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Sleep deprivation in two Saskatchewan First Nation communities: a public health consideration



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ABSTRACT

Objectives: Sleep deprivation is a common problem in Canada and is associated with many health problems. More than a quarter of Canadians get fewer than the recommended sleep hours (<7 h). This paper examines the prevalence and risk factors for sleep deprivation in two First Nation communities in Saskatchewan, Canada.

Methods: The baseline cross-sectional survey was completed between 2018 and 2019 in collaboration with the two Cree First Nation communities in Saskatchewan, Canada. There were five hundred and eighty-eight participants participated in the survey from two communities. A Multivariate logistic regression model was used for analysis.

Results: The prevalence of sleep deprivation (<7 h of sleep) was 25.4%. The multivariate logistics regression revealed that middle and older age groups, visible mold in the house, and being male with nighttime insomnia symptoms were significantly associated with a higher risk of sleep deprivation among study participants in the study.

Conclusions: In these two First Nation communities, a higher proportion of the participants reported having sleep deprivation. This was a unique study, which evolved from ongoing research collaboration with two First Nation communities in Saskatchewan, Canada. Findings will be helpful in the management of patients with sleep deprivation in these communities; as well as for co-creating policy with the communities and future research priorities.

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1. Introduction

Sleep deprivation is a common problem in Canada. More than a quarter (26%) of Canadians get fewer than seven hours of sleep [1,2]. Sleep deprivation is associated with sociodemographic and socioeconomic risk factors, lifestyle factors, non-communicable diseases/chronic health conditions and factors related to the sleep environment. Socioeconomic positioning was a robust determinant of sleep deprivation [3–7]. In Canada, people aged 18 to 64 with

higher household education and income were more likely to report sleeping 7–9 h per night, compared with those with less education and lower incomes [3]. A recent study reported that male gender, older age, low social status, and high coffee intake was associated with objectively determined short sleep duration [4]. Another study reported that short sleep duration was associated with sociodemographic or socioeconomic factors and further described that those with lower levels of education, low household income quartiles and employment status of 'unemployed' and 'disability retirees' were the most likely to report shorter sleep durations (≤ 5 h) [5]. The prevalence of short sleep was increased for the lowest household income quintile, those with less than high school education, and among African Americans (compared with Whites) [6]. Ehlers et al. reported that American Indian ethnicity, being older than 30 years, having only a high school diploma were predictive factors for sleep deprivation [7].

Studies have shown an association between lifestyle factors and sleep deprivation. Zhu et al. [4] reported that an inverse 'U-shaped' relationship between objective sleep duration and physical activity level and observed that the most physically active slept between 6–7 h. Kline [8] showed that intervening on physical activity levels has been shown to improve sleep efficiency and sleep duration. Another study reported that exercise promoted increased sleep efficiency and duration regardless of the mode and intensity of activity [9]. A meta-analysis investigating the association between portable screen-based media devices and sleep outcomes found that bedtime media usage was associated with insufficient sleep duration and poor sleep quality [10]. However, another meta-analysis found no association between television watching and sleep duration but did find that computer use was associated with a shorter total sleep duration [11]. A report by Hysing et al. [12] indicated that daytime and bedtime use of electronic devices were both related to sleep measures, with an increased risk of short sleep duration, long sleep onset latency and increased sleep deficiency. A dose–response relationship observed between sleep duration and use of electronic devices specifically the association between personal computer use and risk of less than 5 h of sleep compared with the recommended sleep hours [12]. One study reported that short sleepers (≤ 6 h) were more likely to smoke tobacco than adequate sleepers (≥ 7 h) [13]. The findings of Hamidovic et al. [14] suggested that sleep loss may increase the likelihood of smoking during abstinence because of the potential of nicotine to reduce subjective sleepiness. Nakata et al. [15] reported that exposure to passive smoking at work was associated with short sleep duration in men and current smoking or non-traditional use of tobacco related to various subtypes of sleep disturbances (difficulty awakening in the morning and difficulty initiating sleep) in both men and women. Angarita et al. [16] reported that acute exposure to substance drug use was associated with sleep disruption by affecting sleep latency, duration, and quality. Evaluating the empirical evidence, Irish et al. [17] presented several common sleep hygiene recommendations, including regular exercise, stress management, noise reduction, sleep timing regularity, and avoidance of caffeine, nicotine, alcohol, and daytime napping.

Sleep deprivation or insufficient sleep duration leads to many health problems [18–54]. Some authors have shown a relationship with short duration of sleep and increased risk of mortality [19–21]. Mullington et al. [22] summarized findings of the effects of insufficient sleep on cardiovascular risk factors including blood pressure, glucose metabolism, hormonal regulation and inflammation. Another study by Hall et al. [23] reported that the prevalence of the metabolic syndrome and its components were elevated in short sleepers.

