ORIGINAL RESEARCH ARTICLE

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Oral health in a First Nations and a non-Aboriginal population in Manitoba

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***Objectives*:** To analyze the prevalence of poor oral health and selected determinants in First Nations (FN) and Caucasian samples in Manitoba, Canada.
***Study design*:** Cross-sectional survey, nested in a cohort study.
***Methods*:** FN and Caucasian participants completed a questionnaire on socio-demographic variables, oral health symptoms, and oral health-related behaviours as part of a broader cohort study comparing these ethnic groups for different chronic immune mediated diseases.
***Results*:** Caucasians reported higher levels of employment, education, and urban dwelling than FNs ($p < 0.001$). FNs reported smoking more, and having poorer oral health-related behaviours than Caucasians ($p < 0.001$). After adjustment for age and sex, FN reported having more oral health symptoms than Caucasians (odds ratio (OR): 2.71; 95% confidence interval (CI): 1.73, 4.52), but the association was reduced and not statistically significant after adjustment for other socio-demographic variables (OR = 1.34; 95% CI: 0.58, 3.10). Oral health symptoms were associated with current smoking among FN (adjusted OR = 2.67, 95% CI: 1.05, 6.78). Oral hygiene behaviours were significantly related to smoking status, rural living and education for both groups.
***Conclusions*:** Oral health-related behaviours and smoking were found to be significant factors explaining poor oral health, which were lower for the FNs cohort than the Caucasian sample. However oral health and related behaviours were less related to their ethnicity than to socio-demographic factors, suggesting that policies to change behaviour will not result in lasting reductions in oral health differences between these groups in Manitoba.

Keywords: *oral health*; *oral health-related behaviours*; *smoking*; *First Nations*; *social determinants.*

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In the last decade, there has been increasing recognition that poor oral health has an impact on general health (1–3). Poor oral health can lower a person's quality of life, with symptoms such as oral pain, bleeding gums, dental decay and edentulism having negative effects on everyday functions such as eating, talking and interacting with others (4). These may also be an indication of their vulnerability to more serious periodontal diseases, including gingivitis and periodontitis, which can result in loosening of teeth, pain and discomfort, impaired mastication, and eventual tooth loss (5). Periodontal disease has also been associated with increased risk for oral cancer (6–10). Furthermore, poor oral health has been found to compound the health impacts of other diseases, including infectious diseases and diabetes, (1–2,5,11), and the oral micro-organism *Porphyromonas gingivalis* has been associated with periodontitis and rheumatoid arthritis (12,13).

In this paper, we report and discuss the findings from an analysis of oral health-related symptoms and behaviours among First Nations and Caucasians in Manitoba. The data for this analysis were collected as part of a cohort study designed to compare the First Nation and Caucasian communities of Manitoba in terms of the development of rheumatoid arthritis and inflammatory bowel disease. In addition to analyzing oral health related symptoms and behaviours, we examined associations with other lifestyle factors and

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socio-demographic variables to better understand the underlying and proximate determinants of poor oral health in these First Nation and Caucasian communities.

Material and methods

Sample selection

Our Canadian Institutes of Health Research Team Grant in Arthritis and Inflammatory Bowel Disease enrolled a cohort of Manitobans who either have Crohn's disease, ulcerative colitis or rheumatoid arthritis, along with a sample of healthy controls (without any auto-immune disease or first degree relatives with autoimmune disease). We enrolled only persons who were Caucasian or First Nation, and persons of mixed ethnicity were excluded. For this study we are only reporting survey results for the healthy controls among First Nation and Caucasian cohorts. Healthy controls of Caucasian and First Nation descent were recruited through advertisements posted in the University of Manitoba Health Sciences Centre specialty clinics and in the clinics of the participating First Nation communities.

Data collection

The study was approved by the University of Manitoba Research Ethics Board. Subjects completed surveys and underwent venipuncture for a separate aspect of the overall Team Grant study. Socio-demographic variables on the survey included age, sex, employment status, urban or rural residence, and education level. Levels of oral health were measured by asking a series of questions about oral health symptoms, including whether participants experienced bleeding gums while brushing, a metallic taste in the mouth, loose or drifting teeth, and tenderness or pain in the gums when food was stuck. In addition, information about oral health and other health-related behaviours was collected, including brushing, flossing, dental visits, use of dentures, tobacco smoking, and alcohol intake.

