessed depression (and other factors) among Canadian Aboriginal participants with impaired glucose tolerance and Type 2

diabetes. They found no difference in the prevalence between the diabetic and prediabetic group compared to the normoglycemic group. Yet, this study suffered from a number of limitations including a high risk of selection bias and limited study power.<sup>41</sup>

The high prevalence of depression observed in our study is concerning, especially when one considers the findings reported in the literature that help highlight the lack of attention to depression screening and management among Aboriginal diabetic patients in primary health care settings.<sup>34,42</sup> Therefore, it is not surprising to note the many negative consequences of untreated depression, especially in the cases of Aboriginal diabetics, which may manifest as higher burdens of disability, increased cost of hospitalization, and even premature death.<sup>43</sup>

Our results show that diabetes was independently associated with higher risk of experiencing depressive symptoms

**Table 6** Adjusted odds ratios of suicidal ideation

		Model 1	Model 2 N=640,090	Model 3 N=638,610	Model 4 N=684,010
Diabetes (Ref: No)	Yes	1.36* (1.05–1.77)	1.44* (1.09–1.92)	1.4* (1.05–1.88)	1.17 (0.87–1.56)
Age (Ref: ≥55 years)	≤19 years		0.83 (0.57–1.21)	0.74 (0.54–1.00)	0.8 (0.58–1.10)
	20–34 years		1.42* (1.07–1.89)	1.07 (0.81–1.41)	1.09 (0.84–1.43)
	35–54 years		1.83*** (1.43–2.34)	1.39** (1.09–1.79)	1.23* (1.01–1.64)
Sex (Ref: Male)	Female		1.40*** (1.19–1.64)	1.45*** (1.25–1.69)	1.17* (1.01–1.37)
Marital status (Ref: Married)	Common law		1.48*** (1.18–1.87)	1.22 (0.96–1.55)	1.25 (0.98–1.60)
	Widowed/ separated/divorced		2.23*** (1.75–2.83)	1.99*** (1.56–2.55)	1.72*** (1.33–2.23)
	Single		1.86*** (1.49–2.30)	1.63*** (1.32–2.01)	1.52*** (1.22–1.89)
Aboriginal identity (Ref: Métis)	First Nations		1.16*** (1.15–1.16)	1.13*** (1.12–1.14)	
	Inuit		1.29** (1.08–1.56)	1.15 (0.96–1.39)	
Education level (Ref: Bachelor's degree/university degree above bachelor)	Grade 8 or lower/ some secondary education		1.39* (1.05–1.83)		
	Secondary school diploma/some postsecondary education		1.33* (1.02–1.73)		
	Postsecondary certificate or diploma below bachelor level		1.31* (1.02–1.7)		
Smoking (Ref: No)	Daily			1.61*** (1.37–1.89)	1.39*** (1.17–1.64)
	Occasional			1.15 (0.89–1.49)	1.16 (0.88–1.55)
Alcohol use (Ref: No)	Regular			0.59*** (0.49–0.72)	0.71 (0.58–0.87)
	Occasional			0.74** (0.59–0.92)	0.76*** (0.61–0.96)
Drug use (Ref: No)	Yes			3.34*** (2.77–4.03)	2.82*** (2.33–3.42)
Chronic illnesses (Ref: No)	Yes				1.73*** (1.44–2.07)
Anxiety disorders (Ref: No)	Yes				1.52*** (1.22–1.88)
Mood disorders (Ref: No)	Yes				4.64*** (3.77–5.72)
AUC			0.602	0.675	0.768

**Notes:** \*P-value <0.05, \*\*P-value <0.01, \*\*\*P-value <0.001. Empty cells represent variables not included in the model either due to P-value is <0.05 in the previous model or is not the focus of the model. Model 1: Unadjusted. Model 2: Adjusted for age, sex, marital status, aboriginal identity, and level of education. Model 3: Adjusted for age, sex, marital status, level of education, smoking, alcohol use, and drug use. Model 4: Adjusted for age, sex, marital status, smoking, alcohol use, drug use, chronic illnesses, anxiety disorder, and mental disorders.

**Abbreviation:** AUC, area under the curve.

among Aboriginal peoples, even after adjusting for all control variables. This finding supports the growing body of literature that suggests that diabetes and depression are related.<sup>6,18,19,44,45</sup> There is evidence of a bidirectional association whereby diabetes increases the risk of depression<sup>6,18,19</sup> and depression increases the risk of diabetes.<sup>44,45</sup> Given the exploratory, cross-sectional nature of our study, our results confirm the existence but are unable to determine the directionality of this association.

Among the more plausible explanations for the association between diabetes and depression among the Aboriginal Canadian population is the role played by socioeconomic status (SES). In general, SES is a strong predictor of both diabetes and depression.<sup>46–48</sup> SES plays an important role as diabetes is known to be inversely related to the level of income,

education, and housing.<sup>49,50</sup> Within the Canadian Aboriginal context, the social, cultural, and economic inequalities experienced by this population, adversely impact their SES.<sup>51</sup> Their continued struggle to meet basic needs with limited resources, disadvantageous conditions, and risky behaviors (eg, smoking, alcohol drinking, and drug use) impose high levels of chronic stress<sup>52</sup> that may lead to the development of diabetes, depression, and suicidal behavior.<sup>53,54</sup>