Research has shown that when a person sleeps less than 7 h a night there was a dose–response relationship between sleep loss

and obesity, that means the shorter the sleep was cause of the greater the obesity [24–34]. Also, Taheri et al. [28] reported that sleep insufficiency was associated with lower levels of leptin, a hormone produced by an adipose tissue hormone that suppresses appetite, and higher levels of ghrelin, a peptide that stimulates appetite. Another Canadian study reported that short sleep duration sleepers were 35% more likely to experience a 5 kg weight gain [35]. It is known that people who have a short sleep at night are less able to process glucose compared to those who get enough sleep and have increased chance of developing type 2 diabetes [36,37]. In the Sleep Heart Health Study, which was a community-based cohort, adults who reported 5 h of sleep or less were 2.5 times more likely to have type 2 diabetes, compared with those who slept 7–8 h per night [38]. An experimental study supported the relationship between shorter sleep times and impaired glucose tolerance [39]. Possible mechanisms for how short sleep duration and sleep restriction predispose to obesity and type 2 diabetes have been discussed by McNeil & Chaput et al. [29] and Reutrakul et al. [40]. Authors suggested that short sleepers have may have an increase in insulin release and showed the evidence that short sleep enhances susceptibility to food stimuli for energy-dense, high-carbohydrate foods which may lead to obesity and diabetes.

Sleep deprivation leads to high blood pressure, inflammation, and other bodily stress reactions. Two large epidemiological studies reported that sleep loss and sleep complaints are associated with heart attacks and stroke [41,42]. Adults who sleep less than 6 h a night have a 48% greater chance of developing heart disease and a 15% greater chance having a stroke [37]. Grandner et al. [43] presented the association between long or short sleep durations and cardiovascular disease, via several mechanistic pathways. A review by Nagai et al. [44] reported that the short or long sleep duration is independently associated with an increased likelihood of coronary events.

There was sufficient evidence that short sleep duration acts as a risk factor for hypertension [45]. Sleep durations of 5 h per night was associated with a significantly increased risk of hypertension in participants between the ages of 32 and 59 years, and the increased risk continued to be significant after controlling for obesity and diabetes [46]. Another study by Grandner et al. [47] reported that both short and long sleep duration are associated with increased hypertension risk across most age groups. Faraut et al. [48], Hwang et al. [49] and Kumar et al. [50] reported that compared with the recommended sleep duration of 7 h, a sleep duration of less than 5 h per day/night had an increased prevalence of hypertension.

Several studies reported an association between sleep deprivation and impaired neurobehavioral performance [30,51–54]. Al-Abri [51] reported that there is a strong bi-directional relationship between sleep deprivation/disturbance and depression [51]. Author mentioned that chronic sleep deprivation may lead to depression due to the neurochemical changes that occur in the brain and on reverse, depression may lead to distributed sleep or sleep deprivation. Sun et al. [53] reported that participants with short sleep duration (< 5 and $5–6$ h) had a higher risk of depression onset and recurrent depression compared to participants with recommended sleep durations (7–8 h). They also reported the bidirectional relationship between sleep duration and depression. That is, conversely, depression induced short sleep durations. A review by Wu et al. [54] reported that potential association between sleep and circadian rhythm with stress granule formation associated with development of the Alzheimer's disease. In addition, there was a link between accidents [55]; injury [56–59]; poor work performance [60,61] and sleep deprivation.

Several studies reported the prevalence of sleep deprivation among American Indian/Alaska Native populations [7,62,63]. Ehlers et al. [7] reported that the sleep deprivation prevalence in American

Indian/Alaska Native populations was about 30%. Chapman et al. [62] reported in the 2009–2010 Behavioral Risk Factor Surveillance Survey that insufficient sleep rates were higher among American Indian/Alaska Native peoples compared with non-Hispanic Whites (34.2% vs. 27.4%). A study from the 2014 Behavioral Risk Factor Surveillance System reported that the age-adjusted prevalence of healthy sleep duration (≥ 7 h) was lower among American Indians/Alaska Natives (59.6%) compared with non-Hispanic Whites (66.8%) [63].

This information was available for other populations, but little was known about the prevalence of sleep deprivation or insufficient sleep among First Nations peoples in Canada. Also, there were no studies reported in the literature about risk factors and their possible associations with sleep deprivation in First Nations peoples. In this study, we examined prevalence and possible associations between sleep deprivation in two Cree First Nation communities in Saskatchewan using the data from a community-based cross-sectional study. First Nations are one of the three groups of Indigenous peoples in Canada who are the descendants of the original inhabitants of Canada (the other two being Inuit and Métis). First Nations peoples have unique cultures, languages and ceremonies [64,65]. All Indigenous peoples in Canada are impacted by colonization that produces inequities in social and structural determinants of health [66]. The residential school experience in particular negatively impacted the health and wellbeing of survivors as well as their children and grandchildren. This experience attempted to expunge their cultural identity including Indigenous language and cultural customs, their ways of life including consuming traditional foods, and their Indigenous knowledge and family ties linking the youth and Elders [66–68]. Other major impacts from residential school attendance included physical, sexual and emotional abuse, witnessing abuse and isolation from family [67] with intergenerational reverberations. First Nation communities in Canada also frequently report generally poor housing conditions [69–71]. Studies have shown associations between dampness, exposure to visible mould at home and sleep problems [72,73]. To bridge a part of the gap in this current research, this paper examined the prevalence of sleep deprivation and its risk factors and possible associations in two Cree First Nation communities in Saskatchewan, Canada.