Statistical analyses

Differences between First Nation and Caucasian participants with respect to categorical variables were assessed using odds ratios and 95% confidence intervals, with chi-square tests to determine statistical significance. Comparisons for age as a continuous variable were made by comparing means and using the t-test for assessing statistical significance. The association between various socio-demographic characteristics and health behaviours and oral health behaviours were assessed using logistic regression models, separately for First Nation and Caucasians, and combined. For the purposes of our analyses, the frequency of each oral health measure was dichotomised, given a value of 0 if they responded "never" or "rarely", and given a value of 1 if they responded "sometimes", "often" or "always". Significance testing for the variables in Tables I and II was performed using cross-tabulation and chi-square analyses. For use in further multivariate analyses, a dichotomous composite measure for the 4 symptoms of oral health was created. Specifically, if a person reported having only 0 or 1 of these 4 symptoms as "sometimes", "often" or "always", then a value of 0 was assigned. Conversely, if they reported having 2 or more of the 4 symptoms "sometimes" "often" or "always", they were assigned a value of 1 for the composite measure. Binary logistic regression was performed using the composite measure of oral health symptoms (Table III) as well as oral hygiene behaviours (Table IV) as dependent variables, while adjusting for socio-demographic and behavioural characteristics as explanatory variables. Crude and adjusted odds ratios and p-values from these analyses were obtained and are presented in Tables III and IV.

Results

Demographics

The sample included 372 First Nations and 293 Caucasians (Table I). The mean age for the First Nations group was 36.4 years of age, compared to 45.6 years of age for Caucasians ($p < 0.001$). There was a significantly different pattern of education level between the 2 control groups ($p < 0.001$); 71.0% of the First Nations group had not obtained a high school degree compared to 5.8% of the Caucasian group. There was a greater proportion of rural residents among the First Nations group compared to the Caucasian group; 48.9 and 17.4% respectively ($p < 0.001$). There was also a significant difference between the 2 groups with respect to the proportion employed ($p < 0.001$), with 22.5% of First Nations versus 88.7% of Caucasians employed.

Individual risk factors

Overall, the Caucasian group reported brushing, flossing and dental visits more often than First Nations (Table II). Among the First Nations group, 44.8% brush 7 or more times per week, compared to 88.4% of Caucasians ($p < 0.001$); 20.5% of First Nations floss 7 or more times per week compared to 25.4% of Caucasians ($p < 0.001$); 47.2% of First Nations visit the dentist never or only for problems compared to 13% of Caucasians ($p < 0.001$).

Comparing the 2 groups, there was a significantly different pattern of smoking ($p < 0.001$). There were a greater number of current smokers among First Nations and a greater number of past and never smokers among Caucasians. Among current smokers, Caucasians have smoked significantly longer on average, though this may

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Table I. Summary of demographics of the study population

Characteristic	First Nations (n = 372)	Caucasians (n = 293)
Age group		
Mean	36.4 ± 1.19	45.6 ± 1.46†
Gender		
Male	137 (36.8%)	107 (36.5%)
Female	235 (63.2%)	186 (63.5%)
Highest level of education		
Less than Grade 9	67 (18.3%)	4 (1.3%)†
High school (Grade 9–11)	193 (52.7%)	13 (4.5%)
High School degree	55 (14.8%)	40 (13.7%)
Vocational training	5 (1.3%)	38 (13.1%)
Some college or university training	27 (7.3%)	63 (21.6%)
College or university degree	19 (5.1%)	122 (41.9%)
Master's or Ph.D.	1 (0.3%)	11 (3.8%)
Urban/rural residence		
Urban	189 (50.8%)	242 (82.6%)†
Rural	182 (48.9%)	51 (17.4%)
Employment status		
Currently unemployed	279 (77.5%)	33 (11.3%)†
Currently employed	81 (22.5%)	259 (88.7%)

*$p < 0.05$.
**$p < 0.01$.
†$p < 0.001$.
p values represent differences between Caucasian and First Nation populations.

be influenced by a higher average age ($p = 0.007$). Reported alcohol use also differed between groups ($p < 0.001$). While more Caucasians than First Nations indicated that they ever consume alcohol, 9.2% of Caucasians compared to 16.6% of First Nations drank more than 7 drinks per week ($p < 0.001$).