In our study, the prevalence of lifetime suicidal ideation among Aboriginal diabetics was 23.86% compared to 18.71% in nondiabetic respondents. Controlling for the differences in socioeconomic and health-related behavioral factors, diabetes was a statistically significant predictor of suicidal ideation, which is in concordance with previous studies.<sup>55,56</sup> This finding may not be surprising as depression is a strong

risk factor for suicidal behavior,<sup>57</sup> and therefore, it can act as a mediating step in the association between diabetes and suicidal behavior.<sup>58</sup>

Nevertheless, when considering the problems of diabetes and suicidal ideation in the Aboriginal population of Canada, historical context cannot be ignored. For example, the effect of the traumatic experiences of Aboriginal peoples in residential schools has been linked to both suicidal behavior and diabetes.<sup>59,60</sup> It was demonstrated that the structural violence practiced in residential schools not only increased the risk of suicidal behavior among the schools' attendees but also their descendants by suffering from "intergenerational trauma".<sup>59</sup> Additionally, these institutions suppressed indigenous dietary practices and replaced traditional healthy foods with western foods that are high in salt, sugar, and fat.<sup>60</sup> These unhealthy dietary practices were maintained in later generations<sup>60</sup> and may have contributed to the epidemic of diabetes in the Aboriginal population.

It is interesting to note that, in our results, regular alcohol use was associated with a significant protective effect for depressive symptoms and suicidal ideation. This finding seems to contradict those previously published in the literature. These studies mainly focused on heavy and hazardous use of alcohol and found a positive association with depression and suicidal behavior.<sup>61–63</sup> Other studies have also described a J-shaped relationship, whereby regular low-to-moderate drinkers have experienced lower risk of depression relative to abstainers.<sup>64,65</sup> Several explanations for this pattern have been proposed, which include the following: 1) a direct protective effect of alcohol on depression, similar to its effect on coronary heart disease<sup>66</sup> and 2) social aspects of alcohol use related to drinking behavior, whereby in certain cultures, low-to-moderate regular drinkers may psychologically benefit by becoming better socially adjusted compared with those who never drink alcohol.<sup>64</sup> However, our study findings should be interpreted with caution since key details in alcohol use were not available (eg, frequency, quantity, volume, duration) among our participants, which could significantly change the pattern of the interrelationship between alcohol use, depression, and suicidal behavior.<sup>67</sup>

## Strengths and limitations

This study has several strengths, which include the following: 1) a large, representative, national sample; 2) use of weights to statistically adjust our sample, which resulted in the generalizability of our findings among the Aboriginal Canadian population living off-reserve; 3) adjusting for a wide variety of factors (sociodemographic, health-related

behavior, and clinical profile variables); and 4) participants were not recruited based on their diabetes, depression, or suicidal ideation status, therefore, the potential for selection bias was minimal.

This study also has some limitations: 1) the cross-sectional design is helpful in identifying the associations between diabetes, depression, and suicidal ideation, but cannot be used to infer directionality and causality; 2) the use of self-report survey data may be prone to recall bias and social desirability but the validity of the survey has been well established;<sup>29</sup> 3) due to the sensitivity of the topics and possible stigmatization, there is a possibility that participants with depression or suicidal ideation either did not participate in the survey or did not accurately respond to particular questions; and 4) according to Statistic Canada, the sample used for the suicidal ideation question may not be representative for those <18 years old and therefore, caution is required in interpreting the findings.

## Implications for research and clinical practice

This study provides previously unavailable information about diabetes, depression, and suicidal ideation in the Aboriginal Canadian population living off-reserve. It underscores the need to improve awareness among diabetic patients and health care providers on the common co-occurrence of these conditions. It also highlights the importance of depression and suicidal behavior screening for diabetic patients in primary health care settings. Screening and management of depression and suicidal behavior is complicated in Aboriginal patients due to cultural differences that can represent a barrier to effective screening. Therefore, when developing and implementing health policies and health promotion initiatives to address depression and suicidal behavior among Aboriginal diabetics, focus should be given on culturally sensitive and acceptable strategies.

Further research is needed to understand the potential biological and psychological mechanisms implicated in the association between depression and suicidal behavior in patients with diabetes. Longitudinal studies are required to characterize risk factors, identify the course and effect of comorbidity, and assess how it relates to prognosis and response to treatment. It is essential when conducting research with Aboriginal peoples to use an intersectional approach to study the interplay between different social, political, and cultural factors. Future research that examines the patterns of alcohol use among Aboriginal diabetic patients and its effect on development of depression and suicidal behavior is required.

## Conclusion

Our study found that the Aboriginal Canadian diabetic population living off-reserve is at higher risk of experiencing depressive symptoms and suicidal ideation compared with nondiabetic Aboriginal population. Raising awareness, improving the training of health care professionals, and developing culturally appropriate co-screening strategies are important steps in reducing the burden of depression and suicidal behavior among Aboriginal diabetics. Such co-screening efforts can help in the early identification and management of these complex cases and decrease the burden of further disability, hospitalization, and premature death. Future research is required to elucidate the temporal nature of the association between diabetes, depression, and suicidal ideation among the Aboriginal peoples of Canada.

## Ethical approval

This study is exempt from ethics approval because it relies on the use of Statistics Canada public files and secondary analysis of anonymous data (Tri-Council Policy Statement, articles 2.2 and 2.4, respectively). Participation in this survey was voluntary.

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## Disclosure

The authors report no conflicts of interest in this work.

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