2. Material and methods

2.1. Study sample

The baseline survey of the First Nations Sleep Health Project (FNSHP) collaboration was completed between 2018 and 2019 in collaboration with the two Cree First Nation communities (Community A and Community B) in Saskatchewan, Canada. The overall goal of the FNSHP was to study the relationships between sleep disorders and risk factors and co-morbidities, and to evaluate local diagnosis and treatment. Ethics approval was obtained from the University of Saskatchewan's Biomedical Research Ethics Board (Certificate No. Bio #18–110) and followed Chapter 9 (Research Involving the First Nations, Inuit, and Metis Peoples of Canada) in the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans [74]. Individual participants gave their written consent in this research collaboration with the two Saskatchewan First Nation communities.

2.2. Data collection

Research assistants were hired from these communities and trained to conduct the baseline surveys in their respective community. Adults 18 years and older were invited to the Community

Health/Youth Centre to participate in baseline survey. Data were collected via interviewer-administered questionnaires and clinical assessments. A pamphlet describing the study and an invitation to participate in the baseline survey were distributed by the research assistants by door-to-door canvassing and also during local community events such as 'Treaty Days'. Simultaneously, the community members were invited through a social media campaign to participate in the survey. The survey collected information on demographic variables, individual and contextual determinants of sleep health, self-reported height and weight, and objective clinical measurements. This manuscript is based on data from the questionnaires. Demographic information about participants including age, sex, body mass index, education level, money left at the end of the month, life-style factors, sleeping environment, medical history, and sleep health information was obtained from the survey questionnaire.

Information collected on ever diagnosed non-communicable diseases/chronic conditions were: diabetes; high blood pressure; heart problems; stroke; atrial fibrillation; chronic obstructive pulmonary disease/emphysema; asthma; chronic bronchitis; sleep apnea; acid reflux; hypothyroidism; depression, anxiety, post-traumatic stress disorder; Parkinson's disease; chronic pain; kidney disease and restless legs syndrome. Other factors considered were: prescription medication use; sleep medication; and traditional medicines which are used to assist with sleeping.

2.3. Definitions

2.3.1. Sleep duration and sleep deprivation

Sleep duration was calculated using questions about the participant's usual sleep habits during the past month: "When have you usually gone to bed?"; "When have you usually gotten up in the morning?"; "How long has it taken to fall asleep each night?". Taking the difference of the first two questions, the time in bed at night was calculated and then time to falling asleep was subtracted to obtain the actual sleep duration. Recommendations of optimal sleep duration hours were based on those from the National Sleep Foundation [75]. Sleep deprivation was defined as the participants with sleep duration of less than 7 h per night (less than the recommended optimal sleep duration per night).

2.4. Statistical analysis

Statistical analyses were conducted using SPSS software (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp.). Descriptive statistics, mean and standard deviation (SD) were reported for continuous variables and p-values of t-tests were reported for comparing the means of two samples. For categorical variables, frequency and percentage (%) were reported. Chi-square tests were used to determine the bivariable association of sleep deprivation prevalence with the independent variables of interest. Logistic regression models were used to predict the relationship between a binary outcome of sleep deprivation (yes or no) and a set of explanatory variables. A series of logistic regression models were fitted to determine whether potential risk factors, confounders, and interactive effects contributed significantly to the prevalence of sleep deprivation. Based on bivariable analysis, variables with $p < 0.20$ and less than 25% missing variables were included in the multivariate model. All variables that were statistically significant ($p < 0.05$), as well as important clinical factors (sex, age and body mass index (BMI)), were retained in the final multivariable model. Interactions between potential effect modifiers were examined and were retained in the final model if the p-value was < 0.05 . The strength of associations were presented by odds ratios (OR) and their 95% confidence intervals (CI) [76].

3. Results

There were five hundred and eighty-eight participants participated in the baseline survey, 418 individuals from Community A and 170 individuals from Community B. The mean age \pm SD of the 588 study participants was 40.0 ± 15.3 years with a range being from 18 to 78 years. There were 44.2% male and 55.8% females that participated in this study. Sleep duration was available for 567 individuals. The mean sleep duration was 8.18 ± 2.28 h. The prevalence of sleep deprivation was 25.4% (144/567).

Table 1 depicts the bivariate associations with sleep deprivation and determinants. Significantly more males were sleep deprived compared to females. Adults who attended residential school were more likely to report sleep deprivation compared to those that did not attend residential school. The same significant association was not observed between if study participant's parents and grandparents had attended residential school and sleep deprivation. Individuals that engaged in non-traditional use of tobacco/current smokers had a higher prevalence of sleep deprivation than those that did not use/smoke. There was a significantly lower risk of sleep deprivation amongst those who consumed one drink per week compared with those that did not drink. There was a higher prevalence of sleep deprivation in individuals who had sleep apnea compared with those that reported not having diagnosis of sleep apnea. Participants exposed to adverse housing conditions such as visible mold and moldy smell were significantly associated with a higher prevalence of sleep deprivation compared to individuals not exposed to these housing conditions. In addition, "afraid to sleep in your home", "waking up during the night due to terrifying dreams or nightmares or flashback to a traumatic event" and "trouble going to sleep or stay asleep (nighttime insomnia symptoms)" were significantly associated with sleep deprivation. No associations were observed between use of prescription medications, sleep medication or traditional medicines and sleep deprivation.