Oral health symptoms

Comparing the 2 ethnic groups, First Nations reported having more oral health symptoms than Caucasians overall (Table II). Based on chi-square analysis, the statistical difference between those who reported "never", "rarely", or "sometimes, often or always" was significant for bleeding gums from brushing ($p < 0.001$), tender or painful gums when food is stuck ($p < 0.001$), teeth feel loose or drifting ($p = 0.01$), and to a lesser degree, a metallic taste in the mouth ($p = 0.06$).

Associations with socio-demographic and risk factors

Table III shows the relationship between oral health, socio-demographic variables and oral hygiene behaviours. After adjusting for age and sex, First Nations were 2.71 times more likely than Caucasians to report having more than 2 oral problems sometimes, often or always [odds ratio (OR): 2.71; 95% confidence interval (CI): 1.73, 4.52; $p < 0.0001$], but this association became not significant after adjustment for all other variables (OR = 1.34; 95% CI: 0.58, 3.10, $p > 0.05$). Among all of the socio-demographic variables in the model, living rurally among Caucasians was the only factor that remained significantly related to oral health symptoms after adjustment (OR = 1.89, CI: 1.15, 3.09, $p < 0.05$).

Smoking habits correlated significantly with oral health symptoms for both First Nations and Caucasians. However after adjustment for other factors, among Caucasians only past smokers had significantly worse oral health than never smokers (OR = 7.04, 95% CI: 2.15, 23.10), while for First Nations, only current smokers had significantly worse oral health than never smokers (OR = 2.67, 95% CI: 1.05, 6.78).

For oral hygiene habits overall, more dental visits, brushing, and flossing teeth were all significantly associated with less reported oral health symptoms before adjustment. However, after adjusting for all other factors, only brushing remained a significant factor ($p < 0.05$), and particularly among Caucasians (OR = 0.30, 95% CI: 0.09, 0.98).

Logistic regression was also performed to determine the relationship between oral hygiene habits and the socio-demographic and other risk factors. Table IV presents the results of this analysis. Having education beyond a high school degree was significantly related to better oral hygiene habits, although this relationship was decreased after adjustment. After stratifying the

Table II. Summary of behaviour risk factors and oral health symptoms

Behaviour risk factors	First Nations (n = 372)	Caucasian (n = 293)
Brushing		
Never	19 (5.4%)	0 (0%)†
1–6 times per week	176 (49.9%)	33 (11.6%)
7–14 times per week	114 (32.3%)	146 (51.4%)
15+ times per week	44 (12.5%)	105 (37.0%)
Flossing		
Never	129 (36.6%)	52 (18.3%)†
1–6 times per week	151 (42.9%)	160 (56.3%)
7+ times per week	72 (20.5%)	72 (25.4%)
Dentist visits		
Never	30 (8.5%)	3 (1.1%)†
Only for problems	136 (38.7%)	34 (11.9%)
Every 1–3 years	40 (11.4%)	57 (20.0%)
More than once a year	145 (41.3%)	191 (67.0%)
Tobacco smoking		
Never a smoker	81 (22.3%)	155 (52.9%)†
Past smoker <10 years	17 (4.7%)	36 (12.3%)
Past smoker >10 years	17 (4.7%)	52 (17.7%)
Average number of years smoked among past smokers	10.1 (95% CI = 6.89, 13.2)	13.6 (95% CI = 11.54, 15.60)
Current smoker <1 pack per day	207 (56.9%)	35 (11.9%)
Current smoker >1 pack per day	42 (11.5%)	15 (5.1%)
Average number of years smoked among current smokers	15.1 (95% CI = 13.9, 16.4)	19.4** (95% CI = 16.3, 22.6)
Alcohol		
Never drink	122 (34.9%)	35 (12.0%)†
<1 drink per week	102 (29.1%)	111 (38.0%)
1–6 drinks per week	68 (19.4%)	119 (40.8%)
7+ drinks per week	58 (16.6%)	27 (9.2%)
Oral health characteristics		
Gums bleed while brushing		
Never	158 (45.1%)	110 (38.6%)†
Rarely	79 (22.6%)	119 (41.8%)
Sometimes, often or always	113 (32.3%)	56 (19.6%)
Metallic taste in mouth		
Never	278 (79.7%)	221 (77.8%)
Rarely	36 (10.3%)	46 (16.2%)
Sometimes, often or always	35 (10.0%)	17 (5.9%)
Teeth feel loose or drifting		
Never	286 (81.5%)	258 (90.5%)**
Rarely	29 (8.3%)	19 (6.7%)
Sometimes, often or always	36 (10.3%)	8 (2.8%)
Gums feel tender or painful when food is stuck		
Never	201 (57.1%)	157 (55.1%)†
Rarely	53 (15.1%)	76 (26.7%)
Sometimes, often or always	98 (27.8%)	52 (18.2%)

*p <0.05.
**p <0.01.
†p <0.001.
p values represent differences between Caucasian and First Nation populations.