Multivariate logistic regression results are presented in Table 2. It was observed that those in the middle age group (age group 40–49: OR = 2.21; 95% CI (1.16, 4.23)) and older age group (age group 60+: OR = 2.53; 95% CI (1.24, 5.17)), had visible mold in the house (OR = 1.72; 95% CI (1.12, 2.64)), and males with nighttime insomnia symptoms were associated significantly with a higher prevalence of sleep deprivation compared to without nighttime insomnia symptoms (Fig. 1) after adjusting for other factors.

Mean predicted probability of sleep deprivation and trouble going to sleep or staying asleep (nighttime insomnia symptoms) by sex is presented in Fig. 1. Mean predicted probability was higher for males who had nighttime insomnia symptoms compared with those who did not have nighttime insomnia symptoms. There was no significant difference for females with and without nighttime insomnia symptoms.

4. Discussion

Sleep deprivation occurs when a person is not able to get the recommended number of hours of sleep. The prevalence of sleep deprivation among participants in two Cree First Nation communities in Saskatchewan was 25.4%. This prevalence of sleep deprivation was lower (25.4%) when compared with North American Indians/Alaska Native populations reported by Ehlers et al. (30%) [7] and Chapman et al. (34.2%) [62], but very close (26%) to the general population in Canada [1,2]. The results of this study demonstrated that those in the middle and older age groups, visible mold in the house, and males with nighttime insomnia symptoms were associated significantly with a higher prevalence of sleep deprivation after adjusting for other factors.

The amount of sleep needed to feel refreshed, and function well depends upon the individual and varies across the age groups [37]. In Canada, 1 in 4 adults aged 18–34 years; 1 in 3 adults aged 35–64 years and 1 in 4 adults aged 65–79 years are not getting the recommended sleep hours [2], which implies that compared to the middle aged groups, the older age group has a lower risk of sleep deprivation. One study suggests that older adults may actually be more tolerant of sleep deprivation than younger age groups [77]. However, the authors commented that further research was needed to clarify whether older adults were actually more resistant to the effects of sleep loss than younger adults. In this study, presented herein, it was observed that the middle age groups (30–39 years and 40–49 years) and older age group (60+ years) had an increased prevalence of sleep deprivation. There was a linear dose-dependent relationship between age and prevalence of sleep deprivation except for the age group 50–59 years. The preponderance of evidence showed that sleep quality and duration decreased with age [78,79].

As mentioned in the Introduction, housing conditions were poor in First Nation communities in Canada [69–71]. In the current study, 55.7% reported dampness, 51.9% reported visible mold and 49.9% reported moldy smell in the house in the two First Nation communities. Several studies suggest that living in damp or mouldy home environments in the house may be associated with sleep problems. In a cross-sectional study among adults in England, participants living in damp buildings were more likely to report sleep problems [72]. Another study of children reported increased risk for sleep problems in children exposed to visible mould or dampness in the house. Results were significant for any sleep problems (OR = 1.77 (1.21, 2.60)), and short sleep time (OR = 1.68 (1.09, 2.61)) [73]. In this study, it was found that there was an increased prevalence for sleep deprivation in adults exposed to visible mold (OR = 1.72 (1.12, 2.64)). This finding is very important, and points to further public health interventions on poor quality housing stock in First Nation communities. Housing in these communities is funded through federal transfer and has long been considered to be underfunded [80].

Several suggestions have been made by other authors for the possible mechanisms related to exposure to mold and sleep deprivation or disruption. One possible explanation is that damp and moldy environments (which contain beta-glucan) may cause fatigue [81,82], irritation and inflammation in mucus membranes or airways [83]. Another explanation is that moldy environments with higher levels of microbial volatile organic compounds (MVOCs) [84–86] can cause nasal inflammation [82,84,85,87,88], a well-known risk factor for sleep disturbances [89,90]. In addition, mold odors or unpleasant smells that are related to humid environments can impair sleep [82,91].

Finally, the multivariate results revealed that males who had nighttime insomnia symptoms compared to without nighttime insomnia symptoms were associated with significantly higher prevalence of sleep deprivation. The observed sex differences in sleep deprivation outcome is compelling, but not surprising in light of these associations. Other studies, did not report a sex effect on sleep-related outcomes in adults from Indigenous communities residing in the United States [7,92] or Canada [93]. Sabanayagam et al. [92] reported no significant difference in the reported average sleep duration between older (aged ≥ 55 years) Indigenous adult men and women. A few studies have reported a relationship between sleep deprivation and insomnia [94,95]. It has been suggested that objective measured short sleep duration was a risk factor for development of chronic insomnia from poor sleep defined by moderate to severe complaint of difficulty falling asleep, difficulty staying asleep, early awakening, or unrefreshing sleep [94]. The objective which measured short sleep duration was

Table 1
Bivariable associations between sleep deprivation and risk factors (n = 567).