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Table III. Association between oral health symptoms and socio-demographic and behavioural characteristics

	First Nations odds ratio (95% CI)	Caucasian odds ratio (95% CI)	Overall odds ratio (95% CI)	Overall odds ratio (95% CI)
Composite oral symptoms measure	*Adjusted‡ OR*	*Adjusted‡ OR*	*Age and sex-adjusted*	*Adjusted‡ OR*
Age				
	0.99 (0.96, 1.01)	0.99 (0.95, 1.03)	0.98 (0.97, 1.00)	0.99 (0.97, 1.01)
Gender				
Male	Ref	Ref	Ref	Ref
Female	0.95 (0.51, 1.76)	0.39 (0.14, 1.09)	0.75 (0.49, 1.16)	0.72 (0.43, 1.20)
Highest level of education				
Less than Grade 12	Ref	Ref	Ref	Ref
High school degree or more	1.03 (0.54, 1.99)	0.63 (0.13, 3.10)	0.57* (0.37, 0.89)	1.01 (0.55, 1.87)
Urban/rural residence				
Urban	Ref	Ref	Ref	Ref
Rural	1.76 (0.98, 3.16)	3.06* (1.09, 8.57)	2.47† (1.61, 3.80)	1.91* (1.15, 3.16)
Employment status				
Currently unemployed	Ref	Ref	Ref	Ref
Currently employed	1.35 (0.67, 2.73)	1.21 (0.27, 5.47)	0.73 (0.46, 1.14)	1.24 (0.66, 2.34)
Tobacco smoking				
Never a smoker	Ref	Ref	Ref	Ref
Past smoker	3.09 (0.9, 10.64)	7.04** (2.15, 23.10)	3.91† (1.83, 8.35)	4.51† (2.03, 10.02)
Current smoker	2.67* (1.05, 6.78)	3.03 (0.81, 11.32)	4.60† (2.46, 8.60)	3.10** (1.49, 6.45)
Alcohol				
Never drink	Ref	Ref	Ref	Ref
< 1 drink per week	1.46 (0.70, 3.04)	0.74 (0.41, 3.88)	1.25 (0.70, 2.22)	1.11 (0.57, 2.14)
1–6 drinks per week	0.83 (0.35, 1.99)	1.10 (0.24, 5.11)	0.92 (0.50, 1.72)	0.89 (0.43, 1.81)
7+ drinks per week	1.07 (0.45, 2.52)	2.08 (0.33, 13.26)	1.31 (0.64, 2.68)	1.17 (0.54, 2.55)
Ethnicity				
Non-First Nation			Ref	Ref
First Nation			2.71† (1.63, 4.51)	1.34 (0.58, 3.10)
Visit the dentist				
Never or only for problems	Ref	Ref	Ref	Ref
More than once a year or once every 1–3 years	0.72 (0.39, 1.07)	0.87 (0.22, 3.43)	0.46† (0.29, 0.71)	0.70 (0.41, 1.19)
Brush teeth				
Less than 7 times per week	Ref	Ref	Ref	Ref
7 or more times per week	0.56 (0.30, 1.07)	0.30* (0.09, 0.98)	0.34† (0.22, 0.53)	0.50* (0.29, 0.89)
Floss teeth				
Never	Ref	Ref	Ref	Ref
1 or more times per week	0.93 (0.49, 1.76)	1.80 (0.50, 6.50)	0.49* (0.26, 0.92)	1.06 (0.61, 1.86)

*p < 0.05; **p < 0.01; †p < 0.001.
‡ Adjusted for all variables in Table III.

groups and adjusting for all other risk factors, the Caucasian group showed a significant positive relationship between education and dental visits (OR = 3.99, 95% CI: 1.13, 13.75, p < 0.05), and among First Nations, education and brushing showed a significant positive relationship (OR = 3.17, 95% CI: 1.85, 5.45, p < 0.001). For both groups, living rurally was associated with fewer oral hygiene habits before and after adjustment (p < 0.05) (except flossing after adjustment), and this relationship was strongest among Caucasians. For First Nations, being employed was significantly related to fewer dental visits, although the majority were unemployed (OR = 0.52, 95% CI: 0.28, 0.95, p < 0.05). Current smoking status was associated with worse oral hygiene than never smokers for both groups, especially dental visits among Caucasians (p < 0.05).