Variables	Total	Sleep Deprivation		Unadjusted OR (95% CI)	P value
	n (%)	Yes n (%)	No n (%)		
Demographics					
Sex (n = 567)					
Male	248 (43.7)	76 (52.8)	172 (40.7)	1.63 (1.12, 2.39)	0.012
Female	319 (56.3)	68 (47.2)	251 (59.3)	1.00	
Age group, in years (n = 567)					
18-29	170 (30.0)	36 (25.0)	134 (31.7)	1.00	
30-39	139 (24.5)	35 (24.3)	104 (24.6)	1.25 (0.74, 2.13)	0.406
40-49	94 (16.6)	29 (20.1)	65 (15.4)	1.66 (0.94, 2.94)	0.082
50-59	98 (17.3)	23 (16.0)	75 (17.7)	1.14 (0.63, 2.07)	0.663
60+	66 (11.6)	21 (14.6)	45 (10.6)	1.74 (0.92, 3.28)	0.088
Body Mass Index (BMI) (n = 529)					
Obese	247 (46.7)	66 (49.6)	181 (45.7)	1.32 (0.80, 2.17)	0.275
Overweight	148 (28.0)	38 (28.6)	110 (27.8)	1.25 (0.72, 2.17)	0.427
Neither obese or nor overweight	134 (25.3)	29 (21.8)	105 (26.5)	1.00	
Education level (n = 561)					
Less than secondary school graduation	209 (37.3)	50 (35.5)	159 (37.9)	0.91 (0.58, 1.44)	0.687
Secondary school graduation	169 (30.1)	44 (31.2)	125 (29.8)	1.02 (0.63, 1.64)	0.940
Some university/completed university/technical school	183 (32.6)	47 (33.3)	136 (32.4)	1.00	
Employment status (n = 553)					
Social assistance/unemployment insurance	129 (23.3)	35 (25.2)	94 (22.7)	1.01 (0.60, 1.71)	0.954
Unemployed	143 (25.9)	29 (20.9)	114 (27.5)	0.69 (0.41, 1.18)	0.180
Other including retired or home makers	117 (21.2)	31 (22.3)	86 (20.8)	0.98 (0.57, 1.68)	0.950
Employed (full-time, part-time, self-employed)	164 (29.7)	44 (31.7)	120 (29.0)	1.00	
Shift Worker (n = 567)					
Yes	56 (9.9)	14 (9.7)	42 (9.9)	0.98 (0.52, 1.85)	0.943
No	511 (90.1)	130 (90.3)	381 (90.1)	1.00	
Money left at the end of the month (n = 561)					
Not enough money	324 (57.8)	91 (64.1)	233 (55.6)	1.30 (0.79, 2.13)	0.295
Just enough money	120 (21.4)	24 (16.9)	96 (22.9)	0.83 (0.45, 1.55)	0.565
Some money	117 (20.9)	27 (19.0)	90 (21.5)	1.00	
Attend residential school (n = 567)					
Yes	190 (33.5)	58 (40.3)	132 (31.2)	1.49 (1.01, 2.20)	0.047
No	377 (66.5)	86 (59.7)	291 (68.8)	1.00	
Parents or grandparents attended a residential school (n = 567)					
Yes	488 (86.0)	122 (84.8)	366 (86.5)	1.13 (0.54, 2.36)	0.738
No	35 (6.2)	12 (8.3)	23 (5.5)	1.77 (0.66, 4.78)	0.257
Do not know	44 (7.8)	10 (6.9)	34 (8.0)	1.00	
Life-style factors					
Smoking Status/Non-Traditional Use (n = 561)					
Current smoker	402 (71.7)	119 (82.6)	283 (67.9)	1.75 (1.00, 3.06)	0.049
Ex-smoker	66 (11.8)	7 (4.9)	59 (14.1)	0.49 (0.19, 1.26)	0.141
Never smoker	93 (16.6)	18 (12.5)	75 (18.0)	1.00	
Marijuana Use (n = 562)					
Regularly	162 (28.8)	43 (30.3)	119 (28.3)	1.16 (0.75, 1.79)	0.512
Occasionally	85 (15.2)	24 (16.9)	61 (14.5)	1.26 (0.73, 2.16)	0.402
No use	315 (56.0)	75 (52.8)	240 (57.2)	1.00	
Alcohol consumption per week (n = 397)					
More than 1 per week	149 (37.5)	42 (41.2)	107 (36.3)	0.92 (0.55, 1.55)	0.752
One-per week	121 (30.5)	22 (21.6)	99 (33.6)	0.52 (0.29, 0.95)	0.032
Non-drinker	127 (32.0)	38 (37.3)	89 (30.2)	1.00	
Non-medical drugs (n = 563)					
Yes	36 (6.4)	9 (6.3)	27 (6.4)	0.99 (0.45, 2.15)	0.975
No	527 (93.6)	133 (93.7)	394 (93.6)	1.00	
Physical activities at least 3 weeks (n = 528)					
Yes	290 (54.9)	75 (57.3)	215 (54.2)	1.13 (0.76, 1.69)	0.537
No	238 (45.1)	56 (42.7)	182 (45.8)	1.00	
Screen time-2 hours or more (n = 431)					
Yes	284 (65.9)	73 (64.0)	211 (66.6)	0.89 (0.57, 1.40)	0.626
No	147 (34.1)	41 (36.0)	106 (33.4)	1.00	
Non-Communicable Diseases/Chronic Conditions					
Diabetes (n = 534)					
Yes	98 (18.4)	28 (20.6)	70 (17.6)	1.21 (0.74, 1.98)	0.436
No	436 (81.6)	108 (79.4)	328 (82.4)	1.00	
High blood pressure (n = 513)					
Yes	161 (31.4)	48 (37.5)	113 (29.4)	1.44 (0.95, 2.20)	0.086
No	352 (68.6)	80 (62.5)	272 (70.6)	1.00	
Heart problems (n = 531)					
Yes	59 (11.1)	17 (12.8)	42 (10.6)	1.24 (0.68, 2.27)	0.479
No	472 (88.9)	116 (87.2)	356 (89.4)	1.00	
Stroke (n = 548)					
Yes	16 (2.9)	3 (2.2)	13 (3.2)	0.69 (0.19, 2.47)	0.571
No	532 (97.1)	133 (97.8)	399 (96.8)	1.00	

(continued on next page)

Table 1 (continued)

Variables	Total	Sleep Deprivation		Unadjusted OR (95% CI)	P value
	n (%)	Yes n (%)	No n (%)		
Atrial fibrillation (n = 524)					
Yes	12 (2.3)	3 (2.3)	9 (2.3)	1.03 (0.27, 3.87)	0.963
No	512 (97.7)	125 (97.7)	387 (97.7)	1.00	
Chronic obstructive pulmonary disease/emphysema (n = 530)					
Yes	17 (3.2)	5 (3.8)	12 (3.0)	1.25 (0.43, 3.63)	0.677
No	513 (96.8)	128 (96.2)	385 (97.0)	1.00	
Asthma (n = 540)					
Yes	66 (12.2)	19 (14.0)	47 (11.6)	1.23 (0.70, 2.19)	0.472
No	474 (87.8)	117 (86.0)	357 (88.4)	1.00	
Chronic Bronchitis (n = 541)					
Yes	33 (6.1)	10 (7.4)	23 (5.7)	1.33 (0.62, 2.88)	0.465
No	508 (93.9)	125 (92.6)	383 (94.3)	1.00	
Sleep apnea (n = 513)					
Yes	36 (7.0)	14 (11.2)	22 (5.7)	2.09 (1.04, 4.24)	0.039
No	477 (93.0)	111 (88.8)	366 (94.3)	1.00	
Acid Reflux (n = 545)					
Yes	51 (31.0)	51 (37.0)	118 (29.0)	1.44 (0.96, 2.16)	0.081
No	376 (69.0)	87 (63.0)	289 (71.0)	1.00	
Hypothyroidism (n = 530)					
Yes	43 (8.1)	9 (6.8)	34 (8.5)	0.78 (0.36, 1.68)	0.530
No	487 (91.9)	123 (93.2)	364 (91.5)	1.00	
Depression (n = 524)					
Yes	162 (30.9)	50 (36.8)	112 (28.9)	1.43 (0.95, 2.16)	0.087
No	362 (69.1)	86 (63.2)	276 (71.1)	1.00	
Anxiety (n = 525)					
Yes	168 (32.0)	45 (33.8)	123 (31.4)	1.12 (0.74, 1.70)	0.600
No	357 (68.0)	88 (66.2)	269 (68.6)	1.00	
Post-traumatic stress disorder (n = 529)					
Yes	57 (10.8)	16 (11.9)	41 (10.4)	1.17 (0.63, 2.16)	0.615
No	472 (89.2)	118 (88.1)	354 (89.6)	1.00	
Parkinson's disease (n = 541)					
Yes	7 (1.3)	2 (1.5)	5 (1.2)	1.18 (0.23, 6.16)	0.843
No	534 (98.7)	135 (98.5)	399 (98.8)	1.00	
Chronic pain (n = 544)					
Yes	128 (23.5)	38 (28.1)	90 (22.0)	1.39 (0.89, 2.16)	0.146
No	416 (76.5)	97 (71.9)	319 (78.0)	1.00	
Kidney disease (n = 545)					
Yes	23 (4.2)	3 (2.2)	20 (4.9)	0.44 (0.13, 1.50)	0.189
No	522 (95.8)	133 (97.8)	389 (95.1)	1.00	
Restless legs syndrome (RLS) (n = 542)					
Yes	189 (34.9)	56 (41.5)	133 (32.7)	1.46 (0.98, 2.18)	0.064
No	353 (65.1)	79 (58.5)	274 (67.3)	1.00	
Sleep environment					
Dampness (n = 562)					
Yes	313 (55.7)	84 (58.3)	229 (54.8)	1.15 (0.79, 1.69)	0.460
No	249 (44.3)	60 (41.7)	189 (45.2)	1.00	
Visible mold (n = 561)					
Yes	291 (51.9)	89 (62.2)	202 (48.3)	1.76 (1.19, 2.60)	0.004
No	270 (48.1)	54 (37.8)	216 (51.7)	1.00	
Moldy smell (n = 563)					
Yes	281 (49.9)	84 (58.3)	197 (47.0)	1.58 (1.08, 2.31)	0.020
No	282 (50.1)	60 (41.7)	222 (53.0)	1.00	
Smoke inside house (n = 560)					
Yes	242 (43.2)	70 (49.0)	172 (41.2)	1.37 (0.93, 2.00)	0.109
No	318 (56.8)	73 (51.0)	245 (58.8)	1.00	
Crowding (n = 556)					
>1 person/bedroom	406 (73.0)	106 (74.1)	300 (72.6)	1.08 (0.70, 1.66)	0.730
≤ 1 person/bedroom	150 (27.0)	37 (25.9)	113 (27.4)	1.00	
Place of sleep (n = 435)					
Bedroom	326 (74.9)	83 (72.8)	243 (75.7)	0.77 (0.23, 2.56)	0.668
Living room	52 (12.0)	13 (11.4)	39 (12.1)	0.75 (0.19, 2.85)	0.673
Basement	44 (10.1)	14 (12.3)	30 (9.3)	1.05 (0.28, 4.00)	0.943
Other	13 (3.0)	4 (3.5)	9 (2.8)	1.00	
Sleeping arrangement shared with (n = 558)					
Child	114 (20.4)	31 (21.8)	83 (20.0)	0.87 (0.45, 1.68)	0.682
Spouse or partner	174 (31.2)	42 (29.6)	132 (31.7)	0.74 (0.40, 1.38)	0.345
Alone	200 (35.8)	48 (33.8)	152 (36.5)	0.74 (0.40, 1.35)	0.323
Other family member/Other	70 (12.5)	21 (14.8)	49 (11.8)	1.00	
Afraid to sleep in your home (n = 566)					
Yes	58 (10.2)	24 (16.8)	34 (8.0)	2.31 (1.32, 4.04)	0.004
No	508 (89.8)	119 (83.2)	389 (92.0)	1.00	