Table IV. Association between First Nation (FN) status and socio-demographic characteristics and oral health related behaviours (adjusted ORs from logistic regression)

	Brushing OR (95% CI)			Flossing OR (95% CI)			Visiting dentist OR (95% CI)		
	FN	Non-FN	Overall	FN	Non-FN	Overall	FN	Non-FN	Overall
Ethnicity									
Caucasian			Ref			Ref			Ref
First Nation			0.40** (0.20, 0.80)			0.92 (0.46, 1.81)			0.28† (0.14, 0.55)
Age (in years)	0.99 (0.97, 1.01)	1.02 (0.99, 1.06)	1.00 (0.98, 1.03)	1.01 (0.97, 1.03)	1.01 (0.98, 1.04)	1.01 (0.99, 1.03)	0.97 (0.96, 1.01)	0.98 (0.96, 1.02)	0.98 (0.97, 1.00)
Gender									
Male	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Female	2.09** (1.24, 3.53)	3.77** (1.65, 8.60)	2.43† (1.59, 3.73)	2.85† (1.7, 4.78)	5.32† (2.66, 10.7)	3.52† (2.35, 5.25)	1.57 (0.94, 2.60)	2.25* (1.06, 4.96)	1.73** (1.16, 2.64)
Highest level of education									
Less than Grade 12	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
High school or more	3.17† (1.85, 5.45)	1.72 (0.42, 7.05)	2.89† (1.76, 4.73)	1.30 (0.74, 2.29)	2.01 (0.54, 7.47)	1.32 (0.78, 2.21)	1.57 (0.92, 2.68)	3.99* (1.13, 13.8)	1.80* (1.1, 2.98)
Urban/rural residence									
Urban	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Rural	0.67 (0.40, 1.10)	0.49 (0.19, 1.27)	0.60* (0.39, 0.94)	0.67 (0.40, 1.11)	0.41* (0.18, 0.93)	0.60* (0.40, 0.92)	0.91 (0.55, 1.43)	0.54 (0.22, 1.40)	0.78 (0.51, 1.19)
Employment status									
Currently unemployed	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Currently employed	1.58 (0.85, 2.94)	3.16* (1.06, 9.41)	1.66 (0.97, 2.84)	1.19 (0.63,2.25)	1.32 (0.45, 3.84)	1.23 (0.72, 2.10)	0.52* (0.28, 0.95)	1.76 (0.58, 5.37)	0.66 (0.38, 1.14)
Tobacco Smoking									
Never a smoker	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Past smoker	0.67 (0.26, 1.77)	1.18 (0.40, 3.48)	1.00 (0.51, 1.97)	1.50 (0.51, 4.44)	1.27 (0.54, 3.00)	1.36 (0.71, 2.59)	0.95 (0.36, 2.47)	2.42 (0.78, 7.55)	1.36 (0.69, 2.68)
Current smoker	0.54 (0.29, 1.01)	0.55 (0.20, 1.49)	0.59* (0.35, 0.99)	0.62 (0.32, 1.19)	0.94 (0.38, 2.32)	0.68 (0.41, 1.13)	0.57 (0.30, 1.06)	0.32* (0.13, 0.79)	0.49** (0.30, 0.80)
Alcohol									
Never drink	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
<1 drink per week	1.08 (0.58, 2.02)	1.05 (0.25, 4.45)	1.13 (0.65, 1.97)	1.63 (0.86, 3.10)	0.72 (0.22, 2.39)	1.44 (0.84, 2.47)	0.68 (0.37, 1.25)	2.17 (0.62, 7.56)	0.98 (0.58, 1.67)
1–6 drinks per week	1.07 (0.52, 2.19)	0.89 (0.23, 3.51)	1.05 (0.58, 1.92)	2.11* (1.01, 4.43)	0.98 (0.30, 3.19)	1.88* (1.06, 3.36)	1.34 (0.66, 2.71)	1.58 (0.50, 5.02)	1.34 (0.75, 2.40)
7+ drinks per week	0.90 (0.43, 1.87)	0.72 (0.14, 3.78)	0.84 (0.43, 1.64)	0.92 (0.44, 1.90)	0.30 (0.07, 1.19)	0.71 (0.38, 1.33)	0.74 (0.37, 1.51)	1.26 (0.27, 5.90)	0.85 (0.45, 1.61)