Table 1 (continued)

Variables	Total	Sleep Deprivation		Unadjusted OR (95% CI)	P value
	n (%)	Yes n (%)	No n (%)		
Waking up during the night due to terrifying dreams or nightmares or flashback to a traumatic event (n = 564)					
Yes	263 (46.6)	80 (56.3)	183 (43.4)	1.68 (1.15, 2.47)	0.008
No	301 (53.4)	62 (43.7)	239 (56.6)	1.00	
Trouble going to sleep or stay asleep (n = 562)					
Sometimes/most of the time/all of the time	391 (69.6)	115 (80.4)	276 (65.9)	2.13 (1.34, 3.37)	0.001
Never/Rarely	171 (30.4)	28 (19.6)	143 (34.1)	1.00	
Prescription medication use (n = 559)					
Yes	253 (45.3)	67 (46.5)	186 (44.8)	1.07 (0.73, 1.57)	0.723
No	306 (54.7)	77 (53.5)	229 (55.2)	1.00	
Medication use for sleep (n = 558)					
Yes	66 (11.8)	20 (13.9)	46 (11.1)	1.29 (0.73, 2.27)	0.375
No	492 (88.2)	124 (86.1)	368 (88.9)	1.00	
Traditional medication use for sleep (n = 559)					
Yes	30 (5.4)	7 (4.9)	23 (5.5)	0.87 (0.37, 2.07)	0.755
No	137 (95.1)	392 (94.5)		1.00	

Odds ratios that are significantly different from zero (p < 0.05) are shown in bold.

Table 2

Adjusted odds ratios for associations between sleep deprivation and covariates.

Variable	Multivariate Logistic Regression	
	Adjusted odds ratio (95% CI)	p value
Demographics		
Sex		
Male	0.76 (0.32, 1.83)	0.539
Female	1.00	
Age group, in years		
18-29	1.00	
30-39	1.69 (0.93, 3.07)	0.085
40-49	2.21 (1.16, 4.23)	0.016
50-59	1.63 (0.84, 3.17)	0.151
60+	2.53 (1.24, 5.17)	0.011
Body Mass Index (BMI)		
Obese	1.32 (0.78, 2.25)	0.298
Overweight	1.08 (0.59, 1.95)	0.795
Neither obese or nor overweight	1.00	
Sleep environment		
Visible mold		
Yes	1.72 (1.12, 2.64)	0.013
No	1.00	
Trouble going to sleep or stay asleep		
Sometimes/most of the time/all of the time	1.12 (0.57, 2.22)	0.741
Never/Rarely	1.00	
Interaction: Trouble going to sleep or stay asleep and Sex (See Fig. 1)		
Male X Sometimes/most of the time/all of the time (Ref: Never/Rarely)	4.50 (2.17, 9.32)	0.001
Female X Sometimes/most of the time/all of the time (Ref: Never/Rarely)	1.41 (0.57, 2.22)	0.741

Odds ratios that are significantly different from zero (p < 0.05) are shown in bold.

associated with a significantly higher prevalence for persistent insomnia as compared to normal sleep with an odds ratio of 3.19 [95]. Further studies are needed to confirm the relationship or influence of sex on insomnia or sleep deprivation.

This study considered potential associations between several co-morbidities and sleep deprivation but, none were significantly associated with sleep deprivation. In this study, several bivariate associations (p < 0.10) with sleep deprivation such as high blood pressure (hypertension), acid reflex, depression, sleep apnea and restless legs syndrome were observed but not retained in the multivariate regression model. There was sufficient evidence that short sleep duration acts as a risk factor for hypertension [45,49,50]. Also, others have reported an association between short sleep duration and a high risk of depression [51,53,96]. In addition, Sun et al. [53] identified a bidirectional relationship between sleep duration and depression. One study reported that sleep deprivation increased the number and length of apneic events in patients with

sleep apnea and induced apnea in patients who snore [97]. This study did not identify any relationships between obesity [24–34], diabetes [29,36–40], heart problems [22,37–44] and sleep deprivation, in contrast to other authors.