*p <0.05; **p <0.01; †p <0.001.

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Discussion

In this study, we report substantial differences in oral health symptoms, practices and socio-economic indicators between samples of First Nations and Caucasians. Our findings support previous studies done on oral health in Canada (1,14–17). A number of these studies have shown that oral health of First Nations populations is a noticeable public health issue (14,15,18–20). Most have collected and explored data on the oral health knowledge of children or caregivers (21–23), as well as data on measures of oral health among First Nations communities, particularly children (15,18–20). Fewer studies have compared the health of First Nations to the general population or examined adult populations. Ours is the largest study to date that has used multivariate analysis to report on oral health in Canada's First Nations on and off reserve.

In this study we found that compared to Caucasians, First Nations reported significantly more bleeding gums from brushing ($p < 0.001$), tender or painful gums when food is stuck ($p < 0.001$), and feeling teeth are loose or drifting ($p = 0.01$). This is similar to the findings of the Canadian Health Measures Survey (CHMS), in which 11.6% of Canadians on average reported the presence of oral pain often or always compared to 26.8% among Aboriginals in 2007–9 (4). In addition, 29.8% of Inuit people reported oral pain often or always according to the Inuit Oral Health Survey Report of 2008–9 (24). Other studies that have specifically reported on the oral health of First Nations in Canada include Brothwell and Ghiabi, who reported a higher prevalence of periodontitis among the Sandy Bay First Nation in Manitoba (65%) than in the general population of the United States (53.1%) (14). Concurrently, in their study of oral health differences between young Aboriginal and non-Aboriginal children in Ontario, Lawrence et al. reported that significant disparities in dental caries existed between the 2 groups (15).

Our First Nations and Caucasian controls came from very divergent socioeconomic backgrounds, and therefore we explored the impact this may have had on the comparisons between the oral health of these cohorts. Our sample of First Nations respondents is fairly representative of the proportion of the population of on and off reserve First Nations in Canada (25). The attainment of a high school diploma was lower in our sample for off reserve and higher for on-reserve First Nations than the average for Aboriginals in Manitoba, with 27.3% on reserve and 31.2% urban First Nations with a high school diploma in our study, compared to 23% on-reserve Manitoban Aboriginals and highest at 54.8% among Aboriginals between 40–49 living off reserve in Manitoba. Employment rates in our study were quite a bit lower than in the general population. Previously, it was reported that 61.4% Aboriginals were employed in Manitoba generally, compared to the findings in our study of 30% on reserve and 16% in the city for First Nations (32). Some of the differences in oral health between groups reflect the differences that exist in the socioeconomic status of these 2 populations broadly and some might reflect the bias of more First Nations recruited into the study from rural Manitoba compared with Caucasians, in part because they tend to have lower education and employment levels.

In our study, the difference in the oral health composite indicator between First Nations and Caucasians went from being significant to not statistically significant after adjusting for socio-demographic variables and oral-health related behaviours. The lower rates of employment and educational attainment among First Nations in this study compared to the general population may have contributed to the strength of this finding. Nonetheless, the decreased association of the oral health measures and ethnicity after adjustment for other factors indicates that socio-economic characteristics have an influence on oral health regardless of ethnicity. Also in support of this conclusion, we found that there was a significant difference in oral health symptoms between different education levels, urban or rural residence and employment status. This is consistent with past studies that have demonstrated the importance of socio-economic characteristics as determinants for oral health (10,26–31). These differences were greater for Caucasians than for First Nations people. This may be due to the fact that the First Nations group had consistently lower education levels, more rural residents and much less employed people overall, which is consistent with other reports on socio-economic status of First Nations in Manitoba (11,32).

Overall we found that better oral hygiene habits were positively correlated with less reported oral health symptoms, particularly brushing teeth and dental visits, confirming previous studies (14,16). In this study, First Nations reported poorer oral health symptoms as well as poorer oral hygiene behaviours on average than Caucasians. Comparing the Canadian Health Measures Survey and Inuit Oral Health Survey reports, there was also a greater percentage of the general population who reported oral-health-related behaviours including brushing twice a day, flossing at least 5 times a week or visiting the dentist in the last year than among the Inuit, which is seen as an important determinant of oral health (4,24).

In our analysis of the association between oral hygiene and socio-demographic characteristics we found that lower education, living rurally and smoking were all related to poorer oral hygiene habits. Brushing was the only oral health-related behaviour in the study significantly related to oral health symptoms among First Nations respondents after adjustment. Elsewhere, it has

been shown that people from a lower socioeconomic status are less likely to adopt healthy lifestyle practices (4,33,34). For example, the CHMS has reported that within the general population, those who had higher income, private insurance, and were never or past smokers reported brushing, flossing and visiting the dentist more (4). The finding that social determinants affect whether individuals adopt healthy preventive measures suggests that they may be at least as important in determining oral health outcomes as the behaviours themselves (1).

In our study, smoking status was also consistently related to oral health, with smokers experiencing more symptoms among both groups. In addition, smokers were found to have worse oral hygiene habits. This strong correlation decreased somewhat after controlling for other factors, yet remained significant particularly for First Nations. Similarly, the study among Sandy Bay First Nation in Manitoba found that smoking was positively associated with periodontal disease (15). We found that among Caucasians, ever smoking had a negative effect on oral health and hygiene compared to never smoking. Smoking is a well-documented risk factor for a variety of oral health problems, particularly among First Nations who have a higher smoking rate than Caucasians in Manitoba (4,35–39,41). Smoking is estimated to cause over 90% of cancers in the oral cavity, and is associated with aggravated periodontitis, tooth decay, and leukoplakia (mouth lesions that do not heal) (2). There is also a synergistic effect between smoking and alcohol consumption on an increased risk of oral cancer (6,38–40).

There are several limitations to our study. Our sample sizes were not large and sampling was not random, which may have resulted in sampling bias. For example, there was a higher enrolment of rural First Nations than rural Caucasians which may have impacted the average levels of employment, education and other behaviours. Because respondents enrolled in response to advertisements, they may have already been in greater contact with the health care system than those in the general population which may have skewed the data in a positive way. In addition, the differences between education level and employment rates in our samples compared to the general population will have affected our results, although the results we found are fairly consistent with previous findings on oral health and related factors. The use of physical oral examinations would have strengthened our findings. The addition of more previously reported factors influencing oral health would have provided a more nuanced understanding of the factors related to oral health. For example we did not include sugar intake (26), the existence of systemic diseases, such as diabetes that greatly affects First Nations populations (5,16), and environmental factors such as access to fluoridated water. Additional socio-economic variables including income and dental insurance that have been associated with oral health in past studies such as the CHMS would have added depth to the comparison on oral health between both urban and rural First Nations and Caucasians in Manitoba (4,41,42).

In summary, we report that oral health is significantly related to oral hygiene practices, access to dental services, and smoking. Additionally, our comparison of the oral health and related factors of First Nations and Caucasian groups suggests that not only do differences exist, but that the poorer oral health outcomes, oral hygiene, and more smoking among First Nations appears related to factors beyond preventive behaviours. The results of our study are consistent with other studies that have proposed a shift from the biomedical focus on behaviour change (3) towards a focus on addressing differences in broader social determinants of oral health like those described by the reports on the CHMS Oral Health Component and Inuit Oral Health Survey (1,4,24,27,30,42–44). The implication of such an approach is that in addition to focusing on oral health promotion and improved access to dental care for First Nations people in Manitoba, lasting improvements will most effectively be achieved through efforts to address a broad range of relevant issues that have been found to contribute to poor oral health.

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Conflict of interest and funding

Dr Charles Bernstein in the past 2 years has consulted to or served on advisory boards for Abbott Canada, Astra Zeneca Canada, Janssen Canada, Shire Canada and received research grants from Abbott Canada and Prometheus Laboratories and an unrestricted educational grant from Axcan Pharma. The other authors have no potential conflicts to report.

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