Most of the associations between circumstances and sleep deprivation reported in this paper were located as mid-level or proximal determinants of health, poor housing conditions in on reserves communities have been widely reported as having an impact on the health of First Nations peoples [98,99]. Participants from the two Saskatchewan First Nation communities in this study reported poor housing conditions with more than 50% noting dampness, visible mold, and crowding. Our research suggests other situations within the home are also implicated in sleep deprivation, such as being afraid to sleep. More proximally, participants reported high rates of overweight (28%) and obesity (46.7%). In total, about 75% of the population were considered to be overweight or obese. While not significantly associated with sleep deprivation in

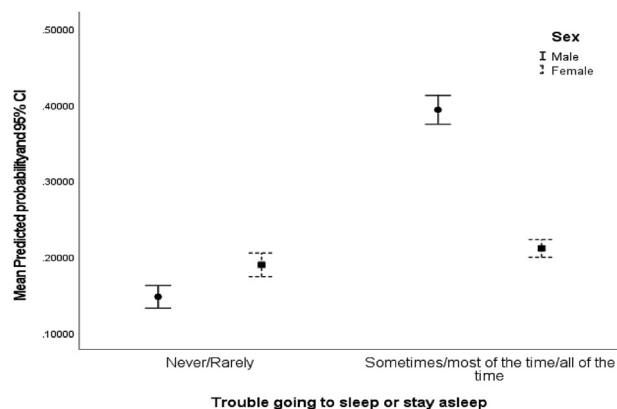


Fig. 1. Mean Predicted probability of sleep deprivation and trouble going to sleep or stay asleep by sex.

this study, others have reported an association between sleep loss and an increased risk of obesity [32,33]. More than half of the study participants were in the age groups of 18–29 years and 30–39 years, with more than 26% unemployed. More than half reported not having enough money left at the end of the month, a marker for poverty. These factors could be reasons for some of the findings observed in this study that showed the associations with sleep deprivation. Young adults may be more vulnerable to acute sleep deprivation than older adults [100]; as well, the use of electronic devices were found to be higher in younger adults [12]. It is important to note that these results also point to the significant influence of more upstream social and structural circumstances which are of particular relevance to Indigenous peoples in Canada. Residential school attendance was significantly associated with sleep deprivation in the bivariable analysis. This specific circumstance is a marker for historical and contemporary structures of colonization policy that have long been implicated in inequitable access to resources for the attainment of optimal health and in poorer health across numerous outcomes compared to the Canadian population overall [67,68,101–103].

This study has several strengths including: the number of participants from the two First Nation communities participating in this study; detailed information about sleep and sleep duration in the community; social and structural information including environmental housing conditions; and exploring medical histories. According to the Statistics Canada Census Profiles [104], overall, 42% (588/1397) of individuals participated in this cross-sectional study, which would be considered to be a very good participation rate. In Community A, the 18+ years population was 752 and 418 (56%) individuals participated. In Community B, the 18+ years population was 645 and 170 (26%) individuals participated. According to the Canadian Census of 2016 [104], the participants had a similar age distribution to the general population of these communities while there were more females who participated in this study and therefore, results may not be generalized to populations of these communities. Further studies are needed to confirm the relationships observed in this study on sleep deprivation.

However, several limitations also existed in this study. First, as these are cross-sectional observations, causation can only be speculative. Another potential limitation is that this study was based on self-reported data and therefore, there is potential for recall bias. Other potential limitations are: residual confounding due to additional confounding factors such as, details about ventilation, traffic noise, household illumination that were not collected in this study; misclassification of ever diagnosed non-communicable diseases/chronic disease conditions due to recall bias; and small sample cell

sizes for some of the reported chronic conditions. An objective assessment of sleep quality and duration was not obtained. Results cannot be generalized to any other First Nations although the tools and applications used could be transferrable.

5. Conclusions

In these two First Nation communities, 25% of the participants reported sleep deprivation. Associated risk factors were older age group, visible mold in the house, and males with nighttime insomnia symptoms. This was a unique study, which evolved with two First Nation communities in Canada, and will be helpful in the management of patients with sleep deprivation in these communities; as well as for co-creating policy with the communities and future research priorities.

Author contributions

Conceptualization, J.A.D., S.A., M.K., P.P., D.R., S.K., N.K., M.F., R.S. and the First Nations Sleep Health Project Team; Data curation, B.P.R., K.M.; Formal analysis, C.P.K.; Funding acquisition, J.A.D., S.A., M.K. and P.P.; Investigation, J.A.D., S.A., M.F., M.K. and P.P.; Methodology, J. A. D., P.P., S. A., M. K., C.P.K., M. F.; Project administration, P.P.; Resources, J.S., C.B., R.S., M.F., T.S.; Supervision, J.A.D. and P.P.; Visualization, S.A., J.S., C.B. and V.R.R.; Writing—original draft, C.P.K., J.A.D., P.P.; Writing—review & editing, J.A.D., C.P.K., B.P.R., K.M., S.A., D.R., S.K., N.K., J.S., C.B., V.R.R., M.F., M.K., T.S., and P.P.

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Abbreviations

FNSHP	First Nations Sleep Health Project
BMI	Body Mass Index
SD	Standard Deviation
OR	Odds Ratio
CI	Confidence Interval

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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